Applicant: **North Sun LLC** A wholly owned entity of 22c Development, LLC

APPLICATION FOR SOLAR FARM DEVELOPMENT PERMIT

MONTGOMERY COUNTY, ILLINOIS PIN 06-14-400-003

APRIL 2024 | VERSION 1

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22c

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1.0 INTRODUCTION

North Sun LLC, a wholly owned entity of 22c Development, LLC, (collectively, the "**Applicant**" or "**North Sun LLC**" or "**22c**"), hereby submits this application for a Solar Farm Development Permit (Application) to construct, operate, and maintain the North Sun LLC solar project, a proposed **up-to-10 MWac** commercial solar energy facility (Project) on a 75 acre parcel and spanning approximately up to sixty-five acres (Project Area) in Raymond Township in Montgomery County, Illinois. As shown on the Solar Farm Development Permit Plans in **Exhibit C**, the Project's site layout meets the required minimum road right-of-way setbacks and property line setbacks per Section F.2.f. of the Montgomery County Solar Ordinance No. 2023-23.

The Project will be sited over up to sixty-five acres of leased property bound to the north and west by agricultural fields, bound to the east by North Road, and bound to the south by N 21st Ave. The Project has partnered via an executed lease agreement with the Wood Family Partnership. The parcel is County Parcel ID 06-14-400-003 and will host the Project's infrastructure. The Project's current land usage can be characterized as cultivated agricultural fields. The project's proposed site entrance is located along North Road in the NE corner of the property, which is a township road at that particular point of the road on the norther portion of the subject property. This Project will ultimately deliver power to the electrical grid through two points of interconnection via the Ameren power lines on the east side of North Road.

22c is also in the midst of helping the Raymond Roundtree Drainage District record its primary easement for a 12" tile line on the property along North Road. This tile line is set back approximately sixty or so feet from the road with a 15 foot easement area set back from the tile centerline, so approximately 30 feet in width is the width of the primary easement the district has and will be recorded in 2024. 22c is helping get this easement recorded while also agreeing to a crossing for its access road which will be perpendicular to North Road for its points of interconnection with Ameren's new 34.5 kV line to Hillsboro and its point of access. None of the actual Project's panels or fence will be over the district tile and prior to construction 22c will furnish the district with a fully plotted and in-depth tile survey of the property for its records and for any legal updates required for the easement. 22c has worked directly with Mr. Wernsing this year to organize this plan and encourages county board members to contact Mr. Wernsing to review and confirm this plan. We highly value the protection of important district tile lines on properties we develop as this is the best farmland in the state and the solar project cannot and will not have any effects on its neighbors'. Any part of the district or property owner's tile that will and could be affected will be upgraded after the survey at the Applicant's cost during pre-construction to minimize any impacts.

Next, the Applicant has considered recent updates to the Montgomery County Solar Ordinance No. 2023-23, amended 06/13/2023, to ensure the Project meets the latest requirements and submits this Application to obtain a Solar Farm Development Permit (SFDP) from the Montgomery County Board.

In preparation for filing the SFDP application, the Applicant has reached out itself to certain neighbors to discuss any vantage point impacts from homes and has used its best effort to make the situation better. A month or so prior to the finalization and submission of this application 22c overnighted a letter to KENNETH & DIONNE MANZER who live on the already-screened property to the south. 22c received no response and will continue to try. 22c will also be attempting to contact ROBERT MULCH as well. Also in preparation for this application filing of the SFDP application, the Applicant or the county mailed through certified mailings per the county code all properties within 250' of the property line, per

Montgomery County Application for a Solar Farm Development Permit, to provide Project awareness and will follow all local notice guidelines as well for other properties at the appropriate time prior to the SFDP public hearing. The list of neighbors is provided in **Exhibit O: List of Neighbors**.

The Project team has also reached out to Montgomery County for application clarification and to provide a preliminary introduction of the project via a Teams Meeting on 3/15/2024. This was a positive meeting and caused the Applicant 22c to immediately reach out to Mr. Wernsing and to implement screening into its design of the solar system. The Applicant asked if screening would be preferred along the earner property line but ultimately came to the conclusion that would not be best given the district tile line which exists there currently. Finally, the project has an executed AIMA agreement with the Department of Agriculture for the property and a fully signed and paid for interconnection agreement with Ameren which resulted in a commitment of nearly $500,000 from the Applicant to Ameren. The Applicant is invested in this county and has been very diligent and thoughtful in doing this the right way for the county to review.

If the Application is approved and a Building Permit is secured, construction of the Project is scheduled to commence in November of 2025. 22c feels this is a proper place for solar development due to its proximity to a 34.5 kV line and it not being near subdivisions or many homes. We look forward to presenting our project and getting to hear the county's feedback.

Thank you so much- Sincerely, from 22c and Kimley-Horn.

22c is an IL based small company on a clear mission: 1. To help prepare the world for the next century through sustainable infrastructure investments primarily through community solar & 2. To help prepare students for the clean energy revolution by supporting education, mentorship, and professional development locally in Uptown, Chicago and other cities in the Chicagoland area.

22c has no foreign investors, is wholly owned by IL residents, and will see you soon! Thank you.

2.0 PROJECT DESCRIPTION

The Project Area is currently cultivated cropland. The Project, if approved, will be a ground-mounted solar energy system comprised of solar photovoltaic (PV) modules, a racking system, inverters, and underground electrical conduits connecting PV array blocks with inverters. The access road, with a gated entrance, is located on the site for access and maintenance of inverters as well as construction access.

Proposed site access to existing roads will be limited to the driveway off of North Road shown on the Solar Farm Development Permit Plans, provided in **Exhibit C**. The existing access will be improved during Final Engineering and Construction. Security fencing will enclose the perimeter of the Project, with road access secured through locked metal gates and a vegetative buffer to the south. The southwest portion of the site not containing arrays will continue to be farmed for the duration of the project. A series of internal access roads will be used to provide access to Project equipment for future maintenance. These roads are typically gravel and will be verified upon final design with the geotechnical engineer recommendations.

One (1) landowner, Kevin Wood (Wood Farms Inc.), has signed agreements to participate in the Project. The parcel trustees are as follows:

> Wood Farms Inc. as to an undivided 1/4 interest, Trustee of the Kevin D. Wood Revocable Trust dated March 27, 1995 as to an undivided 1/8 interest, Trustee of the Bonnie R Wood Revocable Trust dated March 27, 1995 as to an undivided 1/8 interest, Trustee of the Dana M. Morris Revocable Trust dated November 4, 2009 as to an undivided 1/4 interest and Brian Wood as to an undivided 1/4 interest.

2.1 SOLAR FARM DEVELOPMENT PERMIT FINDINGS OF FACT

A. Will the proposed design, location and manner of operation of the proposed Solar Garden or Solar Farm adequately protect the public health, safety and welfare, and the physical environment?

The proposed design, location and manner of operation of the proposed Solar Farm will adequately protect the public health, safety, and welfare, and the physical environment. The proposed Solar Farm is a passive use that does not produce any noxious fumes or odors and will generate no sound beyond the boundaries of the property, which will not only protect the adjacent agricultural uses, but will also protect the property for long-term agricultural use. The Solar Farm will also result in clean energy production with positive outcomes for public health. Finally, the Project will be enclosed by a locked fence and inaccessible to trespassers and vandals.

B. Will the proposed Solar Garden or Solar Farm have a negative impact on the value of neighboring property?

The Solar Farm will not have a negative impact on the value of neighboring property. Solar farms are compatible developments with traditional agricultural, rural, and residential uses of land. Adjacent property owners will feel little to no change in the pre-existing use and enjoyment of their property, and as

established by various studies, the Solar Farm will not substantially diminish property values for adjacent uses.

The Solar Farm will contribute to the general welfare of the community by paying significantly more in property taxes than the property currently generates, creating new local jobs, and injecting capital into the local economy.

C. Will the proposed Solar Garden or Solar Farm have a negative impact on public utilities and on traffic circulation?

The Solar Farm will not have any negative impacts on public utilities or traffic circulation. The Solar Farm will provide for all reasonably necessary public utilities, access roads, drainage facilities without materially disturbing adjacent landowners or the community in general. Further, the Solar Farm will contribute clean energy to the local electrical infrastructure. As part of the Solar Farm, an access road will be developed and Applicant will study water runoff and drainage, and conduct a survey of drain tiles on site, and will address any issues identified in these studies. The stipulations of the AIMA require all projects to avoid drain tiles, re-route them or repair them if damaged.

The Solar Farm will provide adequate measures for ingress and egress so designed as to minimize traffic congestion on project right of ways. The Solar Farm will generate a marginal increase in traffic during construction and several vehicles per quarter for maintenance and inspection during the operation of the Solar Farm once construction is completed.

D. Will the proposed Solar Garden or Solar Farm have an impact on the facilities near the proposed Solar Garden or Solar Farm, such as schools or hospitals or airports that require special protection?

The proposed Solar Farm will not have an impact on the facilities near the Solar Farm and the proposed Solar Farm will not have an impact on schools, hospitals, or local airports. The Solar Farm is not located near a school, hospital or airport. The proposed Solar Farm is a passive use that does not produce any noxious fumes or odors and will generate no sound beyond the boundaries of the property. The Solar Farm will generate clean energy which can serve local uses including schools, hospitals, and airports.

2.2 INTERCONNECTION FACILITIES

The up to 10.00 MW system has approved applications for interconnection on the existing North Road 34.5 kV power line that runs directly south to the Hilsboro substation. See **Exhibit B** for the Project's Interconnection Agreement.

2.3 PROJECT CONSTRUCTION

Dust and noise from construction will be mitigated with industry standard best management practices. Work hours will be limited to 9am – 5pm, Monday through Friday, or as otherwise directed by the County. Below is a high-level construction schedule including number of vehicle trips.

Estimated Vehicles During Construction				
Time Period	**Construction Activity**	**Estimated Increase in Vehicles (All Vehicles)**	**Estimated Total Vehicles Per Day**	**Estimated Total Heavy Vehicles Per Month**
Month 1	Mobilization, Site Clearing, Erosion Control, and Initial Access Drive Improvements	8 – 10 personal vehicles per work day, 3 – 6 contractor vehicles per work day, 1 – 2 material deliveries (tractor-trailer trucks, tandem dump trucks) per work day, 1 – 2 equipment delivery (30-foot bed, box trucks) per week	13 – 20	24 – 48
Months 2 – 5	Fence, Solar Array, and Final Access Road Improvements	20 – 30 personal vehicles per work day, 6 – 8 contractor vehicles per work day, 3 – 4 material deliveries (tractor-trailer truck) per work day, and 1 – 2 equipment deliveries (30-foot bed, box trucks, concrete trucks) per work day.	30 – 44	80 – 120
Month 6	Commissioning and Demobilization	6 – 8 personal vehicles per work day, 3 – 6 contractor vehicles per work day, and approx.. 1 equipment removal (tractor-trailer truck) per week.	9 - 14	4

All equipment uses and operations will be conducted to avoid impeding the flow of traffic on adjacent roadways. Contractor shall maintain access to adjacent landowners for the duration of the project construction. The Contractor shall be fully responsible to provide signs, barricades, warning lights, guard rails, and employ flaggers as necessary when construction endangers either vehicular or pedestrian traffic. These devices shall remain in place until the traffic may proceed normally again. Equipment will operate in the road right-of-way only to add gravel and make minor improvements to proposed site access driveways. Project construction shall ensure all equipment is properly maintained and equipped with manufacturer's standard noise control devices. Overweight/Oversize Permits will be acquired from the Illinois Department of Transportation prior to the issuance of a Building Permit.

2.4 HEALTH AND SAFETY

During the Building Permit process, the Project will coordinate with the appropriate fire safety personnel to ensure adequate plans and systems are in place in the unlikely event a safety issue emerges.

Appropriate signage containing necessary contact and safety information for the solar farm will be displayed in accordance with local code and coordination with staff.

Upon request, a walk-through of the site with the local authorities and emergency agencies will be scheduled once construction is complete. Emergency personnel will also be given the key or code to access the facility. An analysis of the health and safety effects of solar farms in general conducted by others has been included in **Exhibit K**.

Solar farms do not raise concern for fire and explosive hazards. The solar panels and racking, which comprise most of the Project's equipment, are not flammable. Tempered glass offers protection from heat and the elements, and the panels are designed to absorb heat as solar energy. From a study titled Health and Safety Impacts of Solar Photovoltaics by North Carolina State University:

> "…Concern over solar fire hazards should be limited because only a small portion of materials in the panels are flammable, and those components cannot self-support a significant fire. Flammable components of PV panels include the thin layers of polymer encapsulates surrounding the PV cells, polymer back sheets (framed panels only), plastic junction boxes on rear of panel, and insulation on wiring. The rest of the panel is composed of non-flammable components, notably including one or two layers of protective glass that make up over three quarters of the panel's weight." (Cleveland, 2017, p.16).

Refer to **Exhibit K** for the Health and Safety Impacts of Solar Photovoltaics study.

2.5 OPERATIONS AND MAINTENANCE

Once constructed, the solar farm will operate throughout the year, passively generating renewable energy. The site and equipment will be designed, approved, maintained, and inspected to ensure safety and security. Maintenance activities during operation are expected to be minimal with occasional service for inverters and transformers. Solar panels are monitored remotely. Traffic is not anticipated to increase during the operations of the Project.

Maintenance operations will likely be carried out rarely and with minimal traffic as only one vehicle will likely be needed to carry out maintenance tasks several times a year. To prevent shading of the panels for solar energy production and maintain aesthetics of the Project, an on-going vegetation maintenance program will be implemented for all vegetated areas within the fenced boundary and buffer areas. After construction is complete and stabilized vegetation has been established within the leased area, the Project will conduct vegetative management at appropriate frequency based on weather and moisture conditions. This management schedule would continue each year until implementation of the Decommissioning Plan, included in **Exhibit D**.

3.0 FEDERAL AND STATE APPROVALS, PERMITS, AND AGREEMENTS

3.1 FEDERAL AVIATION ADMINISTRATION (FAA)

The FAA's policy for Solar Energy System Projects on Federally Obligated Airports only requires glint and glare screening for solar projects located on federally-obligated towered airports. Since this project is not on an airport, it does not require a glint and glare screening. Per Montgomery County Solar Ordinance section F.2.g, it is required for solar farms within 500' of an airport to provide the results from the Solar Farm Glare Hazard Analysis Tool (SGHAT). Based on the result of the FAA Notice Criteria Tool included in **Exhibit I**, the coordinates of this project and structure heights "do not exceed notice criteria", therefore the Project is not required to complete the SGHAT.

3.2 FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) portal was consulted to determine if any FEMA 100-year floodplains are on the site. The FEMA Firmette, included in **Exhibit J**, effective 01/09/1981, shows no floodplain present within the project boundary.

3.3 U.S. FISH & WILDLIFE SERVICE (USFWS)

The Project will be designed such that federally listed species will not be significantly impacted. Solar projects typically impose only minimal impacts on wildlife species. North Sun LLC evaluated the Project's potential to impact federally protected species. The assessment performed by Kimley-Horn identified four species of plants and animals that may be present within the project area: *Myotis sodalist* (Indiana Bat), *Perimyotis subflavus* (Tricolored Bat), *Grus americana* (Whooping Crane), and *Danaus plexippus* (Monarch Butterfly). Please see **Exhibit G** for more information on mitigation efforts and details of each species. Prior to construction, consultation with the USFWS will occur to confirm a "No Effect" determination for these species.

3.4 ILLINOIS DEPARTMENT OF NATURAL RESOURCES (IDNR) STATE ECOLOGICAL REVIEW

The Applicant consulted with IDNR for potential impacts to state threatened or endangered species. This consultation is conducted pursuant to IDNR's EcoCAT process. EcoCAT refers to IDNR's Ecological Compliance Assessment Tool (EcoCAT). EcoCAT contains the Section, Township, and Range data of the Project and generates a Project map. Species of concern within the identified Project Area (and/or which may be affected by migrating through or, by reason of the Project, avoiding the identified area) are examined as part of the EcoCAT review process.

EcoCAT requires that state agencies and units of local governments consider the potential adverse effects of proposed actions on Illinois endangered and threatened species and sites listed on the Illinois Natural Areas Inventory.

The Applicant submitted an EcoCAT review request to IDNR in March 2024. The Applicant consulted with IDNR through the department's online EcoCAT program for potential impacts to the State threatened or endangered species. The Applicant received a formal response letter, dated 03/06/2024, from IDNR's

EcoCAT review provided in **Exhibit F**. The review indicated there is no record of State-listed threatened or endangered species, Illinois Natural Area Inventory sites, dedicated Illinois Nature Preserves, or registered Land and Water Reserves in the project area. In other words, pursuant to 17 III. Adm. Code Part 1075, the IDNR consultation is terminated.

3.5 ILLINOIS HISTORIC PRESERVATION REVIEW (SHPO)

Under the Illinois State Agency Historic Resources Protection Act, the State Historic Preservation Office (SHPO) division at IDNR is responsible for studying possible Project effects on archaeological and/or architectural (cultural) resources. Agencies requiring SHPO evaluation concurrent with their review include the Illinois Environmental Protection Agency, IDNR, and USACE. The Project contacted the SHPO to determine if any historic or archaeological sites are located within the Project Area. the Project submitted to SHPO on 04/01/2024. Prior to construction, a Phase 1 Archaeological Reconnaissance Survey will be completed, if required by SHPO.

Confirmation of submittal to SHPO has been included in **Exhibit H**.

3.6 ILLINOIS ENVIRONMENTAL PROTECTION AGENCY (IEPA) – SWPPP

IEPA's Bureau of Water is responsible for overseeing the issuance of permits within the National Pollutant Discharge Elimination System (NPDES) program that regulates construction stormwater discharges. Permits require a Storm Water Pollution Prevention Plan (SWPPP), which is a site-specific document that outlines the measures a project will take to reduce pollutants in the stormwater discharges from a construction site. Stormwater controls reduce silt transport and sedimentation during precipitation events.

Prior to construction, the Project will prepare a SWPPP as well as sediment and erosion control plans for submittal and approval for an NPDES Permit through IEPA. The SWPPP will ensure construction activity compliance with guidelines and regulations for controlling sediment and erosion runoff. A preliminary SWPPP has been included in **Exhibit P**.

3.7 ILLINOIS DEPARTMENT OF AGRICULTURE (IDOA)

The Illinois Renewable Energy Facilities Agricultural Impact Mitigation Act (505 ILCS 147/1 et seq.) requires the owner of a commercial solar energy facility to have an Agricultural Impact Mitigation Agreement (AIMA) in place within 45 days prior to the commencement of Project construction. The intent of the AIMA is to preserve and/or restore the integrity of affected agricultural land during construction and decommissioning activities. Illinois State Legislature passed Amendment to House Bill 4412 in January 2023 and is now Public Act 102-1123. The Amendment requires that facility owners enter into an AIMA prior to the date of the required public hearing. The Project entered into an agreement on January 22, 2024, which is included as **Exhibit E**.

4.0 MONTGOMERY COUNTY SOLAR ORDINANCE AND OTHER LOCAL APPROVALS

The Project will comply with Montgomery County Solar Ordinance No. 2023-23 (amended 06/13/2023), as described below and as shown on the Solar Farm Development Permit Plans, included as **Exhibit C**. The Project will be a ground-mounted solar energy system comprised of solar photovoltaic (PV) modules, racking system, inverters and medium voltage transformers, and underground electrical conduits connecting PV array blocks with inverters. The access road with a gated entrance shall be located off of North Road, north of the intersection of N 21st Ave and North Road, for site maintenance, maintenance of inverters, as well as construction access.

4.1 HEIGHT REQUIREMENTS

The Montgomery County Solar Ordinance section C.9, requires solar arrays to be no more than thirty (30') feet in height. However, the Project will comply with Public Act 102-1123 (55 ILCS 5/5-12020) which states that no component of a solar panel, cell or modules may exceed twenty (20) feet in height above the ground at full tilt.

4.2 SETBACKS

Per Section F.2.f of the Montgomery County Solar Ordinance, solar farms are subject to at least the following setbacks and shall be measured from the exterior of the proposed perimeter fencing:

i. Fifty (50) feet from all property lines of the parcel land upon which the Solar Farm is located or to be located.

ii. Fifty (50) feet from the right-of-way of any public road.

iii. One hundred and fifty (150) feet from the nearest point of the outside wall of any occupied community building or dwelling.

The Project will adhere to the requirements set forth above. The Project demonstrates its compliance in the Solar Farm Development Permit Plans, included as **Exhibit C**.

4.3 GLARE

To comply with Section F.2.h. of the Montgomery County Solar Ordinance, the solar energy system shall be designed, constructed, and sited to minimize glare or reflections on adjacent properties and roadways and to not interfere with traffic, including air traffic, or otherwise create a safety hazard. The Project is designed to meet the required setbacks and the proposed solar panels include an anti-reflective coating. Utilizing these measures, the Project will not adversely affect nearby properties or traffic.

4.4 SOILS AND GROUND COVER

Per Section F.2.a of the Montgomery County Solar Ordinance, vegetative screening is required around the perimeter of the solar farm's exterior fencing. The Solar Farm Development Permit Plans, included as **Exhibit C**, has proposed vegetative screening along all parts of the solar farm visible to existing dwellings. Section F.2.a also states that vegetation must be maintained such that noxious weeds are

controlled or eradicated consistent with the Illinois Noxious Weed Law. The Project has developed a Vegetation Maintenance Plan, attached as **Exhibit N**, that includes requirements for mowing, reseeding, and weed management practices.

Per Section F.2.b, a qualified engineer shall certify that the foundation and design of the solar panels racking and support is within accepted professional standards, given local soil and climate conditions. See record of this certification from a State of Illinois registered structural engineer in **Exhibit M**.

4.5 SECURITY BARRIER

Per Section F.2.i-j. of the Montgomery County Solar Ordinance, a fence of at least six (6) feet and not more than twenty-five (25) feet in height shall enclose and secure the Solar Farm. Gates shall also be at least six (6) feet in height and must be equipped with locks to lessen the likelihood of unauthorized entry to the Solar Farm. The Project will adhere to the security barrier requirements set forth in the Montgomery County Solar Ordinance.

4.6 NOISE

Solar farms must provide proof of compliance with noise regulations of the Illinois Pollution Control Board. Manufacturer's sound power level characteristics will be included as a demonstration of compliance with the applicable requirements. The Project has been designed to locate all noise-emitting equipment (inverters and transformers) in the center of the project, furthest away from the surrounding properties. See proof of compliance in the Noise Analysis included in **Exhibit T**.

4.7 LIGHTING

If lighting is provided at the site, lighting shall be shielded and downcast such that the light does not spill onto the adjacent parcel. However, due to the proposed security fence and the nature of the operations of a solar energy facility, additional lighting is not typically needed.

4.8 DECOMMISSIONING PLAN

A Decommissioning Plan is included in **Exhibit D** to ensure the solar facility elements will be properly removed after the solar energy system is inoperable for 6 months. The Decommissioning Plan was developed in accordance with both Section G of the Montgomery County Solar Ordinance and the AIMA. The Decommissioning Plan outlines a strategy for the removal of Project components such as panels, roads, fences, and racking, including any applicable recyclable items once the solar facility is no longer in use. The Decommissioning Plan also includes the removal of landscape and restoration of soil and vegetation. The combination of the native grasses and pollinator friendly seed mix established during the Project life and temporary rest of the soils from agricultural planting will promote soil restoration and more productive farmland after decommissioning.

Prior to commercial operation, the Applicant shall provide Montgomery County with a decommissioning bond to ensure proper decommissioning at the end of the Project life.

4.9 STORMWATER AND NPDES

During final engineering, the pre- and post-drainage areas shall be analyzed for quantity of runoff in the 10-year and 100-year storm events. This analysis is anticipated to show an overall decrease in runoff quantity in the post-condition. This expectation is supported by the Hydrologic Response to Solar Farms (included in **Exhibit L**), an article by USACE which analyzes the hydrologic patterns of a typical solar farm. The industry standard follows this article and assumes that a change in use from row crop to meadow in developing a commercial solar energy facility will reduce runoff.

The National Pollutant Discharge Elimination System (NPDES) is a federally mandated program established under Section 402 of the Clean Water Act. Its goal being to protect, preserve, and improve the Nation's water resources by controlling polluted storm water runoff. To ensure adequate runoff, a NPDES Permit will be applied for and received prior to the commencement of construction activities.

4.10 STANDARDS AND CODES

Per Section E.2-6 and F.2.c of the Montgomery County Solar Ordinance, the Project must comply with the State of Illinois Uniform Building Code, State Electric Code, State Plumbing Code, State Energy Code, State Drainage Laws, and all applicable local, state, and federal regulatory codes. The Applicant understands these requirements and all final engineering documents shall be designed in accordance with these standards.

Per Section F.2.d, all on-site power lines and utility connections must be placed underground unless otherwise expressly approved. The Project will route all medium-voltage electrical lines underground within the Project security fence in accordance with the National Electric Code. The proposed interconnection to existing Ameren power poles shall comply with the Interconnection Agreement with the utility provided.

4.11 AVOIDANCE AND MITIGATION OF DAMAGES TO PUBLIC INFRASTRUCTURE

The Project Team has identified all public roads to be used for transporting materials, construction, operation, or maintenance of the Commercial Solar Energy Facility. These roads were identified using IDOT approved truck routes and are outlined in the Transportation and Access Plan, found in **Exhibit R**. The Project team has also sent a letter to all authority having jurisdiction of these roads to inform them of the project. Records of this Roadway Coordination Correspondence can be found in **Exhibit S**. Any necessary Overweight/Oversize Permits will be acquired from the Illinois Department of Transportation prior to the issuance of a Building Permit.

5.0 CONCLUSION

The North Sun project adheres to all requirements of Montgomery County and State of Illinois and should qualify for a Solar Farm Development Permit to construct a solar farm on North Road in Raymond Township, Montgomery County. North Sun LLC, a wholly owned entity of 22c Development, LLC, seeks a Solar Farm Development Permit that can be transferred if North Sun LLC is sold by 22c Development.

EXHIBIT A: SOLAR FARM DEVELOPMENT PERMIT APPLICATION

Montgomery County, State of Illinois
#1 Courthouse Square, Hillsboro, IL 62049
217-532-9530
http://montgomeryco.com/

APPENDIX A

PETITION / APPLICATION / REQUEST FOR A Solar Farm or Solar Garden Construction Permit. (Revised and effective 6-13-2023)

It is the responsibility of petitioners or requesters of actions placed before the Montgomery County Board to provide specific information and supporting data regarding proposed actions/projects in sufficient detail that will allow a decision to be made or a final course of action chosen. The Board shall not accept a petition or request as properly filed that is not sufficiently detailed, is missing information required by Ordinance, or does not provide sufficient sealed and signed professional studies, reports, and construction documents to support the request or petition based on the reasoned judgment of the Board. The Board is not responsible to make corrections or revise requests/petitions. Incomplete Applications will be returned.

Certain requests, such as a petition / application for a Solar Farm or Solar Garden Construction Permit requires, the Board to conduct a Public Hearing on the matter. No Hearings will be scheduled until such time that petitions/requests have been "Accepted as Properly Filed" by the Board. Similarly, Petitions/Requests shall not be placed on a Board meeting agenda until such time that the petition/request has been "Accepted as Properly Filed" by the Board.

The Date on which the Petition / Application / Request is "Accepted as Properly Filed" constitutes the Legal Beginning Date of any such Construction for all purposes of defining whether a project has been initiated or was is progress in Montgomery County, Illinois.

This petition/application/request for a Solar Farm or Solar Garden Construction Permit shall be completed in its entirety and submitted to the Montgomery County Board, #1 Courthouse Square, Hillsboro, IL, 62049. Once the petition / application for a Solar Farm or Solar Garden Construction Permit is Accepted as Properly Filed by the Board. The application for a Solar Garden or Solar Farm will be reviewed by an independent engineer, appointed by the County at the Petitioners expense, to determine the impact of the use on public utilities, traffic volume and circulation, impact on near-by properties, compliance with Ordinances and laws, and other lawful factors as may be determined reasonable by the Board based on the individual Petition/Application. The Board, following a Public Hearing, prepares its Findings of Facts and may then take action regarding issuance of a Construction Permit.

Notice of the Public Hearing.
The County Board shall hold a Public hearing within sixty (60) days of receiving reviewed information from the independent engineer. At the hearing, any interested party may appear and testify, either in person or by duly authorized agent or attorney. Notice indicating the time, date, place, and the nature of the proposed Solar Farm or Solar Garden Construction Application, shall be given, according to Para. D2. of the Ordinance, before the hearing by:

1. First class mail to the applicant, and to all parties whose property would be directly affected by the proposed use; and
2. Publication in a newspaper of general circulation within this County; and
3. Publication on a state-wide web site.

The Petitioner / Applicant / Requestor is responsible to mail the notices to the last known property tax bill address by PIN number, and submit a Post Office certificate of mailing record to the County but only after receiving the approved text of the Notice from the County. This is at the Petitioner's /Applicant's / Requestor's sole expense.

Properly completed Applications for a Solar Farm or Solar Garden Construction, complete with supporting documentation, are to be submitted to the County Board with sufficient lead time for review based on the complexity of the individual request.

All petitioners, or their representative, must attend the County Board meeting(s) considering their request. If there is no representation the application may be removed from the agenda and rescheduled.

The Montgomery County Board shall make a decision within sixty (60) days of the Public Hearing.

If you have any questions, please contact the Montgomery County Coordinating office at 217-532-9577.

SECTION BELOW TO BE FILLED OUT BY COUNTY OFFICIAL:

Date first Received by the Office of The Montgomery County Board: _____

Date(s) County Board Date Returned application for more information (if applicable):

_____ _____

Date County Board requested revisions were received (if applicable): _____

Date accepted by County Board as properly filed: _____

Filing fee of $2,500.00 Date paid: _____ Check number: _____

Date County acceptance letter is sent to Petitioner: _____

Date of required Public Hearing Notice sent to Petitioner: _____

Date(s) published and where published:

_____

_____

Date notices sent: _____ Public hearing date: _____

County Board determination: _____

_____

APPLICANT & PROPERTY OWNER INFORMATION (Print or Type):

Applicant/Petitioner information: _____

Company Name: North Sun LLC,. a subsidiary of 22c Development, LLC.

Contact Name and Title: Alex Farkes (Owner)

Phone number: (779) 774-5151

Mailing address for all official correspondence unless a Legal Representative is designated in which case all correspondence and contact will be made with that Legal Representative:

_____ Zip: _____

Property Owner Name(s): Kevin Wood

Phone number: _____

Mailing address: 10146 N 21st Ave, Raymond, IL Zip: 62560

Designated Legal Representative *(licensed to practice law in the State of IL)* of Applicant *(if any)*

Name: Mark Gershon (mgershon@polsinelli.com) Phone: (847)-710-2127

Address: 150 N. Riverside Plaza, Suite 3000, Chicago, IL Zip: 60606

Designated Contact Person *(if different from Applicant),* to whom all phone calls, requests for information, clarifications, and coordinator for all actions regarding this Petition, who has the authority to act on behalf of the Petitioner in regard to this Petition/Application/Request. *This does not apply if a Legal Representative has been designated in which case all contact will be made through that Legal Representative.*

Name: Sean Hickey, P.E. Phone: (708)-267-7810

Address: 570 Lake Cook Road, Deerfield, IL Zip: 60015

PROPERTY INFORMATION:

Note: If additional space is needed, please attach additional sheets to the application and reference attachment description in application.

1. Location of the proposed use or structure, and its relationship to existing adjacent uses or structures:
   The Project is sited over approximately 49 acres of leased property bound to the north and west by agricultural fields, bound to the east by North Rd, and bound to the south by N 21st Ave.

2. Legal Description and Acreage: Parcel Acreage: 75 acres.
   Parcel Legal Description: The south half (S 1/2) of the southeast quarter (SE 1/4) of Section fourteen (14), Township ten (10) north, Range four (4) west of the third principal meridian, Montgomery County, Illinois, excepting that part described as follows: Commencing at the intersection of the centerline of F.A. Route 166 as recorded in the recorder's office of Montgomery County in Plat Book 1 on page 95 and the west line of the southeast quarter (SE 1/4) of said Section fourteen (14), thence south 88 degrees 26 minutes 20 seconds east and along the centerline of said F.A. Route 166 a distance of 1006.62 feet; thence north 01 degree 33 minutes 40 seconds east a distance of 40 feet to an iron pin set on the north right of way line of said F.A. Route 166, the point of beginning of the tract herein described; thence continuing north 1 degree 33 minutes 40 seconds east a distance of 435.60 feet to an iron pin; thence south 88 degrees 26 minutes 20 seconds east and parallel with the centerline of said F.A. Route 166 a distance of 500.00 feet to an iron pin; thence south 01 degrees 33 minutes 40 seconds west a distance of 435.60 feet to an iron pin set on the north right of way line of said F.A. Route 166; and thence north 88 degrees 26 minutes 20 seconds west and along the north right of way line of said F.A. Route 166 a distance of 500.00 feet to the true point of beginning.

3. Area and dimensions of the site for the proposed structure(s) or uses.
   See the **Solar Farm Construction Permit Plans** included as **Exhibit C.**

4. Present Use of property:
   Agricultural fields

5. Present Land Classification: Agricultural

6. Proposed Land Use Activity / Nature of the Proposed Use, including type of activity, manner of operation, number of occupants or employees, and similar matters:
Proposed use: Solar Farm

See the **Narrative** included with this application for more details.

7. Height, setbacks, and property lines of the proposed uses and/or structure(s).
See the **Narrative** and the **Solar Farm Construction Permit Plans** included in **Exhibit C.**

8. Location and number of proposed parking/loading spaces by type of vehicles, to include Weight Classifications and size of access drives/ways. The Project has no proposed parking.
See the **Solar Farm Construction Permit Plans** included in **Exhibit C** for proposed drives.

9. Existing and proposed screening, lighting (including intensity) landscaping, erosion control, and drainage) features on the site, including the parking areas.
See the **Solar Farm Construction Permit Plans** included in **Exhibit C.**

10. Disclosure of any potential environmental issues and methods for dealing with them.

See the **Narrative** for environmental studies/consultations performed.

11. Disclosure of any activities requiring outside agency permits and the names, addresses, and phone numbers of the agency points of contact and how those requirements are being met.
See the **Narrative** included with this application.

12. Indicate the suitability of the property in question for Construction:
See the Structural Engineer Certification included in **Exhibit M** for certification that the soils

are suitable for the construction of a solar farm.

13. ADJACENT LAND USE:

A. North: Agricultural

B. South: Residential and Agricultural

C. East: Agricultural

D. West: Agricultural

15. Should this Use be valid only for a specific time period? Yes _____ No X

If Yes, what length of time? _____

16. Does the proposed Permit meet the following standards? Yes X No _____ *(If not, attach a separate sheet explaining why.)*

A. Will the proposed design, location and manner of operation of the proposed Solar Garden or Solar Farm adequately protect the public health, safety and welfare, and the physical environment? See the **Narrative Section 2.1** included with this application.

B. Will the proposed Solar Garden or Solar Farm have a negative impact on the value of neighboring property?
See the **Narrative Section 2.1** included with this application.

C. Will the proposed Solar Garden or Solar Farm have a negative impact on public utilities and on traffic circulation?
See the **Narrative Section 2.1** included with this application.

D. Will the proposed Solar Garden or Solar Farm have an impact on the facilities near the proposed Solar Garden or Solar Farm, such as schools or hospitals or airports that require special protection?

See the **Narrative Section 2.1** included with this application.

ATTACHMENTS REQUIRED:

1. At the time the application is filed, a non-refundable fee is to be paid by the applicant. The application fee for a Solar Garden is $2,500.00 and the application fee for a Solar Farm Permit is $2,500.00.

2. For entities governed by governing boards, a copy of the Board Resolution or Board Meeting Minutes authorizing the governing board's approval to carry out the requested project and to authorize the submission to Montgomery County by a designated entity officer of the required specific requests / applications / petitions is required to be submitted.

3. An area map and site plan from a certified Illinois licensed Engineer.

4. List of the names, current property tax addresses and property tax PIN numbers of property owners located within two-hundred feet and fifty (250') of the property.

5. A Decommissioning plan including:
    A. Process details and cost estimate of decommission.
    B. Anticipated life expectancy of the Solar Farm.
    C. Method of insuring funds will be available for decommissioning and restoration of the project site to its original, natural condition prior to the solar farm construction.
        1. This includes a proposed schedule of payments to be deposited into an escrow account, on a minimum of a yearly basis, held by Montgomery County as assurance for available decommissioning funds.
    D. The cost estimate of decommissioning will be reviewed every five (5) years, by the County's chosen Independent Engineer, and revised if necessary, at the Developers expense. The review and revised plan shall be sent to the Montgomery County Coordinating Office for Board review. If necessary, provisions will be made to the escrow account balance for the decommissioning of the Solar Garden or Solar Farm.

CERTIFICATION OF A SOLAR GARDEN OR SOLAR FARM PERMIT PETITION / APPLICATION / REQUEST

I/We the undersigned, agree that the information herein and attached is true. I/We, the undersigned, do hereby permit officials and/or consultants of Montgomery County, to enter the property described herein to complete a thorough review of this application.

Address: Northeast of the Intersection of N 21st Ave and North Road, Montgomery County, IL 62560

Parcel ID # 06-14-400-003

Applicant's Printed/Typed Name: Alex Farkes

Signature: _____ Date: _____

Property Owner's Printed/Typed Name: Kevin Wood

Signature: _____ Date: _____

Applicant's Legal or other Representative's Printed/Typed Name (*if applicable)*:
Mark Gershon

Signature: _____ Date: _____

STATEMENT OF CONFORMANCE:

I/We, the undersigned, in making a Petition/ Application / Request to Montgomery County for approval of a Solar Farm or Solar Garden Construction Permit described in this application have reviewed the laws and regulations of Montgomery County to the extent that they are applicable to this proposal and understand that: I/We, the undersigned have no reasonable expectation of approval of this request until such time that a Solar Farm or Solar Garden Construction Permit is actually issued by the Montgomery County and have been so notified of issuance in writing. I/We hereby acknowledge, attest to, and accept the following as conditions of obtaining a Solar Farm or Solar Garden Construction Permit in Montgomery County, Illinois.

- **NO** building, construction, alteration, or use may be started prior to the issuance of a Solar Farm or Solar Garden Construction Permit.
- **All** building construction and all site construction must conform to the plans and specifications approved by the Montgomery County Board. No deviation from or revision to an approved plan may take place without the prior written approval of the Montgomery County Board.
- Any Permit, once issued, is non-transferrable to any other legal entity without the express prior written approval of the Montgomery County Board.
- That **ALL** actions associated with this Permit process shall be taken, processed, and interpreted under the Laws of the State of Illinois and Montgomery County and any legal remedies sought by any party in connection with this Solar Farm or Solar Garden Construction Permit shall be brought forth in the Courts of Montgomery County, Illinois for adjudication.
- That if the applicant is an Agent representing the actual owners of multiple properties, or is a lessor, that the Agent has in their possession signed documentation that the actual property owners are aware of their legal responsibilities to be personally liable for the costs associated with Decommissioning if said lessor or Agent fails for any reason to meet this requirement of the Solar Farm or Solar Garden Construction Permit.

Applicant's Printed/Typed Name: Alex Farkes

Signature: _____ Date: _____

Applicant's Legal Representative Printed/Typed Name Signature and Date *(If applicable)*:

Mark Gershon

Signature: _____ Date: _____

NOTE: It is the responsibility of the Applicant to notify the Montgomery County Coordinating Office at each stage of work completed once the Permit is issued.

Email: cbadmins@montgomerycountyil.gov Phone: 217-532-9577

Address: Montgomery County Coordinator
#1 Courthouse Square – Room 202
Hillsboro, IL 62049

EXHIBIT B: INTERCONNECTION AGREEMENT

STANDARD AGREEMENT FOR INTERCONNECTION OF DISTRIBUTED GENERATION FACILITIES WITH A CAPACITY LESS THAN OR EQUAL TO 10 MVA

This agreement (together with all attachments, the "Agreement") is made and entered into this 04 day of March 2024, by and between NORTH SUN LLC ("interconnection customer"), as a LLC organized and existing under the laws of the State of IL and Ameren Illinois Company, ("Electric Distribution Company" or "EDC"), a corporation existing under the laws of the State of Illinois. Interconnection customer and EDC each may be referred to as a "Party", or collectively as the "Parties".

Recitals:

Whereas, interconnection customer is proposing to install or direct the installation of a distributed generation facility, or is proposing a generating capacity addition to an existing distributed generation facility, consistent with the interconnection request application form completed by interconnection customer on _7-29-2022_; and

Whereas, the interconnection customer will operate and maintain, or cause the operation and maintenance of, the DER facility; and

Whereas, interconnection customer desires to interconnect the DER facility with EDC's electric distribution system.

Now, therefore, in consideration of the premises and mutual covenants set forth in this Agreement, and other good and valuable consideration, the receipt, sufficiency and adequacy of which are hereby acknowledged, the Parties covenant and agree as follows:

Article 1. Scope and Limitations of Agreement

1.1 This Agreement shall be used for all approved interconnection requests for DER facilities that fall under Levels 2, 3 and 4 according to the procedures set forth in Part 466 of the Commission's rules (83 Ill. Adm. Code 466) (referred to as the Illinois Distributed Energy Resources Interconnection Standard).

1.2 This Agreement governs the terms and conditions under which the DER facility will interconnect to, and operate in parallel with, the EDC's electric distribution system.

1.3 This Agreement does not constitute an agreement to purchase or deliver the interconnection customer's power.

1.4 Nothing in this Agreement is intended to affect any other agreement between the EDC and the interconnection customer.

1.5 Terms used in this agreement are defined as in Section 466.20 of the Illinois Distributed Generation Interconnection Standard unless otherwise noted.

1.6 Responsibilities of the Parties

1.6.1 The Parties shall perform all obligations of this Agreement in accordance with all applicable laws and regulations.

1.6.2 The EDC shall construct, own, operate, and maintain its interconnection facilities in accordance with this Agreement.

1.6.3 The interconnection customer shall construct, own, operate, and maintain its distributed generation facility and interconnection facilities in accordance with this Agreement.

1.6.4 Each Party shall operate, maintain, repair, and inspect, and shall be fully responsible for, the facilities that it now or subsequently may own unless otherwise specified in the attachments to this Agreement. Each Party shall be responsible for the safe installation, maintenance, repair and condition of its respective lines and appurtenances on its respective sides of the point of interconnection.

1.6.5 The interconnection customer agrees to design, install, maintain and operate its DER facility so as to minimize the likelihood of causing an adverse system impact on the electric distribution system or any other electric system that is not owned or operated by the EDC.

1.7 Parallel Operation Obligations

Once the DER facility has been authorized to commence parallel operation, the interconnection customer shall abide by all operating procedures established in IEEE Standard 1547 and any other applicable laws, statutes or guidelines, including those specified in Attachment 4 of this Agreement.

1.8 Metering

The interconnection customer shall be responsible for the cost to purchase, install, operate, maintain, test, repair, and replace metering and data acquisition equipment specified in Attachments 5 and 6 of this Agreement.

1.9 Reactive Power

1.9.1 Interconnection customers with a DER facility larger than or equal to 1 MVA shall design their DER facilities to maintain a power factor at the point of interconnection between .95 lagging and .95 leading at all times. Interconnection customers with a DER facility smaller than 1 MVA shall design their DER facility to maintain a power factor at the point of interconnection between .90 lagging and .90 leading at all times.

1.9.2 Any EDC requirements for meeting a specific voltage or specific reactive power schedule as a condition for interconnection shall be clearly specified in Attachment 4. Under no circumstance shall the EDC's additional requirements for voltage or reactive power schedules exceed the normal operating capabilities of the DER facility.

1.9.3 If the interconnection customer does not operate the distributed generation facility within the power factor range specified in Attachment 4, or does not operate the distribute generation facility in accordance with a voltage or reactive power schedule specified in Attachment 4, the interconnection customer is in default, and the terms of Article 6.5 apply.

1.10 Standards of Operations

The interconnection customer must obtain all certifications, permits, licenses and approvals necessary to construct, operate and maintain the facility and to perform its obligations under this Agreement. The interconnection customer is responsible for coordinating and synchronizing the DER facility with the EDC's system. The interconnection customer is responsible for any damage that is caused by the interconnection customer's failure to coordinate or synchronize the DER facility with the electric distribution system. The interconnection customer agrees to be primarily liable for any damages resulting from the continued operation of the DER facility after the EDC ceases to energize the line section to which the DER facility is connected. In Attachment 4, the EDC shall specify the shortest reclose time setting for its protection equipment that could affect the DER facility. The EDC shall notify the interconnection customer at least 10 business days prior to adopting a faster reclose time on any automatic protective equipment, such as a circuit breaker or line recloser, that might affect the DER facility.

Article 2. Inspection, Testing, Authorization, and Right of Access

2.1 Equipment Testing and Inspection

The interconnection customer shall test and inspect its DER facility including the interconnection equipment prior to interconnection in accordance with IEEE Standard 1547 (2003) and IEEE Standard 1547.1 (2005). The interconnection customer shall not operate its DER facility in parallel with the EDC's electric distribution system without prior written authorization by the EDC as provided for in Articles 2.1.1-2.1.3.

2.1.1 The EDC shall perform a witness test after construction of the DER facility is completed, but before parallel operation, unless the EDC specifically waives the witness test. The interconnection customer shall provide the EDC at least 15 business days' notice of the planned commissioning test for the DER facility. If the EDC performs a witness test at a time that is not concurrent with the commissioning test, it shall contact the interconnection customer to schedule the witness test at a mutually agreeable time within 10 business days after the scheduled commissioning test designated on the application. If the EDC does not perform the witness test within 10 business days after the commissioning test, the witness test is deemed waived unless the Parties mutually agree to extend the date for scheduling the witness test, or unless the EDC cannot do so for good cause, in which case, the Parties shall agree to another date for scheduling the test within 10 business days after the original scheduled date. If the witness test is not acceptable to the EDC, the EDC shall deliver in writing a detailed technical description of all deficiencies of the DER facility identified by the EDC during the witness test. The interconnection customer has 30 business days after receipt of the written description to address and resolve any deficiencies. This time period may be extended upon agreement between the EDC and the interconnection customer. If the interconnection customer fails to address and resolve the deficiencies to the satisfaction of the EDC, the applicable cure provisions of Article 6.5 shall apply. The interconnection customer shall, if requested by the EDC, provide a copy of all documentation in its possession regarding testing conducted pursuant to IEEE Standard 1547.1.

2.1.2 If the interconnection customer conducts interim testing of the DER facility prior to the witness test, the interconnection customer shall obtain permission from the EDC before each occurrence of operating the DER facility in parallel with the

electric distribution system. The EDC may, at its own expense, send qualified personnel to the DER facility to observe such interim testing, but it cannot mandate that these tests be considered in the final witness test. The EDC is not required to observe the interim testing or precluded from requiring the tests be repeated at the final witness test. During and leading up to the witness test, the EDC shall not limit the interconnection customer's ability to test the DER facility during normal working hours except for safety and reliability reasons.

2.1.3 After the DER facility passes the witness test, the EDC shall affix an authorized signature to the certificate of completion and return it to the interconnection customer approving the interconnection and authorizing parallel operation. The authorization shall not be conditioned or delayed and the EDC shall return the signed certificate of completion to the interconnection customer no more than 10 business days after the date that the DER facility passes the witness test.

2.2 Commercial Operation

The interconnection customer shall not operate the DER facility, except for interim testing as provided in Article 2.1, until such time as the certificate of completion is signed by all Parties.

2.3 Right of Access

The EDC must have access to the disconnect switch and metering equipment of the DER facility at all times. When practical, the EDC shall provide notice to the customer prior to using its right of access.

Article 3. Effective Date, Term, Termination, and Disconnection

3.1 Effective Date

This Agreement shall become effective upon execution by all Parties.

3.2 Term of Agreement

This Agreement shall become effective on the effective date and shall remain in effect unless terminated in accordance with Article 3.3 of this Agreement.

3.3 Termination

3.3.1 The interconnection customer may terminate this Agreement at any time by giving the EDC 30 calendar days prior written notice.

3.3.2 Either Party may terminate this Agreement after default pursuant to Article 6.5.

3.3.3 The EDC may terminate, upon 60 calendar days' prior written notice, for failure of the interconnection customer to complete construction of the DER facility

within 12 months after the in-service date as specified by the Parties in Attachment 2, which may be extended by agreement between the Parties.

3.3.4 The EDC may terminate this Agreement, upon 60 calendar days' prior written notice, if the interconnection customer has abandoned, cancelled, permanently disconnected or stopped development, construction, or operation of the DER facility, or if the interconnection customer fails to operate the DER facility in parallel with the EDC's electric system for three consecutive years.

3.3.5 Upon termination of this Agreement, the DER facility will be disconnected from the EDC's electric distribution system. Terminating this Agreement does not relieve either Party of its liabilities and obligations that are owed or continuing when the Agreement is terminated.

3.3.6 If the Agreement is terminated, the interconnection customer loses its position in the interconnection queue.

3.4 Temporary Disconnection

A Party may temporarily disconnect the DER facility from the electric distribution system in the event one or more of the following conditions or events occurs:

3.4.1 Emergency conditions – shall mean any condition or situation: (1) that in the judgment of the Party making the claim is likely to endanger life or property; or (2) that the EDC determines is likely to cause an adverse system impact, or is likely to have a material adverse effect on the EDC's electric distribution system, interconnection facilities or other facilities, or is likely to interrupt or materially interfere with the provision of electric utility service to other customers; or (3) that is likely to cause a material adverse effect on the DER facility or the interconnection equipment. Under emergency conditions, the EDC or the interconnection customer may suspend interconnection service and temporarily disconnect the DER facility from the electric distribution system. The EDC must notify the interconnection customer when it becomes aware of any conditions that might affect the interconnection customer's operation of the DER facility. The interconnection customer shall notify the EDC when it becomes aware of any condition that might affect the EDC's electric distribution system. To the extent information is known, the notification shall describe the condition, the extent of the damage or deficiency, the expected effect on the operation of both Parties' facilities and operations, its anticipated duration, and the necessary corrective action.

3.4.2 Scheduled maintenance, construction, or repair – the EDC may interrupt interconnection service or curtail the output of the DER facility and temporarily disconnect the DER facility from the EDC's electric distribution system when necessary for scheduled maintenance, construction, or repairs on EDC's electric

distribution system. The EDC shall provide the interconnection customer with notice no less than 5 business days before an interruption due to scheduled maintenance, construction, or repair, or the EDC shall provide notice immediately if the scheduled maintenance, construction, or repair is scheduled less than 5 business days in advance. The EDC shall coordinate the reduction or temporary disconnection with the interconnection customer; however, the interconnection customer is responsible for out-of-pocket costs incurred by the EDC for deferring or rescheduling maintenance, construction or repair at the interconnection customer's request.

3.4.3 Forced outages – The EDC may suspend interconnection service to repair the EDC's electric distribution system. The EDC shall provide the interconnection customer with prior notice, if possible. If prior notice is not possible, the EDC shall, upon written request, provide the interconnection customer with written documentation, after the fact, explaining the circumstances of the disconnection.

3.4.4 Adverse system impact – the EDC must provide the interconnection customer with written notice of its intention to disconnect the DER facility, if the EDC determines that operation of the DER facility creates an adverse system impact. The documentation that supports the EDC's decision to disconnect must be provided to the interconnection customer. The EDC may disconnect the DER facility if, after receipt of the notice, the interconnection customer fails to remedy the adverse system impact, unless emergency conditions exist, in which case, the provisions of Article 3.4.1 apply. The EDC may continue to leave the generating facility disconnected until the adverse system impact is corrected.

3.4.5 Modification of the DER facility – The interconnection customer must receive written authorization from the EDC prior to making any change to the DER facility, other than a minor equipment modification. If the interconnection customer modifies its facility without the EDC's prior written authorization, the EDC has the right to disconnect the DER facility until such time as the EDC concludes the modification poses no threat to the safety or reliability of its electric distribution system.

3.4.6 The EDC's compliance with Article 3 shall preclude any claim for damages for any lost opportunity or other costs incurred by the interconnection customer as a result of an interruption of service under Article 3. Any dispute over whether the EDC complied with Article 3 shall be resolved in accordance with the dispute resolution mechanism set forth in Article 8.

Article 4. Cost Responsibility for Interconnection Facilities and Distribution Upgrades

4.1 Interconnection Facilities

4.1.1 The interconnection customer shall pay, or reimburse the EDC, as applicable, for the cost of the interconnection facilities itemized in Attachment 3. The EDC shall identify the additional interconnection facilities necessary to interconnect the DER facility with the EDC's electric distribution system, the cost of those facilities, and the time required to build and install those facilities, as well as an estimated date of completion of the building or installation of those facilities.

4.1.2 The interconnection customer is responsible for its expenses, including overheads, associated with owning, operating, maintaining, repairing, and replacing its interconnection equipment.

4.2 Distribution Upgrades

The EDC shall design, procure, construct, install, and own any distribution upgrades. The actual cost of the distribution upgrades, including overheads, shall be directly assigned to the interconnection customer whose distributed generation facility caused the need for the distribution upgrades.

Article 5. Billing, Payment, Milestones, and Financial Security

5.1 Billing and Payment Procedures and Final Accounting (Applies to supplemental reviews conducted under Level 2 or 3 review with EDC construction necessary for accommodating the DER facility, and Level 4 reviews)

5.1.1 The EDC shall bill the interconnection customer for the design, engineering, construction, and procurement costs of EDC-provided interconnection facilities and distribution upgrades contemplated by this Agreement as set forth in Attachment 3. The billing shall occur on a monthly basis, or as otherwise agreed to between the Parties. The interconnection customer shall pay each bill within 30 calendar days after receipt, or as otherwise agreed to between the Parties.

5.1.2 Unless waived by the interconnection customer, within 90 calendar days after completing the construction and installation of the EDC's interconnection facilities and distribution upgrades described in Attachments 2 and 3 to this Agreement, the EDC shall provide the interconnection customer with a final accounting report of any difference between (1) the actual cost incurred to complete the construction and installation of the EDC's interconnection facilities and distribution upgrades; and (2) the interconnection customer's previous deposit and aggregate payments to the EDC for the interconnection facilities and distribution upgrades. If the interconnection customer's cost responsibility exceeds its previous deposit and aggregate payments, the EDC shall invoice the

interconnection customer for the amount due and the interconnection customer shall pay the EDC within 30 calendar days. If the interconnection customer's previous deposit and aggregate payments exceed its cost responsibility under this Agreement, the EDC shall refund to the interconnection customer an amount equal to the difference within 30 calendar days after the final accounting report. Upon request from the interconnection customer, if the difference between the budget estimate and the actual cost exceeds 20%, the EDC will provide a written explanation for the difference.

5.1.3 If a Party disputes any portion of its payment obligation pursuant to this Article 5, the Party shall pay in a timely manner all non-disputed portions of its invoice, and the disputed amount shall be resolved pursuant to the dispute resolution provisions contained in Article 8. A Party disputing a portion of an Article 5 payment shall not be considered to be in default of its obligations under this Article.

5.2 Interconnection Customer Deposit

Within 15 business days after signing and returning the interconnection agreement to the EDC, the interconnection customer shall provide the EDC with a deposit equal to 100% of the estimated, non-binding cost to procure, install, or construct any such facilities. However, when the estimated date of completion of the building or installation of facilities exceeds three months from the date of notification, pursuant to Article 4.1.1 of this Agreement, this deposit may be held in escrow by a mutually agreed-upon thirdparty, with any interest to inure to the benefit of the interconnection customer. To the extent that this interconnection agreement is terminated for any reason, the EDC shall return all deposits provided by the interconnection customer, less any actual costs incurred by the EDC.

Article 6. Assignment, Limitation on Damages, Indemnity, Force Majeure, and Default

6.1 Assignment

This Agreement may be assigned by either Party. If the interconnection customer attempts to assign this Agreement, the assignee must agree to the terms of this Agreement in writing and such writing must be provided to the EDC. Any attempted assignment that violates this Article is void and ineffective. Assignment shall not relieve a Party of its obligations, nor shall a Party's obligations be enlarged, in whole or in part, by reason of the assignment. An assignee is responsible for meeting the same obligations as the assignor.

6.1.1 Either Party may assign this Agreement without the consent of the other Party to any affiliate (including mergers, consolidations or transfers, or a sale of a

substantial portion of the Party's assets, between the Party and another entity), of the assigning Party that has an equal or greater credit rating and the legal authority and operational ability to satisfy the obligations of the assigning Party under this Agreement.

6.1.2 The interconnection customer can assign this Agreement, without the consent of the EDC, for collateral security purposes to aid in providing financing for the DER facility.

6.2 Limitation on Damages

Except for cases of gross negligence or willful misconduct, the liability of any Party to this Agreement shall be limited to direct actual damages and reasonable attorney's fees, and all other damages at law are waived. Under no circumstances, except for cases of gross negligence or willful misconduct, shall any Party or its directors, officers, employees and agents, or any of them, be liable to another Party, whether in tort, contract or other basis in law or equity for any special, indirect, punitive, exemplary or consequential damages, including lost profits, lost revenues, replacement power, cost of capital or replacement equipment. This limitation on damages shall not affect any Party's rights to obtain equitable relief, including specific performance, as otherwise provided in this Agreement. The provisions of this Article 6.2 shall survive the termination or expiration of the Agreement.

6.3 Indemnity

6.3.1 This provision protects each Party from liability incurred to third parties as a result of carrying out the provisions of this Agreement. Liability under this provision is exempt from the general limitations on liability found in Article 6.2.

6.3.2 The interconnection customer shall indemnify and defend the EDC and the EDC's directors, officers, employees, and agents, from all damages and expenses resulting from a third party claim arising out of or based upon the interconnection customer's (a) negligence or willful misconduct or (b) breach of this Agreement.

6.3.3 The EDC shall indemnify and defend the interconnection customer and the interconnection customer's directors, officers, employees, and agents from all damages and expenses resulting from a third party claim arising out of or based upon the EDC's (a) negligence or willful misconduct or (b) breach of this Agreement.

6.3.4 Within 5 business days after receipt by an indemnified Party of any claim or notice that an action or administrative or legal proceeding or investigation as to which the indemnity provided for in this Article may apply has commenced, the indemnified Party shall notify the indemnifying Party of such fact. The failure to notify, or a delay in notification, shall not affect a Party's indemnification

obligation unless that failure or delay is materially prejudicial to the indemnifying Party.

6.3.5 If an indemnified Party is entitled to indemnification under this Article as a result of a claim by a third party, and the indemnifying Party fails, after notice and reasonable opportunity to proceed under this Article, to assume the defense of such claim, that indemnified Party may, at the expense of the indemnifying Party, contest, settle or consent to the entry of any judgment with respect to, or pay in full, the claim.

6.3.6 If an indemnifying Party is obligated to indemnify and hold any indemnified Party harmless under this Article, the amount owing to the indemnified person shall be the amount of the indemnified Party's actual loss, net of any insurance or other recovery.

6.4 Force Majeure

6.4.1 As used in this Article, a force majeure event shall mean any act of God, labor disturbance, act of the public enemy, war, acts of terrorism, insurrection, riot, fire, storm or flood, explosion, breakage or accident to machinery or equipment through no direct, indirect, or contributory act of a Party, any order, regulation or restriction imposed by governmental, military or lawfully established civilian authorities, or any other cause beyond a Party's control. A force majeure event does not include an act of gross negligence or intentional wrongdoing by the Party claiming force majeure.

6.4.2 If a force majeure event prevents a Party from fulfilling any obligations under this Agreement, the Party affected by the force majeure event ("Affected Party") shall notify the other Party of the existence of the force majeure event within one business day. The notification must specify the circumstances of the force majeure event, its expected duration, and the steps that the Affected Party is taking and will take to mitigate the effects of the event on its performance. If the initial notification is verbal, it must be followed up with a written notification within one business day. The Affected Party shall keep the other Party informed on a continuing basis of developments relating to the force majeure event until the event ends. The Affected Party may suspend or modify its obligations under this Agreement (other than the obligation to make payments) only to the extent that the effect of the force majeure event cannot be otherwise mitigated.

6.5 Default

6.5.1 No default shall exist when the failure to discharge an obligation (other than the payment of money) results from a force majeure event as defined in this Agreement, or the result of an act or omission of the other Party.

6.5.2 A Party shall be in default ("Default") of this Agreement if it fails in any material respect to comply with, observe or perform, or defaults in the performance of, any covenant or obligation under this Agreement and fails to cure the failure within 60 calendar days after receiving written notice from the other Party. Upon a default of this Agreement, the non-defaulting Party shall give written notice of the default to the defaulting Party. Except as provided in Article 6.5.3, the defaulting Party has 60 calendar days after receipt of the default notice to cure the default; provided, however, if the default cannot be cured within 60 calendar days, the defaulting Party shall commence the cure within 20 calendar days after original notice and complete the cure within six months from receipt of the default notice; and, if cured within that time, the default specified in the notice shall cease to exist.

6.5.3 If a Party has assigned this Agreement in a manner that is not specifically authorized by Article 6.1, fails to provide reasonable access pursuant to Article 2.3, and is in default of its obligations pursuant to Article 7, or if a Party is in default of its payment obligations pursuant to Article 5 of this Agreement, the defaulting Party has 30 days from receipt of the default notice to cure the default.

6.5.4 If a default is not cured as provided for in this Article, or if a default is not capable of being cured within the period provided for in this Article, the nondefaulting Party shall have the right to terminate this Agreement by written notice, and be relieved of any further obligation under this Agreement and, whether or not that Party terminates this Agreement, to recover from the defaulting Party all amounts due under this Agreement, plus all other damages and remedies to which it is entitled at law or in equity. The provisions of this Article shall survive termination of this Agreement.

Article 7. Insurance

For DER facilities with a nameplate capacity of 1 MVA or above, the interconnection customer shall carry sufficient insurance coverage so that the maximum comprehensive/general liability coverage that is continuously maintained by the interconnection customer during the term shall be not less than $2,000,000 for each occurrence, and an aggregate, if any, of at least $4,000,000. The EDC, its officers, employees and agents shall be added as an additional insured on this policy. The interconnection customer agrees to provide the EDC with at least 30 calendar days advance written notice of cancellation, reduction in limits, or non-renewal of any insurance policy required by this Article.

Article 8. Dispute Resolution

8.1 Parties shall attempt to resolve all disputes regarding interconnection as provided in this Article in a good faith manner.

8.2 If there is a dispute between the Parties about implementation or an interpretation of the Agreement, the aggrieved Party shall issue a written notice to the other Party to the Agreement that specifies the dispute and the Agreement articles that are disputed.

8.3 A meeting between the Parties shall be held within 10 days after receipt of the written notice. Persons with decision-making authority from each Party shall attend the meeting. If the dispute involves technical issues, persons with sufficient technical expertise and familiarity with the issue in dispute from each Party shall also attend the meeting. The meeting may be conducted by teleconference. The informal process between the parties shall extend 30 days after the receipt of written notice, after which the dispute is deemed resolved and the timeframes for decisions within the interconnection process resume, unless one of the parties seeks resolution through non-binding arbitration procedures described in Article 8.4 or files a formal complaint at the Commission prior to the end of the 30-day period.

8.4 If the parties are unable to resolve the dispute through the process outlined in Article 8.3, either party may submit the interconnection dispute to an Ombudsman for non-binding arbitration. The party electing non-binding arbitration shall notify the other party of the request in writing. The non-binding arbitration process is limited to 60 days, absent mutual agreement of the parties and the Ombudsman to a longer period.

8.5 Each party shall bear its own fees, costs and expenses and an equal share of the expenses of the non-binding arbitration.

8.6 Within 10 days after the conclusion of the procedures in Article 8.4, either party may initiate a formal complaint with the Commission and ask for an expedited resolution of the dispute. If the complaint seeks expedited resolution, any written recommendation of the Ombudsman shall be appended to the complaint. The formal complaint shall proceed as a contested hearing pursuant to the Commission’s Rules of Practice.

8.7 A party may, after good faith negotiations have failed, decline to pursue non-binding arbitration and instead initiate a formal complaint with the Commission. The formal complaint shall proceed as a contested hearing pursuant to the Commission's Rules of Practice.

8.8 Pursuit of dispute resolution may not affect an interconnection request or an interconnection applicant's position in the EDC's interconnection queue.

8.9 If the Parties fail to resolve their dispute under the dispute resolution provisions of this Article, nothing in this Article shall affect any Party's rights to obtain equitable relief, including specific performance, as otherwise provided in this Agreement.

Article 9. Miscellaneous

9.1 Governing Law, Regulatory Authority, and Rules

The validity, interpretation and enforcement of this Agreement and each of its provisions shall be governed by the laws of the State of Illinois, without regard to its conflicts of law principles. This Agreement is subject to all applicable laws and regulations. Each Party expressly reserves the right to seek change in, appeal, or otherwise contest any laws, orders or regulations of a governmental authority. The language in all parts of this Agreement shall in all cases be construed as a whole, according to its fair meaning, and not strictly for or against the EDC or interconnection customer, regardless of the involvement of either Party in drafting this Agreement.

9.2 Amendment

Modification of this Agreement shall be only by a written instrument duly executed by both Parties.

9.3 No Third-Party Beneficiaries

This Agreement is not intended to and does not create rights, remedies, or benefits of any character whatsoever in favor of any persons, corporations, associations, or entities other than the Parties, and the obligations in this Agreement assumed are solely for the use and benefit of the Parties, their successors in interest and, where permitted, their assigns.

9.4 Waiver

9.4.1 Except as otherwise provided in this Agreement, a Party's compliance with any obligation, covenant, agreement, or condition in this Agreement may be waived by the Party entitled to the benefits thereof only by a written instrument signed by the Party granting the waiver, but the waiver or failure to insist upon strict compliance with the obligation, covenant, agreement, or condition shall not operate as a waiver of, or estoppel with respect to, any subsequent or other failure.

9.4.2. Failure of any Party to enforce or insist upon compliance with any of the terms or conditions of this Agreement, or to give notice or declare this Agreement or the rights under this Agreement terminated, shall not constitute a waiver or relinquishment of any rights set out in this Agreement, but the same shall be and remain at all times in full force and effect, unless and only to the extent expressly set forth in a written document signed by that Party granting the waiver or relinquishing any such rights. Any waiver granted, or relinquishment of any right,

by a Party shall not operate as a relinquishment of any other rights or a waiver of any other failure of the Party granted the waiver to comply with any obligation, covenant, agreement, or condition of this Agreement.

9.5 Entire Agreement

Except as provided in Article 9.1, this Agreement, including all attachments, constitutes the entire Agreement between the Parties with reference to the subject matter of this Agreement, and supersedes all prior and contemporaneous understandings or agreements, oral or written, between the Parties with respect to the subject matter of this Agreement. There are no other agreements, representations, warranties, or covenants that constitute any part of the consideration for, or any condition to, either Party's compliance with its obligations under this Agreement.

9.6 Multiple Counterparts

This Agreement may be executed in two or more counterparts, each of which is deemed an original, but all constitute one and the same instrument.

9.7 No Partnership

This Agreement shall not be interpreted or construed to create an association, joint venture, agency relationship, or partnership between the Parties, or to impose any partnership obligation or partnership liability upon either Party. Neither Party shall have any right, power or authority to enter into any agreement or undertaking for, or act on behalf of, or to act as or be an agent or representative of, or to otherwise bind, the other Party.

9.8 Severability

If any provision or portion of this Agreement shall for any reason be held or adjudged to be invalid or illegal or unenforceable by any court of competent jurisdiction or other governmental authority, (1) that portion or provision shall be deemed separate and independent, (2) the Parties shall negotiate in good faith to restore insofar as practicable the benefits to each Party that were affected by the ruling, and (3) the remainder of this Agreement shall remain in full force and effect.

9.9 Environmental Releases

Each Party shall notify the other Party of the release of any hazardous substances, any asbestos or lead abatement activities, or any type of remediation activities related to the DER facility or the interconnection facilities, each of which may reasonably be expected to affect the other Party. The notifying Party shall (1) provide the notice as soon as practicable, provided that Party makes a good faith effort to provide the notice no later than 24 hours after that Party becomes aware of the occurrence, and (2) promptly furnish

to the other Party copies of any publicly available reports filed with any governmental authorities addressing such events.

9.10 Subcontractors

Nothing in this Agreement shall prevent a Party from using the services of any subcontractor it deems appropriate to perform its obligations under this Agreement; provided, however, that each Party shall require its subcontractors to comply with all applicable terms and conditions of this Agreement in providing services and each Party shall remain primarily liable to the other Party for the performance of the subcontractor.

9.10.1 A subcontract relationship does not relieve any Party of any of its obligations under this Agreement. The hiring Party remains responsible to the other Party for the acts or omissions of its subcontractor. Any applicable obligation imposed by this Agreement upon the hiring Party shall be equally binding upon, and shall be construed as having application to, any subcontractor of the hiring Party.

9.10.2 The obligations under this Article cannot be limited in any way by any limitation of subcontractor's insurance.

Article 10. Notices

10.1 General

Unless otherwise provided in this Agreement, any written notice, demand, or request required or authorized in connection with this Agreement ("Notice") shall be deemed properly given if delivered in person, delivered by recognized national courier service, or sent by first class mail, postage prepaid, to the person specified below:

If to Interconnection Customer:

Interconnection Customer: NORTH SUN LLC

Attention: ALEXANDER FARKES

Address: 4753 N BROADWAY STREET, FLOOR 2

City: CHICAGO State: IL Zip: 60640

Phone: 7797745151 Fax: E-Mail: ALE @22C.NET

If to EDC:

EDC: Ameren Illinois Company

Attention: Ameren Illinois Net Metering Coordinator

Address: 10 Richard Mark Way – Mail Code 910

City: Collinsville State: IL Zip: 62234

Phone: _____ Fax: _____ E-Mail: RenewablesIllinois@ameren.com

Alternative Forms of Notice

Any notice or request required or permitted to be given by either Party to the other Party and not required by this Agreement to be in writing may be given by telephone, facsimile or e-mail to the telephone numbers and e-mail addresses set out above.

10.2 Billing and Payment

Billings and payments shall be sent to the addresses set out below:

If to Interconnection Customer:

Interconnection Customer: NORTH SUN LLC

Attention: ALEXANDER FARKES

Address: 4753 N BROADWAY STREET, FLOOR 2

City: CHICAGO State: IL Zip: 60640

If to EDC:

Ameren Net Metering Coordinator

10 Richard Mark Way _ Mail Code 910

Collinsville State: IL Zip: 62234

EDC: Ameren Illinois Attention:

Address:

City:

10.3 Designated Operating Representative

The Parties may also designate operating representatives to conduct the communications that may be necessary or convenient for the administration of this Agreement. This person will also serve as the point of contact with respect to operations and maintenance of the Party's facilities.

Interconnection Customer's Operating Representative:

Attention: ALEXANDER FARKES

Address: 4753 N BROADWAY STREET, FLOOR 2

City: CHICAGO State: IL Zip: 60640

EDC's Operating Representative: Ameren Illinois

Attention: Ameren Illinois Net Metering Coordinator

Address: 10 Richard Mark Way – Mail Code 910

City: Collinsville State: IL Zip: 62234

10.4 Changes to the Notice Information
Either Party may change this notice information by giving five business days written notice before the effective date of the change.

Article 11. Signatures

IN WITNESS WHEREOF, the Parties have caused this Agreement to be executed by their respective duly authorized representatives.

For the Interconnection Customer: -

Name: DocuSigned by: alexander x Jarfis C5181BAE55D5405...

Title: SOLE OWNER

Date: 3-4-2024

For EDC:

Name: Brian Ripperda

Title: Director, Technology Applications

Date: March 4, 2024

Attachment 1

Definitions

Adverse system impact – A negative effect that compromises the safety or reliability of the electric distribution system or materially affects the quality of electric service provided by the electric distribution company (EDC) to other customers.

Applicable laws and regulations – All duly promulgated applicable federal, State and local laws, regulations, rules, ordinances, codes, decrees, judgments, directives, or judicial or administrative orders, permits and other duly authorized actions of any governmental authority, having jurisdiction over the Parties.

Commissioning test – Tests applied to a distributed generation facility by the applicant after construction is completed to verify that the facility does not create adverse system impacts. At a minimum, the scope of the commissioning tests performed shall include the commissioning test specified IEEE Standard 1547 Section 5.4 "Commissioning tests."

Distributed generation facility – The equipment used by an interconnection customer to generate or store electricity that operates in parallel with the electric distribution system. A distributed generation facility typically includes an electric generator, prime mover, and the interconnection equipment required to safely interconnect with the electric distribution system or a local electric power system.

Distribution upgrades – A required addition or modification to the EDC's electric distribution system at or beyond the point of interconnection to accommodate the interconnection of a distributed generation facility. Distribution upgrades do not include interconnection facilities.

Electric distribution company or EDC – Any electric utility entity subject to the jurisdiction of the Illinois Commerce Commission.

Electric distribution system – The facilities and equipment used to transmit electricity to ultimate usage points such as homes and industries from interchanges with higher voltage transmission networks that transport bulk power over longer distances. The voltage levels at which electric distribution systems operate differ among areas but generally carry less than 100 kilovolts of electricity. Electric distribution system has the same meaning as the term Area EPS, as defined in 3.1.6.1 of IEEE Standard 1547.

Facilities study – An engineering study conducted by the EDC to determine the required modifications to the EDC's electric distribution system, including the cost and the time required to build and install the modifications, as necessary to accommodate an interconnection request.

Force majeure event – Any act of God, labor disturbance, act of the public enemy, war, acts of terrorism, insurrection, riot, fire, storm or flood, explosion, breakage or accident to machinery or

equipment through no direct, indirect, or contributory act of a Party, any order, regulation or restriction imposed by governmental, military or lawfully established civilian authorities, or any other cause beyond a Party's control. A force majeure event does not include an act of gross negligence or intentional wrongdoing.

Governmental authority – Any federal, State, local or other governmental regulatory or administrative agency, court, commission, department, board, other governmental subdivision, legislature, rulemaking board, tribunal, or other governmental authority having jurisdiction over the Parties, their respective facilities, or the respective services they provide, and exercising or entitled to exercise any administrative, executive, police, or taxing authority or power; provided, however, that this term does not include the interconnection customer, EDC or any affiliate of either.

IEEE Standard 1547 – The Institute of Electrical and Electronics Engineers, Inc. (IEEE), 3 Park Avenue, New York NY 10016-5997, Standard 1547 (2003), "Standard for Interconnecting Distributed Resources with Electric Power Systems."

IEEE Standard 1547.1 – The IEEE Standard 1547.1 (2005), "Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems."

Interconnection agreement or Agreement – The agreement between the interconnection customer and the EDC. The interconnection agreement governs the connection of the distributed generation facility to the EDC's electric distribution system and the ongoing operation of the distributed generation facility after it is connected to the EDC's electric distribution system.

Interconnection customer – The entity entering into this Agreement for the purpose of interconnecting a distributed generation facility to the EDC's electric distribution system.

Interconnection equipment – A group of components or an integrated system connecting an electric generator with a local electric power system or an electric distribution system that includes all interface equipment, including switchgear, protective devices, inverters or other interface devices. Interconnection equipment may be installed as part of an integrated equipment package that includes a generator or other electric source.

Interconnection facilities – Facilities and equipment required by the EDC to accommodate the interconnection of a distributed generation facility. Collectively, interconnection facilities include all facilities, and equipment between the distributed generation facility and the point of interconnection, including modification, additions, or upgrades that are necessary to physically and electrically interconnect the distributed generation facility to the electric distribution system. Interconnection facilities are sole use facilities and do not include distribution upgrades.

Interconnection request – An interconnection customer's request, on the required form, for the interconnection of a new distributed generation facility, or to increase the capacity or change the

operating characteristics of an existing distributed generation facility that is interconnected with the EDC's electric distribution system.

Interconnection study – Any of the following studies, as determined to be appropriate by the EDC: the interconnection feasibility study, the interconnection system impact study, and the interconnection facilities study.

Illinois standard distributed generation interconnection rules – The most current version of the procedures for interconnecting distributed generation facilities adopted by the Illinois Commerce Commission. See 83 Ill. Adm. Code 466.

Parallel operation or Parallel – The state of operation that occurs when a distributed generation facility is connected electrically to the electric distribution system.

Point of interconnection – The point where the distributed generation facility is electrically connected to the electric distribution system. Point of interconnection has the same meaning as the term "point of common coupling" defined in 3.1.13 of IEEE Standard 1547.

Witness test – For lab-certified equipment, verification (either by an on-site observation or review of documents) by the EDC that the interconnection installation evaluation required by IEEE Standard 1547 Section 5.3 and the commissioning test required by IEEE Standard 1547 Section 5.4 have been adequately performed. For interconnection equipment that has not been lab-certified, the witness test shall also include verification by the EDC of the on-site design tests required by IEEE Standard 1547 Section 5.1 and verification by the EDC of production tests required by IEEE Standard 1547 Section 5.2. All tests verified by the EDC are to be performed in accordance with the test procedures specified by IEEE Standard 1547.1.

Attachment 2

Construction Schedule, Proposed Equipment & Settings

This attachment is to be completed by the interconnection customer and shall include the following:

1. The construction schedule for the distributed generation facility.

2. A one-line diagram indicating the distributed generation facility, interconnection equipment, interconnection facilities, metering equipment, and distribution upgrades.

3. Component specifications for equipment identified in the one-line diagram.

4. Component settings.

5. Proposed sequence of operations.

6. A three line diagram showing current potential circuits for protective relays.

7. Relay tripping and control schematic diagram.

Attachment 3

Description, Costs and Time Required to Build and Install the EDC's Interconnection Facilities

This attachment is to be completed by the EDC and shall include the following:

1. Required interconnection facilities, including any required metering.

   Per the prior studies - EDC shall build the substation facilities as required to support the interconnection of the interconnection customer proposed facility up to the point of disconnect. The interconnection would consist of installation of pole, instrument transformers, cabinet, main line disconnect on both sides of tap line, pole mounted recloser (Viper/Intellirupter) and primary metering at POI. The interconnection customer would be responsible for construction to the point of disconnect. All costs shall be paid for and/or reimbursed by the interconnection customer pursuant to Article 5 of this agreement. The interconnection customer is required to construct all facilities which connect to EDC's facilities or otherwise interface with EDC's facilities, all as determined by EDC's final, detailed engineering, in accordance with EDC's published standards.

   Additional required interconnection facilities and system upgrades may be identified while completing Detailed Engineering.

2. An estimate of itemized costs charged by the EDC for interconnection, including overheads, based on results from prior studies.

   North Road Solar: Off of North Rd, Raymond, IL- **5000 KW** (PowerClerk DER-11354)

Queue Position: 2

NOTE: *THE COST ESTIMATE PROVIDED FOR YOUR PROJECT IN THE NEXT SECTION IS CONTINGENT UPON CONSTRUCTION COMPLETION OF ALL SYSTEM UPGRADES REQUIRED OF PROJECT(S) AHEAD OF YOUR PROJECT IN THE QUEUE THAT HAVE AN IMPACT ON THE CONNECTION OF YOUR PROJECT. SHOULD ANY ONE OR MORE OF SUCH PROJECTS WITHDRAW FOR ANY REASON, THE COSTS ASSOCIATED WITH YOUR PROJECT MAY CHANGE TO REFLECT THE COST IMPACT OF SYSTEM UPGRADES THAT NOW MAY BE REQUIRED TO CONNECT YOUR PROJECT AS A RESULT OF THE WITHDRAWAL OF SUCH HIGHER QUEUED PROJECTS.*

An estimate of itemized costs charged by the EDC for interconnection, including overheads.

☐ $394,000.00 for installation of pole, instrument transformers, cabinet, main line disconnect on both sides of tap line, pole mounted recloser (Viper/Intellirupter) and primary metering at POI. This will be subject to a true-up process at the end of the project.

Ameren Illinois reserves the right to revise this estimate prior to and during construction based on the requirements of Good Utility practices not foreseen at the time of the original estimate. The revisions to the estimate may include, but are not limited to, changes in the cost of materials and required labor.

Notwithstanding Section 5.2 of this Agreement, the Parties may agree to other forms of security in lieu of a cash deposit provided such other form of security is acceptable to the EDC.

3. An estimate for the time required to build and install the EDC's interconnection facilities based on results from prior studies and an estimate of the date upon which the facilities will be completed.

The final construction timeline will be developed during the scoping meeting which will be held with the applicant after the deposit is paid in full and will continue to be updated as the developer and Ameren Illinois work thru the construction process. That notwithstanding, it is anticipated that Ameren Illinois will initiate procurement activities immediately following the scoping meeting. Any revisions to the current scope of construction activities and their timeline will be provided immediately after that discussion. The requested in-service date is dependent on the availability of any long lead time equipment and weather impacts on construction activities.

Operating Requirements for Distributed Generation Facilities Operating in Parallel

The EDC shall list specific operating practices that apply to this distributed generation interconnection and the conditions under which each listed specific operating practice applies.

1. Customer shall meet requirements specified in Level 2 or 4 study.

Attachment 5

Monitoring and Control Requirements

This attachment is to be completed by the EDC and shall include the following:

1. The EDC's monitoring and control requirements must be specified, along with a reference to the EDC's written requirements documents from which these requirements are derived.

2. An internet link to the requirements documents.

https://www.ameren.com/service-manual

http://standards.ieee.org

Attachment 6

Metering Requirements

This attachment is to be completed by the EDC and shall include the following:

1. The metering requirements for the distributed generation facility.

   The specific metering requirements and equipment will be specified as part of the Detailed Engineering.

2. Identification of the appropriate tariffs that establish these requirements.

3. An internet link to these tariffs.

https://www.ameren.com/illinois/business/rates/ https://www.ameren.com/illinois/electric-choice/renewables

Attachment 7

As Built Documents

This attachment is to be completed by the interconnection customer and shall include the following:

When it returns the certificate of completion to the EDC, the interconnection customer shall provide the EDC with documents detailing the as-built status of the following:

1. A one-line diagram indicating the distributed generation facility, interconnection equipment, interconnection facilities, and metering equipment.

2. Component specifications for equipment identified in the one-line diagram.

3. Component settings.

4. Proposed sequence of operations.

5. A three-line diagram showing current potential circuits for protective relays.

6. Relay tripping and control schematic diagram.

Ameren ILLINOIS

Please Return This Portion With Your Payment.

AMOUNT DUE	DUE DATE
$394,000.00	Mar 27, 2024
	ACCOUNT NUMBER
	07071-21102

NORTH SUN LLC
4753 BROADWAY ST FLOOR 2
CHICAGO, IL 60640

Ameren Illinois
P.O. Box 88034
Chicago, IL 60680-1034

40700000 0007071211002 00000000 000394000000 000394000000

Keep This Portion For Your Records

ACCOUNT NUMBER	07071-21102
DOJM NUMBER	1000015271
CUSTOMER PO #	

	BILL DATE	Mar 13, 2024
TOTAL AMOUNT DUE BY	Mar 27, 2024	$394,000.00

LOCATION	21034 NORTH RD SOLAR HARVEL, IL

CONSTRUCTION BILLING

CHARGE DATE: 03/12/2024

QUANTITY	DESCRIPTION	COST/ UNIT	AMOUNT
	Miscellaneous		$394000.00
	SOLAR COST ESTIMATE DER-11354. CHRG# 1000015271		

Current Amount Due	$394,000.00
Prior Amount Due	$0.00
Total Amount Due	$394,000.00

Speedpay gives you the added convenience and flexibility of paying your bills by phone or electronically seven days a week, 24 hours a day. Speedpay payments show as "pending payments" on the same day the transaction is processed, and they are credited to your utility account within 48 hours. To use Speedpay, call 1.888.777.3108. A convenience fee applies.

EXHIBIT C: SOLAR FARM DEVELOPMENT PERMIT PLANS

SOLAR FARM DEVELOPMENT PERMIT PLANS FOR

NORTH SUN LLC

LOCATED AT THE INTERSECTION OF N 21ST AVE AND NORTH ROAD

MONTGOMERY COUNTY IL, 62560

PROJECT TEAM

APPLICANT/OWNER
NORTH SUN LLC
4649 N BROADWAY, CHICAGO IL 60640
PHONE: (779) 774-5151
EMAIL: X@22C-DEVELOPMENT.COM

DEVELOPER
22C DEVELOPMENT, LLC
4649 N BROADWAY, CHICAGO IL 60640
CONTACT: ALEX FARKES
PHONE: (779) 774-5151
EMAIL: X@22C-DEVELOPMENT.COM

AUTHORITY HAVING JURISDICTION
MONTGOMERY COUNTY
#1 COURTHOUSE SQUARE
HILSBORO, IL 62049
COUNTY CLERK: SANDY LEITHEISER
PHONE: (217) 532-9530

CIVIL ENGINEER
KIMLEY-HORN AND ASSOCIATES, INC.
570 LAKE COOK ROAD, SUITE 200
DEERFIELD, IL 60015
CONTACT: SEAN HICKEY, P.E.
PHONE: (708) 621-5007
EMAIL: SEAN.HICKEY@KIMLEY-HORN.COM

APPLICABLE CODES

- MONTGOMERY COUNTY ORDINACE NO. 2023-23, AMENDED 06/13/2023
- PUBLIC ACT 102-1123

FLOOD ZONE NOTE:

PER FEMA FIRM MAP 1709920002A EFFECTIVE DATE 01/09/1981, NO FLOODPLAINS ARE PRESENT WITHIN THE PROJECT AREA. THE AREA IS DESIGNED AS ZONE X, AREA OF MINIMAL FLOOD HAZARD.

SITE INFORMATION

PARCEL INFORMATION
PIN: 06-14-400-003
OWNER: WOOD, KEVIN ET AL
AREA: 75.0 AC
PROJECT DESCRIPTION
UP TO 10 MWAC SINGLE AXIS TRACKER SOLAR ARRAY PROJECT

SETBACK TABLE*	
BOUNDARY LINES OF NON-PARTICIPATING PROPERTY	50.0' TO THE NEAREST POINT ON THE PROPERTY LINE OF THE NON PARTICIPATING PROPERTY
BOUNDARY LINES OF PARTICIPATING PROPERTY	NONE
OCCUPIED COMMUNITY BUILDINGS AND DWELLINGS ON NON-PARTICIPATING PROPERTIES	150.0' TO THE NEAREST POINT ON THE PROPERTY LINE OF THE NON-PARTICIPATING PROPERTY
RIGHT-OF-WAY (R.O.W.)	50.0' TO ANY PUBLIC RIGHT-OF-WAY

*SETBACKS PER MONTGOMERY COUNTY SOLAR FARM ORDINANCE F.2.F, UPDATED 06/13/2023.

LOCATION MAP

(NOT TO SCALE)

STATE COUNTY MAP

(NOT TO SCALE)

Sheet List Table	
Sheet Number	Sheet Title
C-100	COVER SHEET
C-200	EXISTING CONDITIONS
C-300	EROSION CONTROL PLAN
C-400	SITE PLAN
C-500	CONSTRUCTION DETAILS
L-100	LANDSCAPE PLAN

LEGAL DESCRIPTION

PARCEL LEGAL DESCRIPTION: THE SOUTH HALF (S 1/2) OF THE SOUTHEAST QUARTER (SE 1/4) OF SECTION FOURTEEN (14), TOWNSHIP TEN (10) NORTH, RANGE FOUR (4) WEST OF THE THIRD PRINCIPAL MERIDIAN, MONTGOMERY COUNTY, ILLINOIS, EXCEPTING THAT PART DESCRIBED AS FOLLOWS: COMMENCING AT THE INTERSECTION OF THE CENTERLINE OF F.A. ROUTE 166 AS RECORDED IN THE RECORDER'S OFFICE OF MONTGOMERY COUNTY IN PLAT BOOK 1 ON PAGE 95 AND THE WEST LINE OF THE SOUTHEAST QUARTER (SE 1/4) OF SAID SECTION FOURTEEN (14), THENCE SOUTH 88 DEGREES 26 MINUTES 20 SECONDS EAST AND ALONG THE CENTERLINE OF SAID F.A. ROUTE 166 A DISTANCE OF 1006.62 FEET; THENCE NORTH 01 DEGREE 33 MINUTES 40 SECONDS EAST A DISTANCE OF 40 FEET TO AN IRON PIN SET ON THE NORTH RIGHT OF WAY LINE OF SAID F.A. ROUTE 166, THE POINT OF BEGINNING OF THE TRACT HEREIN DESCRIBED; THENCE CONTINUING NORTH 1 DEGREE 33 MINUTES 40 SECONDS EAST A DISTANCE OF 435.60 FEET TO AN IRON PIN; THENCE SOUTH 88 DEGREES 26 MINUTES 20 SECONDS EAST AND PARALLEL WITH THE CENTERLINE OF SAID F.A. ROUTE 166 A DISTANCE OF 500.00 FEET TO AN IRON PIN; THENCE SOUTH 01 DEGREES 33 MINUTES 40 SECONDS WEST A DISTANCE OF 435.60 FEET TO AN IRON PIN SET ON THE NORTH RIGHT OF WAY LINE OF SAID F.A. ROUTE 166; AND THENCE NORTH 88 DEGREES 26 MINUTES 20 SECONDS WEST AND ALONG THE NORTH RIGHT OF WAY LINE OF SAID F.A. ROUTE 166 A DISTANCE OF 500.00 FEET TO THE TRUE POINT OF BEGINNING

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No.	REVISIONS	DATE

Kimley»Horn

570 LAKE COOK RD SUITE 200
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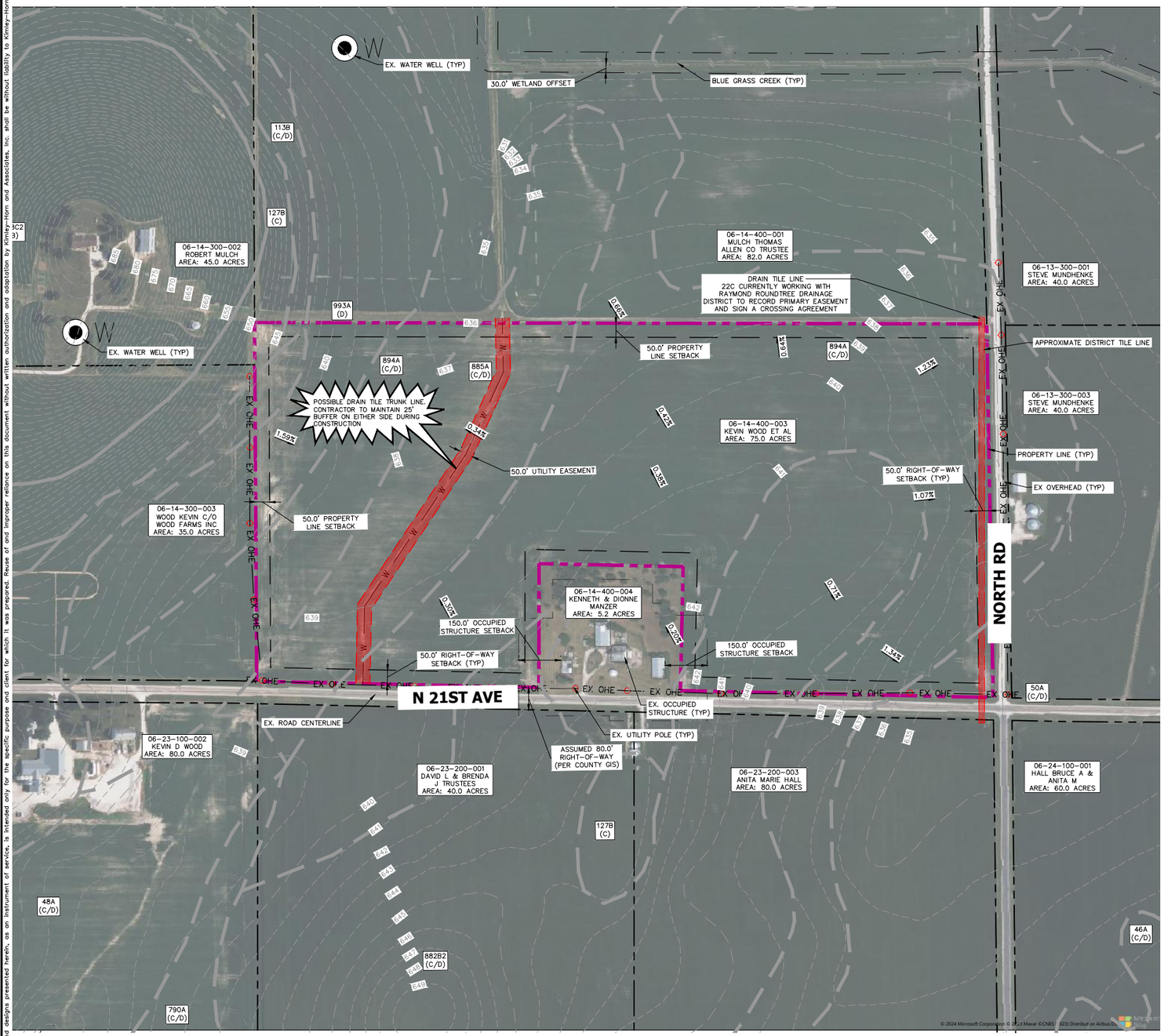
PRELIMINARY- NOT FOR CONSTRUCTION

KHA PROJECT 268330024
DATE 04/05/2024
SCALE AS SHOWN
DESIGNED BY HLL
DRAWN BY HLL
CHECKED BY SMH

COVER SHEET

NORTH SUN LLC
MONTGOMERY COUNTY, IL

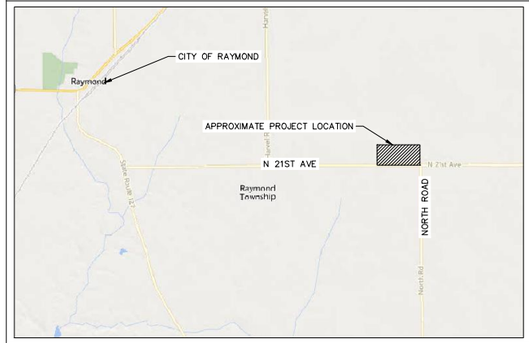
SHEET NUMBER
C-100



GRAPHIC SCALE IN FEET
0 100 200 400

NORTH

VICINITY MAP



SCALE 1" = 5000'

LEGEND

ROAD LABEL	N 2200TH ST
PROJECT BOUNDARY (ESTIMATED PER COUNTY GIS, ACCESSED 02/06/2024)	
PROPERTY LINE (PER COUNTY GIS, ACCESSED 02/06/2024)	
PROPERTY LINE SETBACKS (PER MONTGOMERY COUNTY ORDINANCE NO. 2023-23, DATED 06/13/2023)	
EX. ROAD CENTERLINE (TRACED PER AERIAL)	
ROAD RIGHT-OF-WAY (TRACED PER AERIAL)	R/W
EX. OVERHEAD ELECTRIC (TRACED PER AERIAL)	EX OHE
EX. UTILITY POLE (TRACED PER AERIAL)	
EX. OCCUPIED COMMUNITY BUILDING/DWELLING (TRACED PER AERIAL)	
EX. OCCUPIED COMMUNITY BUILDING/DWELLING OFFSET	
EX. ASSUMED DRAIN TILE	W
EX. UTILITY EASEMENT	
EX. SLOPE	XX%
EX. CONTOURS	XXX
EX. DELINEATED STREAM (PER NWI, ACCESSED ON 02/07/2024)	
30' WETLAND/ STREAM BUFFER	
SOIL BOUNDARY	

NOTES

1. SETBACKS FOR COMMERCIAL SOLAR ENERGY FACILITIES (PER MONTGOMERY COUNTY ORDINANCES NO. 2023-23, ORDINANCE FOR SOLAR ENERGY FARMS AND SOLAR GARDEN INSTALLATIONS IN UNINCORPORATED MONTGOMERY COUNTY, ILLINOIS) ARE AS FOLLOWS:
   - 1.1. NON-PARTICIPATING PROPERTY LINE SETBACK: 50 FT
   - 1.2. ROAD/STREET/HIGHWAY RIGHT-OF-WAY SETBACK: 50 FT
   - 1.3. EX. RESIDENCE SETBACK: 150 FT
2. KIMLEY-HORN ASSUMED CONSTRUCTABILITY SETBACKS:
   - 2.1 WETLAND NON-REGULATED CONSTRUCTABILITY SETBACK: 30 FT
   - 2.2 FEMA FLOODPLAIN CONSTRUCTABILITY SETBACK: 30 FT
3. ALL EXISTING PARCEL INFORMATION AND TAX PARCEL BOUNDARIES ARE PROVIDED BY MONTGOMERY COUNTY GIS ON 02/06/2024.
4. PER THE UNIVERSITY OF ILLINOIS WATER GIS MAP (ACCESSED 02/07/2024) NO WATER WELLS EXIST WITHIN THE SUBJECT PARCEL.
5. PER THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA), THERE ARE NO FLOODPLAINS WTHIN THE SUBJECT PARCEL. THE SITE RESIDES ON FEMA PANEL (17099200O2A).
6. WATERWAYS/WETLANDS WERE OBTAINED FROM THE NATIONAL WETLAND INVENTORY WETLANDS MAPPER (ACCESSED ON 02/07/2024).

SOILS DATA TABLE

MAP UNIT SYMBOL	MAP UNIT NAME	HYDROLOGIC SOIL GROUP
46A	HERRICK SILT LOAM, 0 TO 2 PERCENT SLOPE	C/D
48A	EBBERT SILT LOAM, 0 TO 2 PERCENT SLOPE	C/D
50A	VIRDEN SILTY CLAY LOAM, 0 TO 2 PERCENT SLOPE	C/D
113B	OCONEE SILT LOAM, 2 TO 5 PERCENT SLOPES	C/D
113B2	OCONEE SILT LOAD, 2 TO 5 PERCENT SLOPES, ERODED	C/D
127A	HARRISON SILT LOAM, 0 TO 2 PERCENT SLOPES	C
127B	HARRISON SILT LOAM, 2 TO 5 PERCENT SLOPES	C
127C2	HARRISON SILT LOAM, 5 TO 10 PERCENT SLOPES, ERODED	C
128C2	DOUGLAS SILT LOAM, 5 TO 10 PERCENT SLOPES, ERODED	B
287A	CHAUNCEY SILT LOAM, 0 TO 2 PERCENT SLOPES	C/D
470B2	KELLER SILT LOAM, 2 TO 5 PERCENT SLOPES, ERODED	C/D
790A	HERRICK-BIDDLE SILT LOAMS, 0 TO 2 PERCENT SLOPES	C/D
882A	OCONEE-DARMSTADT-COULTERVILLE SILT LOAMS, 0 TO 2 PERCENT SLOPES	C/D
882B2	OCONEE-DARMSTADT-COULTERVILLE SILT LOAMS, 2 TO 5 PERCENT SLOPES, ERODED	C/D
885A	VIRDEN-FOSTERBURG SILT LOAMS, 0 TO 2 PERCENT SLOPES	C/D
894A	HERRICK-BIDDLE-PIASA SILT LOAMS, 0 TO 2 PERCENT SLOPES	C/D
993A	COWDEN-PIASA SILT LOAMS, 0 TO 2 PERCENT SLOPES	D
3074A	RADFORD SILT LOAM, 0 TO 2 PERCENT SLOPES, FREQUENTLY FLOODED	B/D

SITE DATA TABLE

PIN #	06-14-400-003
APPLICANT	NORTH SUN LLC
PROPERTY OWNER	**KEVIN WOOD ET AL**
SITE ADDRESS	NW OF INTERSECTION OF N 21ST AVE AND NORTH RD, MONTGOMERY COUNTY IL, 62560
LEGAL DESCRIPTION	SEC 27 TWP 04 RNG 01 PT E SE SW & PT NE SW (LYING S OF RR) 2023-1942 344/889--04/1983
ZONING JURISDICTION	MONTGOMERY COUNTY
CURRENT LAND USE	CROPLAND
PROPOSED AREA	SOLAR FARM
TOTAL PARCEL AREA	75.0 ± AC
RIGHT-OF-WAY SETBACK	50.0'
PROPERTY LINE SETBACK	50.0'
RESIDENTIAL SETBACK	150.0'

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No.	REVISIONS	DATE

Kimley»Horn

570 LAKE COOK RD SUITE 200
DEERFIELD, IL 60015
WWW.KIMLEY-HORN.COM

PRELIMINARY- NOT FOR CONSTRUCTION

KHA PROJECT 268330024
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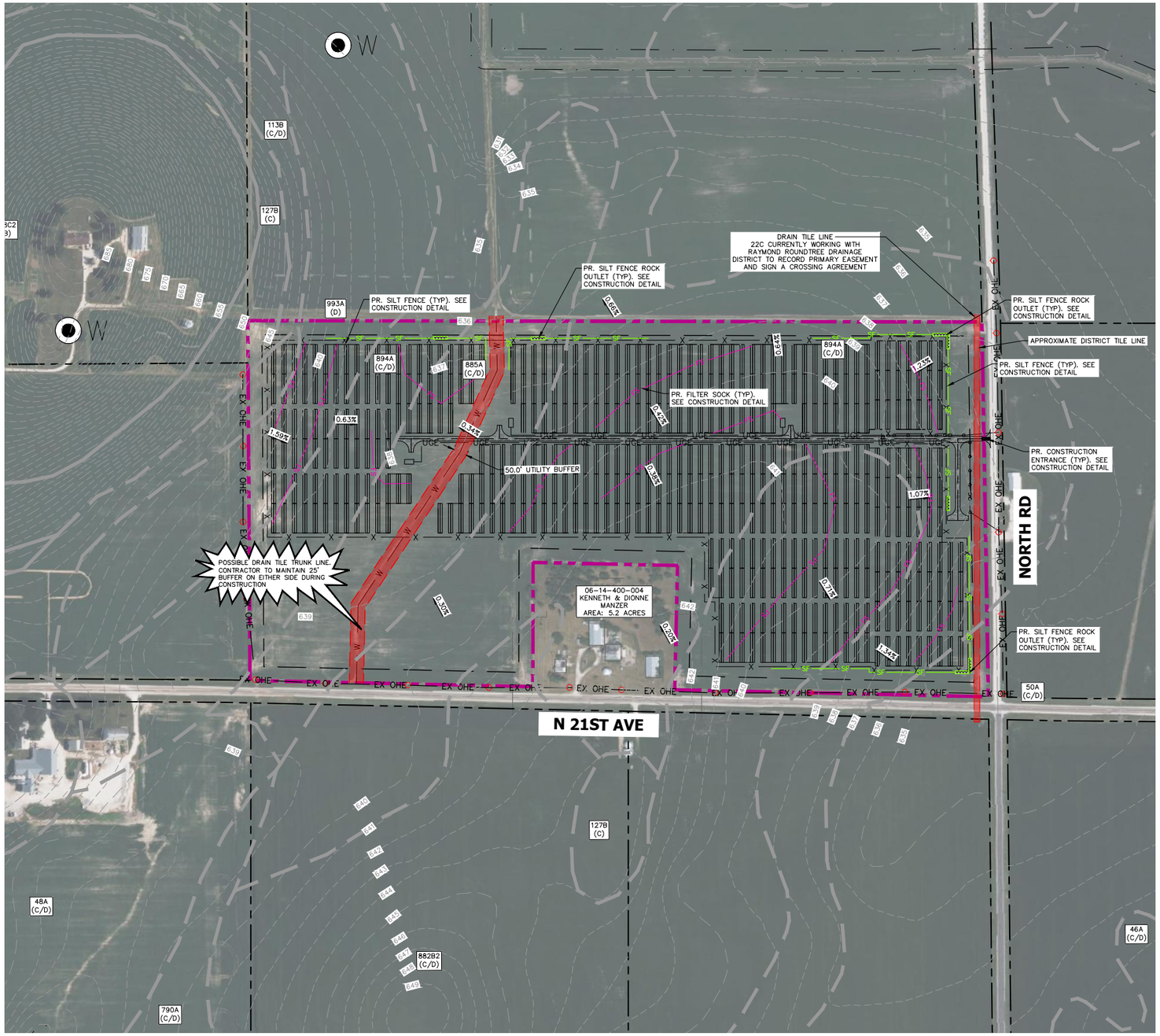
CHECKED BY SMH

EXISTING CONDITIONS

NORTH SUN LLC

MONTGOMERY COUNTY, IL

SHEET NUMBER
C-200



GRAPHIC SCALE IN FEET
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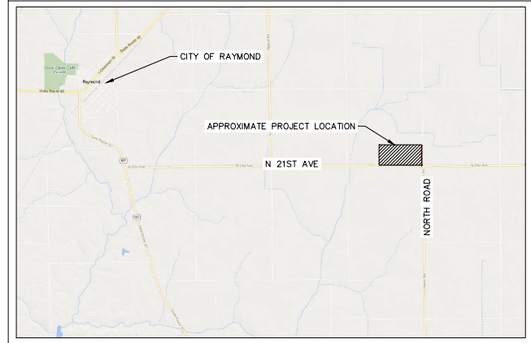
NORTH

VICINITY MAP



SCALE 1" = 5000'

LEGEND

ROAD LABEL	N 2200TH ST
PROJECT BOUNDARY (ESTIMATED PER COUNTY GIS, ACCESSED 02/06/2024)	
PROPERTY LINE (PER COUNTY GIS, ACCESSED 02/06/2024)	
PROPERTY LINE SETBACKS (PER MONTGOMERY COUNTY ORDINANCE NO. 2023-23, DATED 06/13/2023)	
EX. ROAD CENTERLINE (TRACED PER AERIAL)	
ROAD RIGHT-OF-WAY (TRACED PER AERIAL)	R/W
EX. OVERHEAD ELECTRIC (TRACED PER AERIAL)	EX OHE
EX. UTILITY POLE (TRACED PER AERIAL)	
EX. OCCUPIED COMMUNITY BUILDING/DWELLING (TRACED PER AERIAL)	
EX. OCCUPIED COMMUNITY BUILDING/DWELLING OFFSET	
EX. ASSUMED DRAIN TILE	W
EX. UTILITY EASEMENT	
EX. SLOPE	XX%
EX. CONTOURS	XXX
EX. STREAM (PER NWI, ACCESSED ON 02/07/2024)	
30' WETLAND/ STREAM BUFFER	
SOIL BOUNDARY	
PR. SILT FENCE	SF
PR. FILTER SOCK	FS
PR. SILT FENCE ROCK OUTLET	
PR. CONSTRUCTION ENTRANCE	
PR. SECURITY FENCE	X
PR. UTILITY POLE	
PR. EQUIPMENT PAD	
PR. SOLAR ARRAY	
PR. PANEL EXTENTS	
PR. OVERHEAD ELECTRIC	OH
PR. UNDERGROUND ELECTRIC	UGE
PR. GRAVEL ACCESS ROAD	

NOTES

1. THE PURPOSE OF THIS PLAN IS FOR SOLAR FARM PERMIT REVIEW AND APPROVAL BY MONTGOMERY COUNTY TO CONSTRUCT A SOLAR FARM.
2. THIS PLAN WAS PRODUCED UTILIZING GIS RESOURCES AND INFORMATION FROM MULTIPLE SOURCES, INCLUDING MONTGOMERY COUNTY, GOOGLE EARTH, NATIONAL WETLANDS INVENTORY (NWI), FEMA, NRCS SOIL INFORMATION, AND USGS TOPOGRAPHIC INFORMATION.
3. SUBJECT PROPERTY DOES NOT LIE WITHIN A SPECIAL FLOOD HAZARD AS SHOWN ON THE FLOOD INSURANCE RATE MAP (COMMUNITY PANEL 1709920002A) PUBLISHED BY THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA).
4. STORMWATER MANAGEMENT FACILITIES TO BE PROVIDED AS REQUIRED BY COUNTY AND/OR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMITTING, REQUIREMENTS TO BE DETERMINED DURING FINAL ENGINEERING.
5. THE LOCATIONS OF PROPOSED IMPROVEMENTS, INCLUDING BUT NOT LIMITED TO: AGGREGATE ACCESS ROAD, FENCING, SOLAR ARRAY RACKING, INVERTER/TRANSFORMER PADS, OVERHEAD POLES AND LINES, ETC., SHOWN ARE APPROXIMATE AND ARE SUBJECT TO MODIFICATION DUE TO SITE CONDITIONS, ADDITIONAL PERMITTING REQUIREMENTS, EQUIPMENT SPECIFICATIONS, AND/OR OTHER CONSTRAINTS DURING FINAL ENGINEERING.
6. SETBACKS SHOWN ON THIS PLAN ARE BASED ON THE MONTGOMERY COUNTY CODE OF ORDINANCES #2023-23.
7. SILT FENCE HAS BEEN PLACED AT DOWNSTREAM EXTERNAL BOUNDARIES.
8. FILTER SOCK IS PROPOSED TO CHECK EROSIVE FLOWS ACROSS SITE.
9. RIP RAP OUTFALLS ARE PLACED AT CONCENTRATED FLOW POINTS IN THE PERIMETER CONTROLS.
10. ALL DIMENSIONS SHOWN ARE AT 90 DEGREES UNLESS OTHERWISE NOTED.

SITE DATA TABLE

PIN #	06-14-400-003
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ZONING JURISDICTION	MONTGOMERY COUNTY
CURRENT LAND USE	CROPLAND
PROPOSED AREA	SOLAR FARM
TOTAL PARCEL AREA	75.0 ± AC
PRELIMINARY DISTURBED AREA	48.4 ± AC (AREA WITHIN FENCE)
PRELIMINARY SOLAR AREA	41.2 ± AC
RIGHT-OF-WAY SETBACK	50.0'
PROPERTY LINE SETBACK	50.0'
RESIDENTIAL SETBACK	150.0'
TOTAL MODULES	27,540
TOTAL POWER OUTPUT (AC)	UP TO 10 MWac
GROUND COVER RATIO (GCR)	40%

EROSION CONTROL BMPS

DESCRIPTION	QUANTITY
SILT FENCE	3,200 LF
FILTER SOCK	5,900 LF
RIP RAP OUTFALL	7 (EACH)
CONSTRUCTION ENTRANCE	1 (EACH)

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No.	REVISIONS	DATE

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KHA PROJECT 268330024
DATE 04/05/2024
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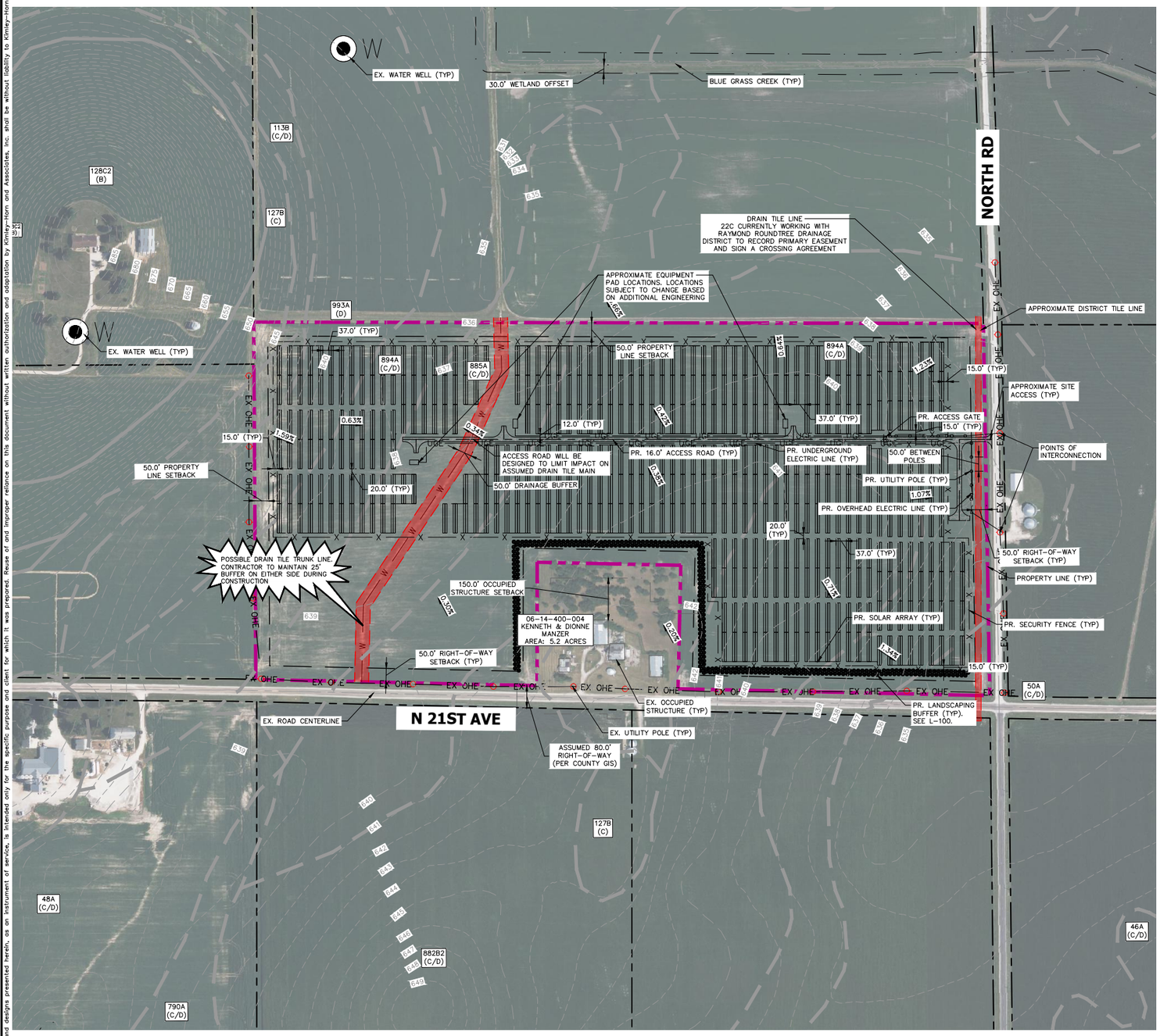
EROSION CONTROL PLAN

NORTH SUN LLC

MONTGOMERY COUNTY, IL

SHEET NUMBER
C-300



GRAPHIC SCALE IN FEET
0 100 200 400

NORTH

VICINITY MAP

SCALE 1" = 5000'

LEGEND

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EX. OVERHEAD ELECTRIC (TRACED PER AERIAL)	EX OHE
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EX. OCCUPIED COMMUNITY BUILDING/DWELLING (TRACED PER AERIAL)	
EX. OCCUPIED COMMUNITY BUILDING/DWELLING OFFSET	
EX. ASSUMED DRAIN TILE	W
EX. DRAINAGE BUFFER	
EX. SLOPE	XX%
EX. CONTOURS	XXX
EX. DELINEATED STREAM (PER NWI, ACCESSED ON 02/07/2024)	
30' WETLAND/ STREAM BUFFER	
SOIL BOUNDARY	
PR. SECURITY FENCE	X X
PR. UTILITY POLE	
PR. EQUIPTMENT PAD	
PR. SOLAR ARRAY	
PR. PANEL LIMIT	
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6. SETBACKS SHOWN ON THIS PLAN ARE BASED ON THE MONTGOMERY COUNTY CODE OF ORDINANCES #2023-23.
7. ALL DIMENSIONS SHOWN ARE AT 90 DEGREES UNLESS OTHERWISE NOTED.
8. PRIOR TO CONSTRUCTION, 22C SHALL CONDUCT A TILE SURVEY TO PLOT AND POTENTIALLY UPGRADE THE RAYMOND ROUNDTREE TILE LINE, FORM A LEGAL DESCRIPTION TO BE RECORDED FOR RAYMOND ROUNDTREE DRAINAGE DISTRICTS RECORDS UNTO THE PROPERTY, AND SIGN A CROSSING AGREEMENT UP TO THE DISTRICT'S LIKING TO PROTECT THE TILE. NO PANELS OR RACKING OR FENCE WILL BE WITHIN 40' OF THE DISTRICT TILE LINE FOR THE AVOIDANCE OF DOUBT.

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PROPERTY LINE SETBACK	50.0'
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TOTAL POWER OUTPUT (AC)	UP TO 10 MWac
GROUND COVER RATIO (GCR)	40%

SOILS DATA TABLE

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48A	EBBERT SILT LOAM, 0 TO 2 PERCENT SLOPE	C/D
50A	VIRDEN SILTY CLAY LOAM, 0 TO 2 PERCENT SLOPE	C/D
113B	OCONEE SILT LOAM, 2 TO 5 PERCENT SLOPES	C/D
113B2	OCONEE SILT LOAD, 2 TO 5 PERCENT SLOPES, ERODED	C/D
127A	HARRISON SILT LOAM, 0 TO 2 PERCENT SLOPES	C
127B	HARRISON SILT LOAM, 2 TO 5 PERCENT SLOPES	C
127C2	HARRISON SILT LOAM, 5 TO 10 PERCENT SLOPES, ERODED	C
128C2	DOUGLAS SILT LOAM, 5 TO 10 PERCENT SLOPES, ERODED	B
287A	CHAUNCEY SILT LOAM, 0 TO 2 PERCENT SLOPES	C/D
470B2	KELLER SILT LOAM, 2 TO 5 PERCENT SLOPES, ERODED	C/D
790A	HERRICK-BIDDLE SILT LOAMS, 0 TO 2 PERCENT SLOPES	C/D
882A	OCONEE-DARMSTADT-COULTERVILLE SILT LOAMS, 0 TO 2 PERCENT SLOPES	C/D
882B2	OCONEE-DARMSTADT-COULTERVILLE SILT LOAMS, 2 TO 5 PERCENT SLOPES, ERODED	C/D
885A	VIRDEN-FOSTERBURG SILT LOAMS, 0 TO 2 PERCENT SLOPES	C/D
894A	HERRICK-BIDDLE-PIASA SILT LOAMS, 0 TO 2 PERCENT SLOPES	C/D
993A	COWDEN-PIASA SILT LOAMS, 0 TO 2 PERCENT SLOPES	D
3074A	RADFORD SILT LOAM, 0 TO 2 PERCENT SLOPES, FREQUENTLY FLOODED	B/D

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KHA PROJECT	268330024
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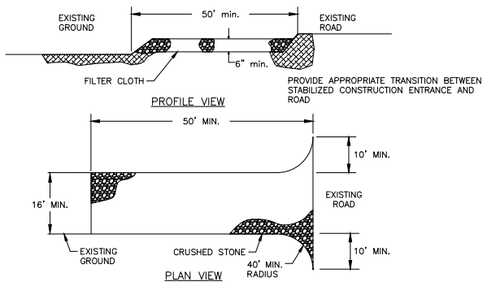
DRAWN BY	HLL
CHECKED BY	SMH

SITE PLAN

NORTH SUN LLC

MONTGOMERY COUNTY, IL

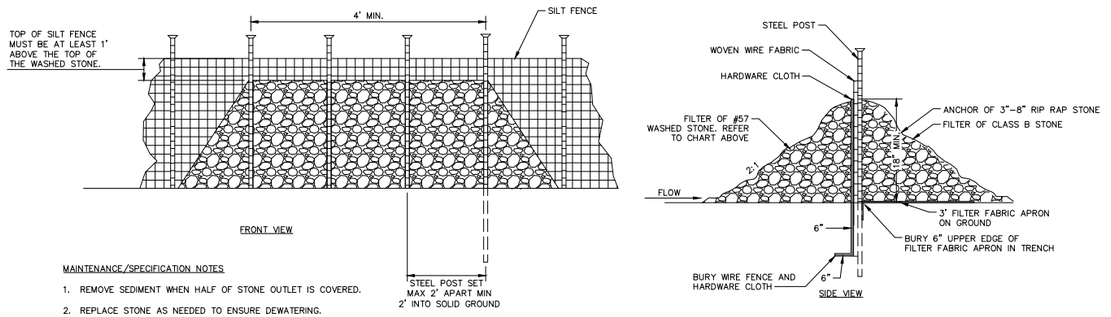
SHEET NUMBER
C-400



1. STONE FOR A STABILIZED CONSTRUCTION ENTRANCE SHALL BE 1 TO 2 INCH STONE, RECLAIMED STONE, OR RECYCLED CONCRETE EQUIVALENT.
2. THE LENGTH OF THE STABILIZED ENTRANCE SHALL NOT BE LESS THAN 50 FEET.
3. THE THICKNESS OF THE STONE FOR THE STABILIZED ENTRANCE SHALL NOT BE LESS THAN 6 INCHES.
4. THE WIDTH OF THE ENTRANCE SHALL NOT BE LESS THAN THE FULL WIDTH OF THE PROPOSED ENTRANCE.
5. GEOTEXTILE FILTER CLOTH (MIRAFI HP370 OR APPROVED EQUIVALENT) SHALL BE PLACED OVER THE ENTIRE AREA PRIOR TO PLACING THE STONE.
6. ALL SURFACE WATER THAT IS FLOWING TO OR DIVERTED TOWARDS THE CONSTRUCTION ENTRANCE SHALL BE PIPED BENEATH THE SURFACE.
7. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO EXISTING ROAD. THIS MANY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE OR ADDITIONAL LENGTH AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED, OR TRACKED ONTO EXISTING ROAD SHALL BE REMOVED IMMEDIATELY.

1 TEMPORARY STABILIZED CONSTRUCTION ENTRANCE DETAIL

SCALE: NTS

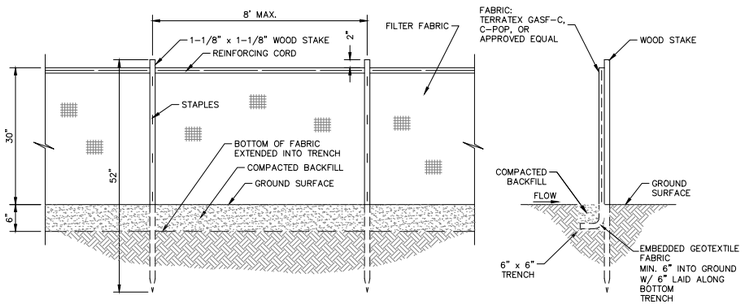


MAINTENANCE/SPECIFICATION NOTES

1. REMOVE SEDIMENT WHEN HALF OF STONE OUTLET IS COVERED.
2. REPLACE STONE AS NEEDED TO ENSURE DEWATERING.
3. SILT FENCE OUTLETS SHOULD NOT BE LOCATED WHERE THE OUTFLOW WILL ERODE THE SOIL BELOW.

2 SILT FENCE ROCK OUTLET DETAIL

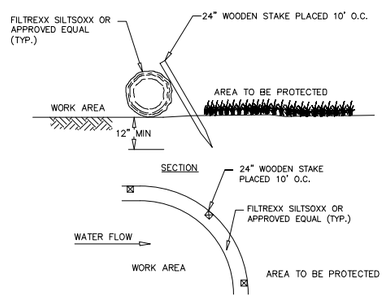
SCALE: NTS



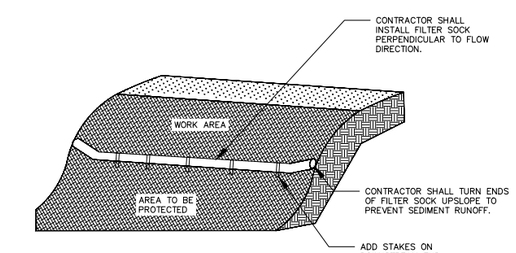
1. AASHTO M288 05 SILT FENCE OR APPROVED EQUIVALENT TO BE FASTENED SECURELY TO FENCE POSTS WITH STAPLES EVERY 24" AT TOP AND MID SECTION.
2. WHEN TWO SECTIONS OF AASHTO M288 05 SILT FENCE OR APPROVED EQUIVALENT ADJOIN EACH OTHER THEY SHALL BE OVERLAPPED BY SIX INCHES AND FOLDED.
3. MAINTENANCE SHALL BE PERFORMED AS NOTED IN THE EROSION CONTROL PLAN. COLLECTED MATERIAL SHALL BE REMOVED WHEN "BULGES" DEVELOP IN THE SILT FENCE.

3 STANDARD SILT FENCE

SCALE: NTS



1. FILTER SOCK SHALL BE 8" DIAMETER MIN.
2. SOCKS TO BE FILLED WITH BIODEGRADABLE COMPOST MATERIAL.
3. WOODEN STAKES SHALL BE PLACED DOWNSLOPE OF THE FILTER SOCK.



MAXIMUM SLOPE LENGTH (FT) ABOVE FILTER SOCK

SLOPE: PERCENT	8 INCH	12 INCH	18 INCH	24 INCH
2 (OR LESS)	300	375	500	650
5	200	250	275	325
10	100	125	150	200
15	70	85	100	160
20	50	65	70	130
22	40	50	55	100

4 FILTER SOCK SEDIMENT CONTROL

SCALE: NTS

No.	REVISIONS	DATE

Kimley»Horn
© 2024 KIMLEY-HORN AND ASSOCIATES, INC.
570 LAKE COOK RD SUITE 200
DEERFIELD, IL 60015
WWW.KIMLEY-HORN.COM

PRELIMINARY- NOT FOR CONSTRUCTION

KHA PROJECT 268330024
DATE 04/05/2024
SCALE AS SHOWN
DESIGNED BY HLL
DRAWN BY HLL
CHECKED BY SMH

CONSTRUCTION DETAILS

NORTH SUN LLC
MONTGOMERY COUNTY, IL

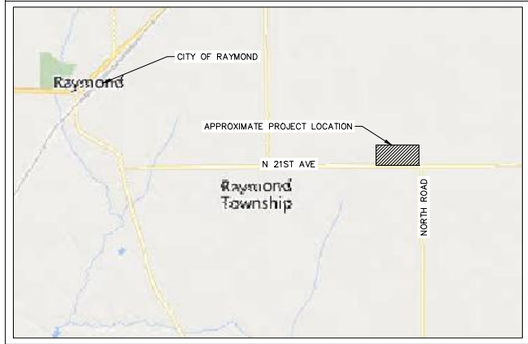
SHEET NUMBER
C-500

Call Before You Dig
JULIE
1-800-892-0123

CONCEPT PLANTS

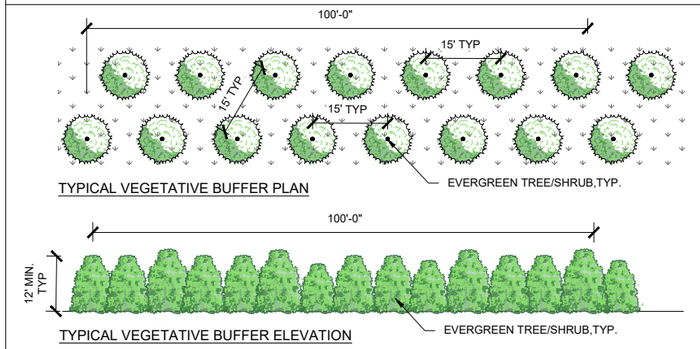
	EVERGREEN TREE/SHRUB SAWARA CYPRESS `SOFT SERVE`	338
	JUNIPERUS VIRGINIANA	
	JUNIPERUS CHINESIS `MOUNTBATTEN`	
	PICEA PUNGENS `FAT ALBERT`	
	TAXUS CUSPIDATA `CAPITATA`	
	TAXUS X MEDIA `HICKSII`	
	THUJA OCCIDENTALIS `WOODWARDI`	

VICINITY MAP



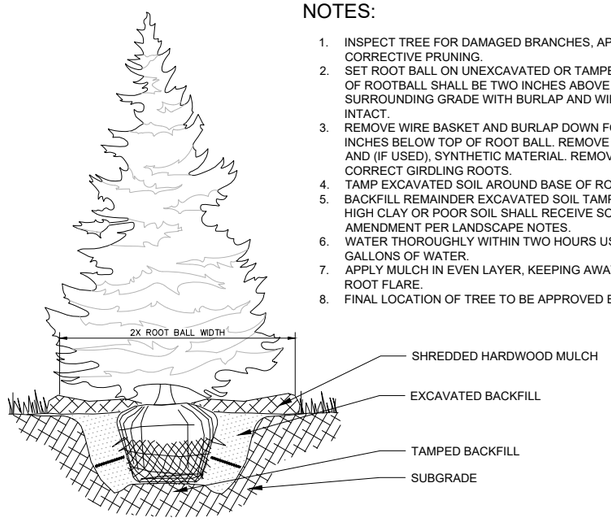
SCALE 1" = 5000'

VEGETATIVE BUFFER



TYPICAL VEGETATIVE BUFFER PLAN

TYPICAL VEGETATIVE BUFFER ELEVATION



NOTES:

1. INSPECT TREE FOR DAMAGED BRANCHES, APPLY CORRECTIVE PRUNING.
2. SET ROOT BALL ON UNEXCAVATED OR TAMPED SOIL. TOP OF ROOTBALL SHALL BE TWO INCHES ABOVE SURROUNDING GRADE WITH BURLAP AND WIRE BASKET INTACT.
3. REMOVE WIRE BASKET AND BURLAP DOWN FOUR TO SIX INCHES BELOW TOP OF ROOT BALL. REMOVE ALL TWINE AND (IF USED), SYNTHETIC MATERIAL. REMOVE OR CORRECT GIRDLING ROOTS.
4. TAMP EXCAVATED SOIL AROUND BASE OF ROOTBALL.
5. BACKFILL REMAINDER EXCAVATED SOIL TAMPED LIGHTLY. HIGH CLAY OR POOR SOIL SHALL RECEIVE SOIL AMENDMENT PER LANDSCAPE NOTES.
6. WATER THOROUGHLY WITHIN TWO HOURS USING 10 TO 15 GALLONS OF WATER.
7. APPLY MULCH IN EVEN LAYER, KEEPING AWAY FROM ROOT FLARE.
8. FINAL LOCATION OF TREE TO BE APPROVED BY OWNER.

1 EVERGREEN TREE PLANTING

NTS

Call Before You Dig
JULIE
1-800-892-0123

No.	REVISIONS	DATE

Kimley»Horn

570 LAKE COOK RD SUITE 200
DEERFIELD, IL 60015
WWW.KIMLEY-HORN.COM

PRELIMINARY- NOT FOR CONSTRUCTION

KHA PROJECT	268330024
DATE	04/05/2024
SCALE	AS SHOWN
DESIGNED BY	HLL
DRAWN BY	HLL
CHECKED BY	SMH

LANDSCAPE PLAN

NORTH SUN LLC

MONTGOMERY COUNTY, IL

SHEET NUMBER
L-100

EXHIBIT D: DECOMISSIONING PLAN

DECOMMISSIONING PLAN

NORTH SUN LLC
MONTGOMERY COUNTY, ILLINOIS

Prepared for:

22c DEVELOPMENT, LLC

4649 N Broadway, Chicago, IL 60640

Contact: Alex Farkes

Prepared By:

Kimley-Horn & Associates, Inc.

570 Lake Cook Rd, Suite 200

Deerfield, IL 60015

Contact: Sean Hickey, P.E.

Prepared on: April 2024

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A. Opinion of Probable Construction Cost with Salvage

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1.0 INTRODUCTION

Background

North Sun LLC, a wholly owned entity of 22c Development, LLC (collectively, the "**Applicant**" or "**North Sun LLC**" or "**22c**"), hereby submits this application for a Solar Farm Development Permit (Application) to construct, operate, and maintain the North Sun LLC solar project, a proposed up to 10 MWac solar farm (Project) on approximately 75 acres (Project Area) in Raymond Township in Montgomery County, Illinois. As shown on in the **Solar Farm Development Permit Application Exhibit C: Solar Farm Development Permit Plans**, the Project's site layout meets the required minimum road right-of-way setbacks and property line setbacks per Section F.2.f. of the Montgomery County Solar Ordinance No. 2023-23.

The Project will be sited over approximately 49 acres of leased property bound to the north and west by agricultural fields, bound to the east by North Road, and bound to the south by N 21st Ave. In existing conditions, the site is a relatively flat agricultural field.

This Decommissioning Plan (Plan) is developed in compliance with Agricultural Impact Mitigation Agreement (AIMA) and the Montgomery County Zoning Ordinance Number 2023-23 Section G.

This Plan covers and addresses the following elements outlined in the conditions of the AIMA and Montgomery County Zoning Ordinance:

- Removal of Above Ground and Below Ground Infrastructure;
- Repair of compaction and rutting;
- Prevention of soil erosion;
- Access roads;
- Weed/vegetation control;
- Decommissioning plans and financial assurance of commercial solar energy facilities.

In addition, per the AIMA, in **Exhibit E**, the Project must be fully decommissioned within twelve (12) months of the end of the Project's useful life. A Project is considered at the end of its useful life when the Facility Owner has not paid landowners the agreed upon amount for six (6) consecutive months.

2.0 PROJECT COMPONENTS

The Project Components that are subject to decommission include the equipment summarized below. The decommission activities associated with these components are discussed in Section 3.0 of this Plan.

Solar Photovoltaic (PV) Equipment

The project will use Solar Photovoltaic (PV) modules mounted on single axis tracker steel pile foundations.

Internal Power Collection System

The PV-generated DC power will be collected from each of the multiple rows of PV modules through one or more combiner boxes and conveyed to inverters. The inverters will convert the DC power to AC power, which will be interconnected into the existing power line running along the east side of North Road.

Transformers and PV combining switchgear will be mounted on concrete foundations.

Earthwork

It is anticipated that the site will require minimal grading for the Project. Site grading and drainage will be conducted in accordance with Final Civil Construction plans.

Roads

Access to the Project will be off of North Road. The site access will be constructed in accordance with County and/or Township requirements and the Final Civil Construction Plans. The on-site site access road is anticipated to be gravel. A culvert may be required and will be designed during Final Engineering.

Fencing

The Project site will be fenced with an eight foot fence. An entry gate will be provided near the site access North Road.

3.0 PROJECT DECOMMISSION AND RECYLCING

Decommission includes removal of above-ground and below-ground structures. Only minor grading is anticipated during construction; and therefore, will require limited or no grading following decommission. Temporary erosion and sedimentation control Best Management Practices should be implemented during the decommission phase of the Project. Work hours on site will be typical 9 am – 5 pm or as otherwise required by the County.

Decommission Preparation

Prior to commencement of the decommission process, assess existing site conditions and prepare the site for demolition. Demolition debris shall be placed in temporary onsite storage area(s) pending final transportation and disposal and/or recycling according to the procedures listed below.

Permits and Approvals

It is anticipated that an NPDES Permit from the Illinois Environmental Protection Agency (IEPA) and a SWPPP will be required. The proposed development area of the site does not contain waters of the United States or Threatened or Endangered species; thus, no federal approvals are expected. Appropriate applications for permits from the state and/or local authorities having jurisdiction (AHJs) shall be submitted and approved prior to decommission activities.

PV Equipment Removal and Recycling

During decommissioning, Project components shall be removed from the site and recycled or disposed of at an appropriately licensed disposal facility. Above ground portions of the PV module supports shall be removed. Below ground portions of the PV module supports shall be removed entirely where practical, but to a depth of 5 feet at a minimum. Those supports that are more firmly anchored (e.g., such as embedded in bedrock) may be cut off at least five feet below ground or to the depth of bedrock, and the remaining support left in place. This depth will avoid impact of underground equipment on future farming or other construction activities. The demolition debris and removed equipment may be cut or dismantled into pieces that can be safely lifted or carried with the onsite equipment being used. The debris and equipment shall be processed for transportation and delivery to an appropriately licensed disposal facility or recycling center. Modules shall be recycled in accordance with the solar module manufacturer's (or equivalent) recycling program. No hazardous materials or waste will be used during operation of the solar facility, and disposal of hazardous material or waste will not be required during decommission.

Internal Power Collection System

The cables, inverters, and transformers shall be dismantled. The concrete foundations shall be broken up, removed and recycled. If ground-screw foundations are used, they shall be removed and recycled. According to the AIMA, underground cables that are buried greater than 5' are not required to be removed; however, for this estimate, they will be counted as removed. Overhead conductors shall be removed from the poles, and the poles and pole foundations shall be removed. Aluminum from the conductors shall be recycled or removed from the site to an appropriately licensed disposal facility.

Roads

Gravel from on-site access roads shall be removed and recycled. Once the gravel is removed, the soil below the access roads shall be scarified a depth of 18-inches and blended as noted in the Site Restoration section below.

Fencing

Project site perimeter fence shall be removed at the end of the decommission project. Since the project site is not currently fenced, this includes removal of all posts, footings, fencing material, gates, etc. to return the site to pre-project condition.

Landscaping

Unless requested in writing to remain in place by the land Owner, all vegetative landscaping and screening installed as part of the Project will be removed. Any weed control equipment used during the project, including weed-control fabrics or other ground covers shall be removed. Landscape areas will be restored as noted in the Site Restoration section below.

Site Restoration

Once removal of all project equipment and landscaping is complete, all areas of the project site that are unvegetated or where vegetation was disturbed/removed as part of decommissioning shall be restored by the applicant. Restoration shall consist of applying additional topsoil, seed, and necessary fertilizer to ensure that adequate vegetation is established throughout the project site. Areas that exhibit compaction and/or rutting shall be scarified a depth of 18-inches prior to placement of topsoil and seed. The existence of drainage tile lines or underground utilities may necessitate less scarification depth. The applicant is responsible for promptly repairing damage to drain tiles and other drainage systems that result from decommissioning of the commercial solar energy facility.

4.0 FUTURE LAND USE

Per the requirements of the Illinois Department of Agriculture (IDOA), an Agricultural Impact Mitigation Agreement (AIMA) must be signed by the Facility owner and filed with the County Board prior to the Commencement of Construction. The IDOA prepared the AIMA to help preserve the integrity of any Agricultural Land that is impacted by the Construction and Decommission of a Commercial Solar Energy Facility. Per the AIMA, all solar panels shall be removed from the property and the land must be restored to its pre-existing condition for agricultural use at the end of the project life cycle. This Decommissioning Plan is consistent with the AIMA requirements to return the land to its pre-project conditions as an agricultural field. Refer to **Application for Solar Farm Development Permit Exhibit E: Agricultural Impact Mitigation Agreement** for the signed AIMA.

5.0 PROJECT DECOMMISSION COSTS AND FINANCIAL ASSURANCE

The AIMA and Montgomery County Ordinance Number 2023-23 Section G requires the Owner and/or Operator to provide a present-day decommission cost estimate, and provide the County with Financial Assurance to cover the estimated costs of Decommission of the Facility. Provisions of this Financial Assurance shall be phased in over the first 11 years of the Project's operations. Additional detail can be found in the Standard Solar AIMA and Montgomery County Ordinance Number 2023-23 Section G. See **Exhibit A: Opinion of Probable Construction Cost with Salvage.** Industry standard prices in 2024 for removal costs were determined using RS Means cost data. Removal cost includes materials, contractor installation/demolition, mobilization and demobilization, overhead and profit, and performance bonding.

EXHIBIT A

Opinion of Probable Construction Cost With Salvage

North Sun LLC
Montgomery County, IL
Decommissioning Estimate Pro Forma with Salvage

Kimley»Horn

The Engineer has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions. Opinions of probable costs provided herein are based on the information known to Engineer at this time and represent only the Engineer's judgment as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs. LS = Lump Sum, HR = Hours, EA = Each, LF = Linear Feet.

Item	Quantity	Unit	Unit Price	Total Salvage	Total Price (incl. markups)	Total Price
Mobilization	1	LS		$ -	$25,370.00	$ (25,370.00)
Contractor's G&A	1	LS		$ -	$4,320.00	$ (4,320.00)
SWPPP, Erosion Control Measures	49	AC	$670.00	$ -	$32,830.00	$ (32,830.00)
Seeding	2.5	AC	$2,813.56	$ -	$7,033.90	$ (7,033.90)
Tilling 6" topsoil/scarifying access road and rough grading existing soil	1	AC	$32,407.94	$ -	$32,407.94	$ (32,407.94)
Remove and Recycle Chainlink Fence, 8' High	7,810	LF	$6.56	$ 4,810.96	$51,233.60	$ (46,422.64)
Remove Power Pole	12	EA	$725.05	$ -	$8,700.60	$ (8,700.60)
Remove and Recycle AC Cables	3,464	LF	$2.22	$ 545.58	$7,690.08	$ (7,144.50)
Remove and Recycle DC Cables	102,206	LF	$0.30	$ 16,097.45	$30,661.80	$ (14,564.36)
Backfill AC and DC trenches	57,475	LF	$0.47	$ -	$27,013.25	$ (27,013.25)
Remove and Recycle Inverters	3	EA	$3,662.03	$ 16,200.00	$10,986.09	$ 5,213.91
Remove and Recycle Photovoltaic Modules	27,540	EA	$6.20	$ 77,694.87	$170,748.00	$ (93,053.13)
Remove and Recycle Piles	5,000	EA	$17.88	$ 79,200.00	$89,400.00	$ (10,200.00)
Remove and Recycle Support Assemblies	771,618	LB	$0.05	$ 84,877.98	$38,580.90	$ 46,297.08
			Subtotal:	**$ 279,426.83**	**$536,976.16**	**$ (257,549.33)**
				40-Year Inflation (3%/year):		**$ (582,586.31)**
					Total:	**$ (840,135.63)**

Notes:

1. Quantities were recorded on 03/22/2024.
2. Equipment rental rates and labor productivity and unit rates were derived from RSMeans Online (Heavy Construction, 2024 data).
3. Labor, material, and equipment rates are based on the RSMeans City Cost Index (CCI) for Springfield.
4. PV Module Removal/Recycle labor and equipment costs are computed at present values.
5. The age at decommissioning of this estimate is 40 years.
6. This estimate assumes 120 modules/tracker for two-thirds length trackers and 180 modules/tracker for full length trackers.
7. This estimate assumes 500 piles per MWac.
8. This estimate assumes 77,162 LB of support assemblies per 1 MW output.
9. Material salvage values were based off of current US salvage exchange rates.
10. Photovoltaic Module material salvage rate is based on straight-line depreciation of modules (-0.5% per year).
11. Material salvage values were determined using the most prevalent salvageable metal in each component. Copper Wire @$0.16/LF (AC and DC Cables) and Steel @0.62/LF of fence, @$0.99/pile, and @$0.11/LB.
12. Inverter resale value is dependent on the assumption that all inverters will be decommissioned and resold half way through their useful life (every 5 years).

EXHIBIT E: AGRICULTRAL IMPACT MITIGATION AGREEMENT (AIMA)

Illinois Department of Agriculture

JB Pritzker, Governor
Jerry Costello II, Director

Bureau of Land and Water Resources
State Fairgrounds • P.O. Box 19281 • Springfield, IL 62794-9281 • 217/782-6297 • TDD 866/287-2999 • Fax 217/557-0993

January 24, 2024

Dear Landowner:

As the landowner across which the North Sun LLC is planning to construct a community scale solar farm and related ±5 MW Commercial Solar Energy Facility, that will consist of solar panel arrays, racking systems, access roads, an onsite underground collection system, inverters and transformers, the Illinois Department of Agriculture would like to inform you of the following matter.

Effective January 22, 2024, North Sun LLC and the Illinois Department of Agriculture (IDOA) entered into an Agricultural Impact Mitigation Agreement (AIMA) establishing standards and policies that North Sun LLC will follow as it constructs a ±5 MW community scale commercial Solar Energy Facility over agricultural land in Montgomery County. The enclosed AIMA will provide a high level of protection to such land, but it may not address specific concerns that you may have. Such concerns must be addressed individually in your own easement contract to accomplish your specific goals.

As you review the AIMA, you may identify procedures that you would like to change. Your right to negotiate changes is preserved by Paragraph B. on page one of the AIMA. It states, "Except for Section 17B. through F., all actions set forth in this AIMA are subject to modification through negotiation by Landowners and the Facility Owner, provided such changes are negotiated in advance of the respective Construction or Deconstruction activities." It is your decision as to whether you discuss the changes you desire with the right-of-way agent that is assigned to you. Of course, you also have the option to seek your own attorney to make sure your interests are protected.

As you consider your personal interests, you may want to include the owner indemnification clause in your individual easement agreement to protect yourself, your family and future heirs against future claims or expenses arising from the commercial solar energy facility's construction, repairs and maintenance. This item is covered in Section 16 of the AIMA. We feel it is best that such issues are left to landowners to address in their individual easement contracts if specific items are of concern.

Please note that although the IDOA has entered the AIMA with the North Sun LLC it does not constitute our endorsement of the project. The AIMA's sole purpose is to provide a high level of protection to landowners and agricultural land that will be impacted by the construction of the Solar Farm.

If you have questions, feel free to contact Jeffrey Evers of my staff at 217-785-5594, the address listed above or agr.aima@illinois.gov.

Sincerely,

Brian Rennecker, Chief
Bureau of Land and Water Resources

Enclosure
BR:JE

cc: Jerry Costello II, IDOA Director
Clay Nordsiek, IDOA
Bill Bodine, Laura Harmon - IL Farm Bureau
Garrett W. Thalgott – IL Farm Bureau
Montgomery Co. Farm Bureau Manager
Montgomery Co. Soil and Water Conservation District (SWCD)
Regional Representatives

STANDARD AGRICULTURAL IMPACT MITIGATION AGREEMENT
between
NORTH SUN LLC

and the
ILLINOIS DEPARTMENT OF AGRICULTURE
Pertaining to the Construction of a Commercial Solar Energy Facility
in
MONTGOMERY County, Illinois

Pursuant to the Renewable Energy Facilities Agricultural Impact Mitigation Act (505 ILCS 147), the following standards and policies are required by the Illinois Department of Agriculture (IDOA) to help preserve the integrity of any Agricultural Land that is impacted by the Construction and Deconstruction of a Commercial Solar Energy Facility. They were developed with the cooperation of agricultural agencies, organizations, Landowners, Tenants, drainage contractors, and solar energy companies to comprise this Agricultural Impact Mitigation Agreement (AIMA).

NORTH SUN LLC, hereafter referred to as Commercial Solar Energy Facility Owner, or simply as Facility Owner, plans to develop and/or operate a 5.00 MWac Commercial Solar Energy Facility in MONTGOMERY County [GPS Coordinates: 39.307372, -89.495308], which will consist of up to 50 acres that will be covered by solar facility related components, such as solar panel arrays, racking systems, access roads, an onsite underground collection system, inverters and transformers and any affiliated electric transmission lines. This AIMA is made and entered between the Facility Owner and the IDOA.

If Construction does not commence within four years after this AIMA has been fully executed, this AIMA shall be revised, with the Facility Owner's input, to reflect the IDOA's most current Solar Farm Construction and Deconstruction Standards and Policies. This AIMA, and any updated AIMA, shall be filed with the County Board by the Facility Owner prior to the commencement of Construction.

The below prescribed standards and policies are applicable to Construction and Deconstruction activities occurring partially or wholly on privately owned agricultural land.

Conditions of the AIMA

The mitigative actions specified in this AIMA shall be subject to the following conditions:

A. All Construction or Deconstruction activities may be subject to County or other local requirements. However, the specifications outlined in this AIMA shall be the minimum standards applied to all Construction or Deconstruction activities. IDOA may utilize any legal means to enforce this AIMA.

B. Except for Section 17. B. through F., all actions set forth in this AIMA are subject to modification through negotiation by Landowners and the Facility Owner, provided such changes are negotiated in advance of the respective Construction or Deconstruction activities.

C. The Facility Owner may negotiate with Landowners to carry out the actions that Landowners wish to perform themselves. In such instances, the Facility Owner shall offer Landowners the area commercial rate for their machinery and labor costs.

D. All provisions of this AIMA shall apply to associated future Construction, maintenance, repairs, and Deconstruction of the Facility referenced by this AIMA.

E. The Facility Owner shall keep the Landowners and Tenants informed of the Facility's Construction and Deconstruction status, and other factors that may have an impact upon their farming operations.

F. The Facility Owner shall include a statement of its adherence to this AIMA in any environmental assessment and/or environmental impact statement.

G. Execution of this AIMA shall be made a condition of any Conditional/Special Use Permit. Not less than 30 days prior to the commencement of Construction, a copy of this AIMA shall be provided by the Facility Owner to each Landowner that is party to an Underlying Agreement. In addition, this AIMA shall be incorporated into each Underlying Agreement.

H. The Facility Owner shall implement all actions to the extent that they do not conflict with the requirements of any applicable federal, state and local rules and regulations and other permits and approvals that are obtained by the Facility Owner for the Facility.

I. No later than 45 days prior to the Construction and/or Deconstruction of a Facility, the Facility Owner shall provide the Landowner(s) with a telephone number the Landowner can call to alert the Facility Owner should the Landowner(s) have questions or concerns with the work which is being done or has been carried out on his/her property.

J. If there is a change in ownership of the Facility, the Facility Owner assuming ownership of the Facility shall provide written notice within 90 days of ownership transfer, to the Department, the County, and to Landowners of such change. The Financial Assurance requirements and the other terms of this AIMA shall apply to the new Facility Owner.

K. The Facility Owner shall comply with all local, state and federal laws and regulations, specifically including the worker protection standards to protect workers from pesticide exposure.

L. Within 30 days of execution of this AIMA, the Facility Owner shall use Best Efforts to provide the IDOA with a list of all Landowners that are party to an Underlying Agreement and known Tenants of said Landowner who may be affected by the Facility. As the list of Landowners and Tenants is updated, the Facility Owner shall notify the IDOA of any additions or deletions.

M. If any provision of this AIMA is held to be unenforceable, no other provision shall be affected by that holding, and the remainder of the AIMA shall be interpreted as if it did not contain the unenforceable provision.

Definitions

Abandonment	When Deconstruction has not been completed within 12 months after the Commercial Solar Energy Facility reaches the end of its useful life. For purposes of this definition, a Commercial Solar Energy Facility shall be presumed to have reached the end of its useful life if the Commercial Solar Energy Facility Owner fails, for a period of 6 consecutive months, to pay the Landowner amounts owed in accordance with an Underlying Agreement.

Aboveground Cable	Electrical power lines installed above ground surface to be utilized for conveyance of power from the solar panels to the solar facility inverter and/or point of interconnection to utility grid or customer electric meter.
Agricultural Impact Mitigation Agreement (AIMA)	The Agreement between the Facility Owner and the Illinois Department of Agriculture (IDOA) described herein.
Agricultural Land	Land used for Cropland, hayland, pastureland, managed woodlands, truck gardens, farmsteads, commercial ag-related facilities, feedlots, livestock confinement systems, land on which farm buildings are located, and land in government conservation programs used for purposes as set forth above.
Best Efforts	Diligent, good faith, and commercially reasonable efforts to achieve a given objective or obligation.
Commercial Operation Date	The calendar date of which the Facility Owner notifies the Landowner, County, and IDOA in writing that commercial operation of the facility has commenced. If the Facility Owner fails to provide such notifications, the Commercial Operation Date shall be the execution date of this AIMA plus 6 months.
Commercial Solar Energy Facility (Facility)	A solar energy conversion facility equal to or greater than 500 kilowatts in total nameplate capacity, including a solar energy conversion facility seeking an extension of a permit to construct granted by a county or municipality before June 29, 2018. "Commercial solar energy facility" does not include a solar energy conversion facility: (1) for which a permit to construct has been issued before June 29, 2018; (2) that is located on land owned by the commercial solar energy facility owner; (3) that was constructed before June 29, 2018; or (4) that is located on the customer side of the customer's electric meter and is primarily used to offset that customer's electricity load and is limited in nameplate capacity to less than or equal to 2,000 kilowatts.
Commercial Solar Energy Facility Owner deemed (Facility Owner)	A person or entity that owns a commercial solar energy facility. A Commercial Solar Energy Facility Owner is not nor shall it be to be a public utility as defined in the Public Utilities Act.
County	The County or Counties where the Commercial Solar Energy Facility is located.
Construction	The installation, preparation for installation and/or repair of a Facility.
Cropland	Land used for growing row crops, small grains or hay; includes land which was formerly used as cropland, but is currently enrolled in a government conservation program; also includes pastureland that is classified as Prime Farmland.

Deconstruction	The removal of a Facility from the property of a Landowner and the restoration of that property as provided in the AIMA.
Deconstruction Plan	A plan prepared by a Professional Engineer, at the Facility's expense, that includes: (1) the estimated Deconstruction cost, in current dollars at the time of filing, for the Facility, considering among other things: i. the number of solar panels, racking, and related facilities involved; ii. the original Construction costs of the Facility; iii. the size and capacity, in megawatts of the Facility; iv. the salvage value of the facilities (if all interests in salvage value are subordinate to that of the Financial Assurance holder if abandonment occurs); v. the Construction method and techniques for the Facility and for other similar facilities; and (2) a comprehensive detailed description of how the Facility Owner plans to pay for the Deconstruction of the Facility.
Department	The Illinois Department of Agriculture (IDOA).
Financial Assurance	A reclamation or surety bond or other commercially available financial assurance that is acceptable to the County, with the County or Landowner as beneficiary.
Landowner	Any person with an ownership interest in property that is used for agricultural purposes and that is party to an Underlying Agreement.
Prime Farmland	Agricultural Land comprised of soils that are defined by the USDA Natural Resources Conservation Service (NRCS) as "Prime Farmland" (generally considered to be the most productive soils with the least input of nutrients and management).
Professional Engineer	An engineer licensed to practice engineering in the State of Illinois.
Soil and Water Conservation District (SWCD)	A unit of local government that provides technical and financial assistance to eligible Landowners for the conservation of soil and water resources.
Tenant	Any person, apart from the Facility Owner, lawfully residing or leasing/renting land that is subject to an Underlying Agreement.
Topsoil	The uppermost layer of the soil that has the darkest color or the highest content of organic matter; more specifically, it is defined as the "A" horizon.
Underlying Agreement	The written agreement between the Facility Owner and the Landowner(s) including, but not limited to, an easement, option, lease, or license under the terms of which another person has constructed, constructs, or intends to construct a Facility on the property of the Landowner.

Underground Cable	Electrical power lines installed below the ground surface to be utilized for conveyance of power within a Facility or from a Commercial Solar Energy Facility to the electric grid.
USDA Natural Resources Conservation Service (NRCS)	An agency of the United States Department of Agriculture that provides America's farmers with financial and technical assistance to aid with natural resources conservation.

Construction and Deconstruction Standards and Policies

1. Support Structures

A. Only single pole support structures shall be used for the Construction and operation of the Facility on Agricultural Land. Other types of support structures, such as lattice towers or H-frames, may be used on nonagricultural land.

B. Where a Facility's Aboveground Cable will be adjacent and parallel to highway and/or railroad right-of-way, but on privately owned property, the support structures shall be placed as close as reasonably practicable and allowable by the applicable County Engineer or other applicable authorities to the highway or railroad right-of-way. The only exceptions may be at jogs or weaves on the highway alignment or along highways or railroads where transmission and distribution lines are already present.

C. When it is not possible to locate Aboveground Cable next to highway or railroad right-of-way, Best Efforts shall be expended to place all support poles in such a manner to minimize their placement on Cropland (i.e., longer than normal above ground spans shall be utilized when traversing Cropland).

2. Aboveground Facilities

Locations for facilities shall be selected in a manner that is as unobtrusive as reasonably possible to ongoing agricultural activities occurring on the land that contains or is adjacent to the Facility.

3. Guy Wires and Anchors

Best Efforts shall be made to place guy wires and their anchors, if used, out of Cropland, pastureland and hayland, placing them instead along existing utilization lines and on land other than Cropland. Where this is not feasible, Best Efforts shall be made to minimize guy wire impact on Cropland. All guy wires shall be shielded with highly visible guards.

4. Underground Cabling Depth

A. Underground electrical cables located outside the perimeter of the (fence) of the solar panels shall be buried with:

1. a minimum of 5 feet of top cover where they cross Cropland.
2. a minimum of 5 feet of top cover where they cross pastureland or other non-Cropland classified as Prime Farmland.
3. a minimum of 3 feet of top cover where they cross pastureland and other Agricultural Land not classified as Prime Farmland.

4. a minimum of 3 feet of top cover where they cross wooded/brushy land.

B. Provided that the Facility Owner removes the cables during Deconstruction, underground electric cables may be installed to a minimum depth of 18 inches:

1. Within the fenced perimeter of the Facility; or

2. When buried under an access road associated with the Facility provided that the location and depth of cabling is clearly marked at the surface.

C. If Underground Cables within the fenced perimeter of the solar panels are installed to a minimum depth of 5 feet, they may remain in place after Deconstruction.

5. Topsoil Removal and Replacement

A. Any excavation shall be performed in a manner to preserve topsoil. Best Efforts shall be made to store the topsoil near the excavation site in such a manner that it will not become intermixed with subsoil materials.

B. Best Efforts shall be made to store all disturbed subsoil material near the excavation site and separate from the topsoil.

C. When backfilling an excavation site, Best Efforts shall be used to ensure the stockpiled subsoil material will be placed back into the excavation site before replacing the topsoil.

D. Refer to Section 7 for procedures pertaining to rock removal from the subsoil and topsoil.

E. Refer to Section 8 for procedures pertaining to the repair of compaction and rutting of the topsoil.

F. Best Efforts shall be performed to place the topsoil in a manner so that after settling occurs, the topsoil's original depth and contour will be restored as close as reasonably practicable. The same shall apply where excavations are made for road, stream, drainage ditch, or other crossings. In no instance shall the topsoil materials be used for any other purpose unless agreed to explicitly and in writing by the Landowner.

G. Based on the mutual agreement of the landowner and Facility Owner, excess soil material resulting from solar facility excavation shall either be removed or stored on the Landowner's property and reseeded per the applicable National Pollution Discharge Elimination System (NPDES) permit/Stormwater Pollution Prevention Plan (SWPPP). After the Facility reaches the end of its Useful Life, the excess subsoil material shall be returned to an excavation site or removed from the Landowner's property, unless otherwise agreed to by Landowner.

6. Rerouting and Permanent Repair of Agricultural Drainage Tiles

The following standards and policies shall apply to underground drainage tile line(s) directly or indirectly affected by Construction and/or Deconstruction:

A. Prior to Construction, the Facility Owner shall work with the Landowner to identify drainage tile lines traversing the property subject to the Underlying Agreement to the extent reasonably practicable. All drainage tile lines identified in this manner shall be shown on the Construction and Deconstruction Plans.

B. The location of all drainage tile lines located adjacent to or within the footprint of the Facility shall be recorded using Global Positioning Systems (GPS) technology. Within 60 days after Construction is complete, the Facility Owner shall provide the Landowner, the IDOA, and the respective County Soil and Water Conservation District (SWCD) with "as built" drawings (strip maps) showing the location of all drainage tile lines by survey station encountered in the Construction of the Facility, including any tile line repair location(s), and any underground cable installed as part of the Facility.

C. **Maintaining Surrounding Area Subsurface Drainage**

If drainage tile lines are damaged by the Facility, the Facility Owner shall repair the lines or install new drainage tile line(s) of comparable quality and cost to the original(s), and of sufficient size and appropriate slope in locations that limit direct impact from the Facility. If the damaged tile lines cause an unreasonable disruption to the drainage system, as determined by the Landowner, then such repairs shall be made promptly to ensure appropriate drainage. Any new line(s) may be located outside of, but adjacent to the perimeter of the Facility. Disrupted adjacent drainage tile lines shall be attached thereto to provide an adequate outlet for the disrupted adjacent tile lines.

D. **Re-establishing Subsurface Drainage Within Facility Footprint**

Following Deconstruction and using Best Efforts, if underground drainage tile lines were present within the footprint of the facility and were severed or otherwise damaged during original Construction, facility operation, and/or facility Deconstruction, the Facility Owner shall repair existing drainage tiles or install new drainage tile lines of comparable quality and cost to the original, within the footprint of the Facility with sufficient capacity to restore the underground drainage capacity that existed within the footprint of the Facility prior to Construction. Such installation shall be completed within 12 months after the end of the useful life of the Facility and shall be compliant with Figures 1 and 2 to this Agreement or based on prudent industry standards if agreed to by Landowner.

E. If there is any dispute between the Landowner and the Facility Owner on the method of permanent drainage tile line repair, the appropriate County SWCD's opinion shall be considered by the Facility Owner and the Landowner.

F. During Deconstruction, all additional permanent drainage tile line repairs beyond those included above in Section 6.D. must be made within 30 days of identification or notification of the damage, weather and soil conditions permitting. At other times, such repairs must be made at a time mutually agreed upon by the Facility Owner and the Landowner. If the Facility Owner and Landowner cannot agree upon a reasonable method to complete this restoration, the Facility Owner may implement the recommendations of the appropriate County SWCD and such implementation constitutes compliance with this provision.

G. Following completion of the work required pursuant to this Section, the Facility Owner shall be responsible for correcting all drainage tile line repairs that fail due to Construction and/or Deconstruction for one year following the completion of Construction or Deconstruction, provided those repairs were made by the Facility Owner. The Facility Owner shall not be responsible for drainage tile repairs that the Facility Owner pays the Landowner to perform.

7. Rock Removal

With any excavations, the following rock removal procedures pertain only to rocks found in the uppermost 42 inches of soil, the common freeze zone in Illinois, which emerged or were brought to the site as a result of Construction and/or Deconstruction.

A. Before replacing any topsoil, Best Efforts shall be taken to remove all rocks greater than 3 inches in any dimension from the surface of exposed subsoil which emerged or were brought to the site as a result of Construction and/or Deconstruction.

B. If trenching, blasting, or boring operations are required through rocky terrain, precautions shall be taken to minimize the potential for oversized rocks to become interspersed in adjacent soil material.

C. Rocks and soil containing rocks removed from the subsoil areas, topsoil, or from any excavations, shall be removed from the Landowner's premises or disposed of on the Landowner's premises at a location that is mutually acceptable to the Landowner and the Facility Owner.

8. Repair of Compaction and Rutting

A. Unless the Landowner opts to do the restoration work on compaction and rutting, after the topsoil has been replaced post-Deconstruction, all areas within the boundaries of the Facility that were traversed by vehicles and Construction and/or Deconstruction equipment that exhibit compaction and rutting shall be restored by the Facility Owner. All prior Cropland shall be ripped at least 18 inches deep or to the extent practicable, and all pasture and woodland shall be ripped at least 12 inches deep or to the extent practicable. The existence of drainage tile lines or underground utilities may necessitate less ripping depth. The disturbed area shall then be disked.

B. All ripping and disking shall be done at a time when the soil is dry enough for normal tillage operations to occur on Cropland adjacent to the Facility.

C. The Facility Owner shall restore all rutted land to a condition as close as possible to its original condition upon Deconstruction, unless necessary earlier as determined by the Landowner.

D. If there is any dispute between the Landowner and the Facility Owner as to what areas need to be ripped/disked or the depth at which compacted areas should be ripped/disked, the appropriate County SWCD's opinion shall be considered by the Facility Owner and the Landowner.

9. Construction During Wet Weather

Except as provided below, construction activities are not allowed on agricultural land during times when normal farming operations, such as plowing, disking, planting or harvesting, cannot take place due to excessively wet soils. With input from the landowner, wet weather conditions may be determined on a field by field basis.

A. Construction activities on prepared surfaces, surfaces where topsoil and subsoil have been removed, heavily compacted in preparation, or otherwise stabilized (e.g. through cement mixing) may occur at the discretion of the Facility Owner in wet weather conditions.

B. Construction activities on unprepared surfaces will be done only when work will not result in rutting which may mix subsoil and topsoil. Determination as to the potential of subsoil and topsoil mixing will be made in consultation with the underlying Landowner, or, if approved by the Landowner, his/her designated tenant or designee.

10. Prevention of Soil Erosion

A. The Facility Owner shall work with Landowners and create and follow a SWPPP to prevent excessive erosion on land that has been disturbed by Construction or Deconstruction of a Facility.

B. If the Landowner and Facility Owner cannot agree upon a reasonable method to control erosion on the Landowner's property, the Facility Owner shall consider the recommendations of the appropriate County SWCD to resolve the disagreement.

C. The Facility Owner may, per the requirements of the project SWPPP and in consultation with the Landowner, seed appropriate vegetation around all panels and other facility components to prevent erosion. The Facility Owner must utilize Best Efforts to ensure that all seed mixes will be as free of any noxious weed seeds as possible. The Facility Owner shall consult with the Landowner regarding appropriate varieties to seed.

11. Repair of Damaged Soil Conservation Practices

Consultation with the appropriate County SWCD by the Facility Owner shall be carried out to determine if there are soil conservation practices (such as terraces, grassed waterways, etc.) that will be damaged by the Construction and/or Deconstruction of the Facility. Those conservation practices shall be restored to their preconstruction condition as close as reasonably practicable following Deconstruction in accordance with USDA NRCS technical standards. All repair costs shall be the responsibility of the Facility Owner.

12. Compensation for Damages to Private Property

The Facility Owner shall reasonably compensate Landowners for damages caused by the Facility Owner. Damage to Agricultural Land shall be reimbursed to the Landowner as prescribed in the applicable Underlying Agreement.

13. Clearing of Trees and Brush

A. If trees are to be removed for the Construction or Deconstruction of a Facility, the Facility Owner shall consult with the Landowner to determine if there are trees of commercial or other value to the Landowner.

B. If there are trees of commercial or other value to the Landowner, the Facility Owner shall allow the Landowner the right to retain ownership of the trees to be removed and the disposition of the removed trees shall be negotiated prior to the commencement of land clearing.

14. Access Roads

A. To the extent practicable, access roads shall be designed to not impede surface drainage and shall be built to minimize soil erosion on or near the access roads.

B. Access roads may be left intact during Construction, operation or Deconstruction through mutual agreement of the Landowner and the Facility Owner unless otherwise restricted by federal, state, or local regulations.

C. If the access roads are removed, Best Efforts shall be expended to assure that the land shall be restored to equivalent condition(s) as existed prior to their construction, or as otherwise agreed to by the Facility Owner and the Landowner. All access roads that are removed shall be ripped to a depth of 18 inches. All ripping shall be performed consistent with Section 8.

15. Weed/Vegetation Control

A. The Facility Owner shall provide for weed control in a manner that prevents the spread of weeds. Chemical control, if used, shall be done by an appropriately licensed pesticide applicator.

B. The Facility Owner shall be responsible for the reimbursement of all reasonable costs incurred by owners of agricultural land where it has been determined by the appropriate state or county entity that weeds have spread from the Facility to their property. Reimbursement is contingent upon written notice to the Facility Owner. Facility Owner shall reimburse the property owner within 45 days after notice is received.

C. The Facility Owner shall ensure that all vegetation growing within the perimeter of the Facility is properly and appropriately maintained. Maintenance may include, but not be limited to, mowing, trimming, chemical control, or the use of livestock as agreed to by the Landowner.

D. The Deconstruction plans must include provisions for the removal of all weed control equipment used in the Facility, including weed-control fabrics or other ground covers.

16. Indemnification of Landowners

The Facility Owner shall indemnify all Landowners, their heirs, successors, legal representatives, and assigns from and against all claims, injuries, suits, damages, costs, losses, and reasonable expenses resulting from or arising out of the Commercial Solar Energy Facility, including Construction and Deconstruction thereof, and also including damage to such Facility or any of its appurtenances, except where claims, injuries, suits, damages, costs, losses, and expenses are caused by the negligence or intentional acts, or willful omissions of such Landowners, and/or the Landowners heirs, successors, legal representatives, and assigns.

17. Deconstruction Plans and Financial Assurance of Commercial Solar Energy Facilities

A. Deconstruction of a Facility shall include the removal/disposition of all solar related equipment/facilities, including the following utilized for operation of the Facility and located on Landowner property:

1. Solar panels, cells and modules;
2. Solar panel mounts and racking, including any helical piles, ground screws, ballasts, or other anchoring systems;
3. Solar panel foundations, if used (to depth of 5 feet);

4. Transformers, inverters, energy storage facilities, or substations, including all components and foundations; however, Underground Cables at a depth of 5 feet or greater may be left in place;
5. Overhead collection system components;
6. Operations/maintenance buildings, spare parts buildings and substation/switching gear buildings unless otherwise agreed to by the Landowner;
7. Access Road(s) unless Landowner requests in writing that the access road is to remain;
8. Operation/maintenance yard/staging area unless otherwise agreed to by the Landowner; and
9. Debris and litter generated by Deconstruction and Deconstruction crews.

B. The Facility Owner shall, at its expense, complete Deconstruction of a Facility within twelve (12) months after the end of the useful life of the Facility.

C. During the County permit process, or if none, then prior to the commencement of construction, the Facility Owner shall file with the County a Deconstruction Plan. The Facility Owner shall file an updated Deconstruction Plan with the County on or before the end of the tenth year of commercial operation.

D. The Facility Owner shall provide the County with Financial Assurance to cover the estimated costs of Deconstruction of the Facility. Provision of this Financial Assurance shall be phased in over the first 11 years of the Project's operation as follows:

1. On or before the first anniversary of the Commercial Operation Date, the Facility Owner shall provide the County with Financial Assurance to cover ten (10) percent of the estimated costs of Deconstruction of the Facility as determined in the Deconstruction Plan.
2. On or before the sixth anniversary of the Commercial Operation Date, the Facility Owner shall provide the County with Financial Assurance to cover fifty (50) percent of the estimated costs of Deconstruction of the Facility as determined in the Deconstruction Plan.
3. On or before the eleventh anniversary of the Commercial Operation Date, the Facility Owner shall provide the County with Financial Assurance to cover one hundred (100) percent of the estimated costs of Deconstruction of the Facility as determined in the updated Deconstruction Plan provided during the tenth year of commercial operation.

The Financial Assurance shall not release the surety from liability until the Financial Assurance is replaced. The salvage value of the Facility may only be used to reduce the estimated costs of Deconstruction if the County agrees that all interests in the salvage value are subordinate or have been subordinated to that of the County if Abandonment occurs.

E. The County may, but is not required to, reevaluate the estimated costs of Deconstruction of any Facility after the tenth anniversary, and every five years thereafter, of the Commercial Operation Date. Based on any reevaluation, the County may require changes in the level of Financial Assurance used to calculate the phased Financial Assurance levels described in Section 17.D. required from the Facility Owner. If the County is unable to its satisfaction to perform the investigations necessary to approve the Deconstruction Plan filed by the Facility Owner, then the County and Facility may mutually agree on the selection of a Professional Engineer independent of the Facility Owner to conduct any necessary investigations. The Facility Owner shall be responsible for the cost of any such investigations.

F. Upon Abandonment, the County may take all appropriate actions for Deconstruction including drawing upon the Financial Assurance.

Concurrence of the Parties to this AIMA

The Illinois Department of Agriculture and NORTH SUN LLC concur that this AIMA is the complete AIMA governing the mitigation of agricultural impacts that may result from the Construction and Deconstruction of the solar farm project in ONTGOMEF County within the State of Illinois.

The effective date of this AIMA commences on the date of execution.

STATE OF ILLINOIS
DEPARTMENT OF AGRICULTURE

Jerry Costello II

By: Jerry Costello II, Director 4

Clay Nordsiek

By ~~Tess Sangana, General Counsel~~
Clay Nordsiek, Deputy General Counsel

801 E. Sangamon Avenue, 62702
State Fairgrounds, POB 19281 Springfield,
IL 62794-9281

1/22/24, 20

NORTH SUN LLC

DocuSigned by:
alexander x farkes
C5181BAE55D5405...

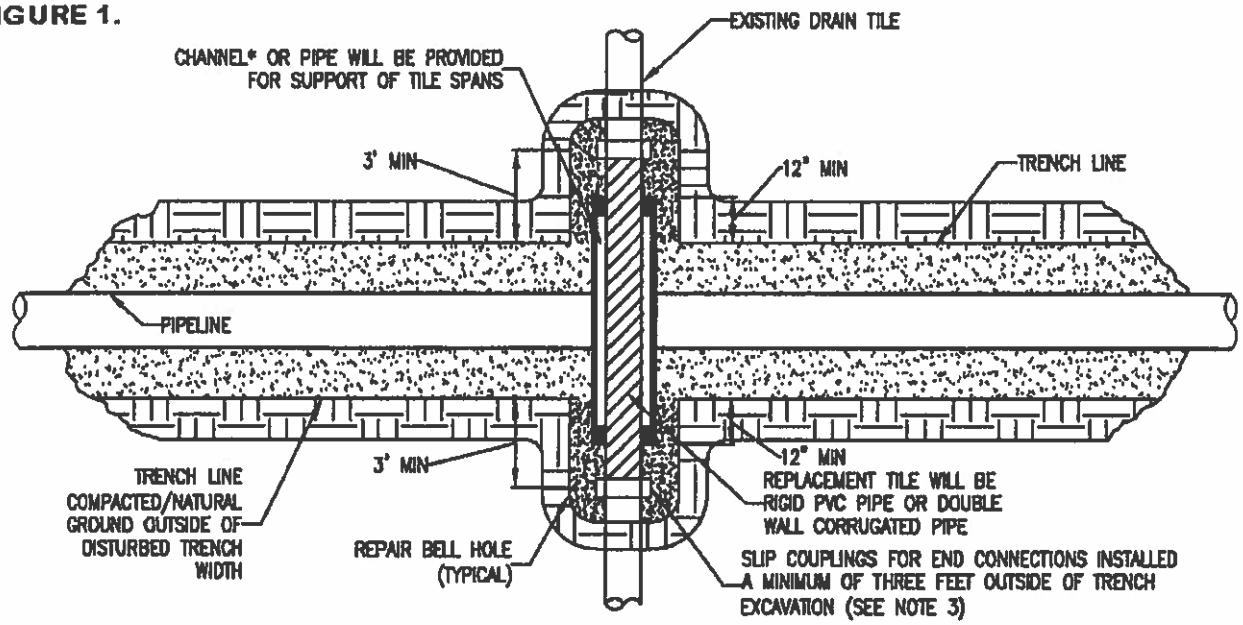
By ALEXANDER FARKES, OWNER

4753 N BROADWAY, FLOOR 2
CHICAGO, ILLINOIS 60640

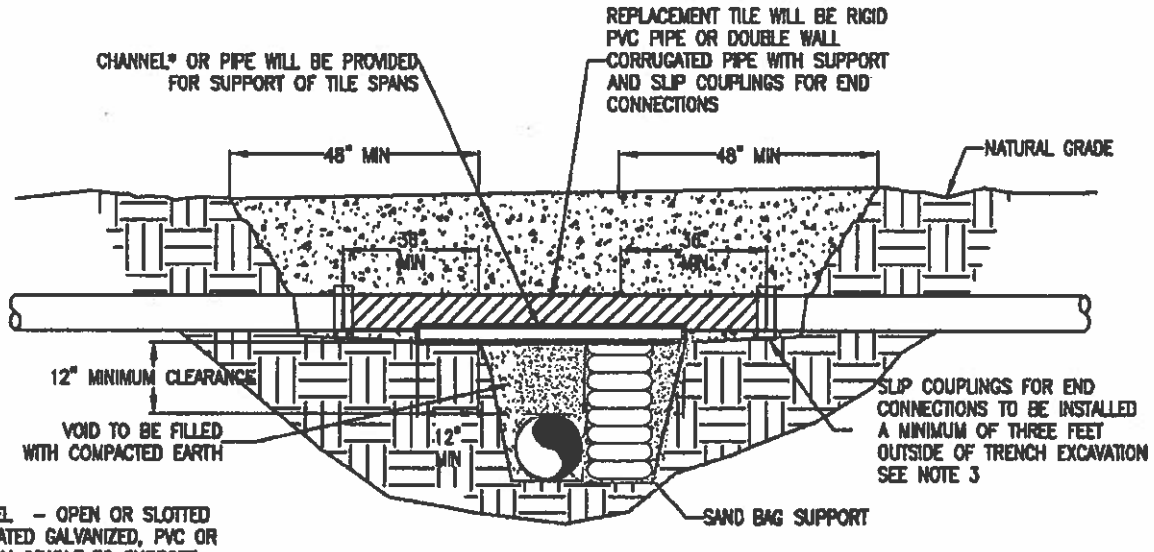
Address

DECEMBER18, 2023

FIGURE 1.



PLAN
N.T.S.



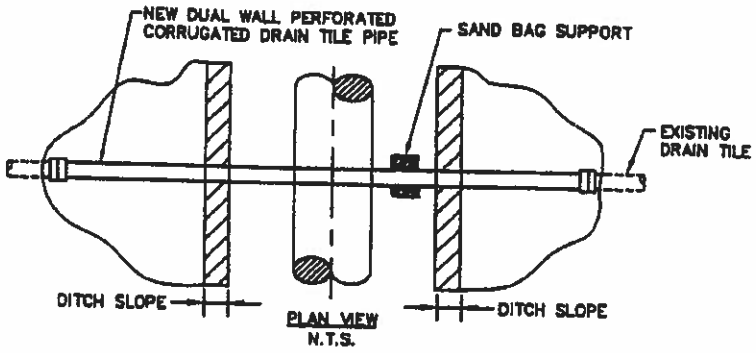
CROSS SECTION
N.T.S.

NOTE:

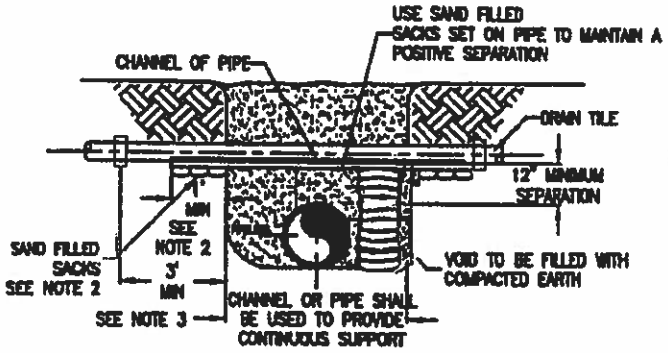
1. IMMEDIATELY REPAIR TILE IF WATER IS FLOWING THROUGH TILE AT TIME OF TRENCHING. IF NO WATER IS FLOWING AND TEMPORARY REPAIR IS DELAYED, OR NOT MADE BY THE END OF THE WORK DAY, A SCREEN OR APPROPRIATE 'NIGHT CAP' SHALL BE PLACED ON OPEN ENDS OF TILE TO PREVENT ENTRAPMENT OF ANIMALS ETC.
2. CHANNEL OR PIPE (OPEN OR SLOTTED) MADE OF CORRUGATED GALVANIZED PIPE, PVC OR ALUMINUM WILL BE USED FOR SUPPORT OF DRAIN TILE SPANS.
3. INDUSTRY STANDARDS SHALL BE FOLLOWED TO ENSURE PROPER SEAL OF REPAIRED DRAIN TILES.

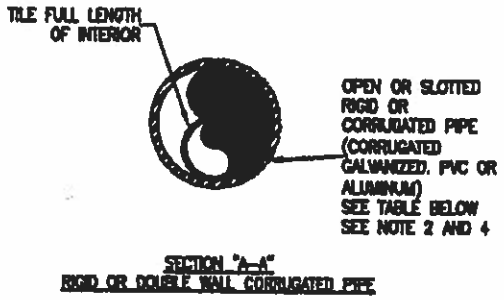
TEMPORARY DRAIN TILE REPAIR

FIGURE 2.



PLAN VIEW





END VIEWS

MINIMUM SUPPORT TABLE			
TILE SIZE	CHANNEL SIZE	PIPE SIZE	
3"	4" @ 5.4 #/ft	4"	STD. WT.
4"-5"	5" @ 6.7 #/ft	6"	STD. WT.
6"-9"	7" @ 9.8 #/ft	9"-10"	STD. WT.
10"	10" @ 15.3 #/ft	12"	STD. WT.

NOTE:

1. TILE REPAIR AND REPLACEMENT SHALL MAINTAIN ORIGINAL ALIGNMENT GRADIENT AND WATER FLOW TO THE GREATEST EXTENT POSSIBLE. IF THE TILE NEEDS TO BE RELOCATED, THE INSTALLATION ANGLE MAY VARY DUE TO SITE SPECIFIC CONDITIONS AND LANDOWNER RECOMMENDATIONS.
2. 1'-0" MINIMUM LENGTH OF CHANNEL OR RIGID PIPE (OPEN OR SLOTTED CORRUGATED GALVANIZED, PVC OR ALUMINUM CRADLE) SHALL BE SUPPORTED BY UNDISTURBED SOIL, OR IF CROSSING IS NOT AT RIGHT ANGLES TO PIPELINE, EQUIVALENT LENGTH PERPENDICULAR TO TRENCH. SHIM WITH SAND BAGS TO UNDISTURBED SOIL FOR SUPPORT AND DRAINAGE GRADIENT MAINTENANCE (TYPICAL BOTH SIDES).
3. DRAIN TILES WILL BE PERMANENTLY CONNECTED TO EXISTING DRAIN TILES A MINIMUM OF THREE FEET OUTSIDE OF EXCAVATED TRENCH LINE USING INDUSTRY STANDARDS TO ENSURE PROPER SEAL OF REPAIRED DRAIN TILES INCLUDING SLIP COUPLINGS.
4. DIAMETER OF RIGID PIPE SHALL BE OF ADEQUATE SIZE TO ALLOW FOR THE INSTALLATION OF THE TILE FOR THE FULL LENGTH OF THE RIGID PIPE.
5. OTHER METHODS OF SUPPORTING DRAIN TILE MAY BE USED IF ALTERNATE PROPOSED IS EQUIVALENT IN STRENGTH TO THE CHANNEL/PIPE SECTIONS SHOWN AND IF APPROVED BY COMPANY REPRESENTATIVES AND LANDOWNER IN ADVANCE. SITE SPECIFIC ALTERNATE SUPPORT SYSTEM TO BE DEVELOPED BY COMPANY REPRESENTATIVES AND FURNISHED TO CONTRACTOR FOR SPANS IN EXCESS OF 20', TILE GREATER THEN 10" DIAMETER, AND FOR "HEADER" SYSTEMS.
6. ALL MATERIAL TO BE FURNISHED BY CONTRACTOR.
7. PRIOR TO REPAIRING TILE, CONTRACTOR SHALL PROBE LATERALLY INTO THE EXISTING TILE TO FULL WIDTH OF THE RIGHTS OF WAY TO DETERMINE IF ADDITIONAL DAMAGE HAS OCCURRED. ALL DAMAGED/DISTURBED TILE SHALL BE REPAIRED AS NEAR AS PRACTICABLE TO ITS ORIGINAL OR BETTER CONDITION.

PERMANENT DRAIN TILE REPAIR

EXHIBIT F: ILLINOIS DEPARMENT OF NATURAL RESOURCES (IDNR) ECOCAT

EcoCAT
Ecological Compliance Assessment Tool

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Applicant: 22c Development LLC
Contact: Sean Hickey
Address: 4649 N Broadway
Chicago, IL 60640

IDNR Project Number: 2411470
Date: 03/06/2024

Project: North Sun LLC
Address: Intersection of 21st Ave and North Road, Raymond

Description: Construction of solar farm with associated access roads and utilities.

Natural Resource Review Results

Consultation for Endangered Species Protection and Natural Areas Preservation (Part 1075)

The Illinois Natural Heritage Database contains no record of State-listed threatened or endangered species, Illinois Natural Area Inventory sites, dedicated Illinois Nature Preserves, or registered Land and Water Reserves in the vicinity of the project location.

Consultation is terminated. This consultation is valid for two years unless new information becomes available that was not previously considered; the proposed action is modified; or additional species, essential habitat, or Natural Areas are identified in the vicinity. If the project has not been implemented within two years of the date of this letter, or any of the above listed conditions develop, a new consultation is necessary. Termination does not imply IDNR's authorization or endorsement.

Location

The applicant is responsible for the accuracy of the location submitted for the project.

County: Montgomery

Township, Range, Section:
10N, 4W, 14

IL Department of Natural Resources Contact
Adam Rawe
217-785-5500
Division of Ecosystems & Environment

Government Jurisdiction
IL Environmental Protection Agency
Terri LeMasters
1020 North Grand Avenue East
Springfield, Illinois 62794 -9276

Disclaimer

The Illinois Natural Heritage Database cannot provide a conclusive statement on the presence, absence, or condition of natural resources in Illinois. This review reflects the information existing in the Database at the time of this inquiry, and should not be regarded as a final statement on the site being considered, nor should it be a substitute for detailed site surveys or field surveys required for environmental assessments. If additional protected resources are encountered during the project's implementation, compliance with applicable statutes and regulations is required.

Terms of Use

By using this website, you acknowledge that you have read and agree to these terms. These terms may be revised by IDNR as necessary. If you continue to use the EcoCAT application after we post changes to these terms, it will mean that you accept such changes. If at any time you do not accept the Terms of Use, you may not continue to use the website.

1. The IDNR EcoCAT website was developed so that units of local government, state agencies and the public could request information or begin natural resource consultations on-line for the Illinois Endangered Species Protection Act, Illinois Natural Areas Preservation Act, and Illinois Interagency Wetland Policy Act. EcoCAT uses databases, Geographic Information System mapping, and a set of programmed decision rules to determine if proposed actions are in the vicinity of protected natural resources. By indicating your agreement to the Terms of Use for this application, you warrant that you will not use this web site for any other purpose.

2. Unauthorized attempts to upload, download, or change information on this website are strictly prohibited and may be punishable under the Computer Fraud and Abuse Act of 1986 and/or the National Information Infrastructure Protection Act.

3. IDNR reserves the right to enhance, modify, alter, or suspend the website at any time without notice, or to terminate or restrict access.

Security

EcoCAT operates on a state of Illinois computer system. We may use software to monitor traffic and to identify unauthorized attempts to upload, download, or change information, to cause harm or otherwise to damage this site. Unauthorized attempts to upload, download, or change information on this server is strictly prohibited by law.

Unauthorized use, tampering with or modification of this system, including supporting hardware or software, may subject the violator to criminal and civil penalties. In the event of unauthorized intrusion, all relevant information regarding possible violation of law may be provided to law enforcement officials.

Privacy

EcoCAT generates a public record subject to disclosure under the Freedom of Information Act. Otherwise, IDNR uses the information submitted to EcoCAT solely for internal tracking purposes.

EXHIBIT G: ECOSPHERE INFORMATION FOR PLANNING AND CONSULTATION (IPAC)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Southern Illinois Sub-Office
Southern Illinois Sub-office
8588 Route 148
Marion, IL 62959-5822
Phone: (618) 998-5945
Email Address: Marion@fws.gov
https://www.fws.gov/office/illinois-iowa-ecological-services

In Reply Refer To:
Project Code: 2024-0060982
Project Name: North Sun LLC

March 11, 2024

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed, and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through IPaC by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at: https://www.fws.gov/sites/default/files/documents/endangered-species-consultation-handbook.pdf

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts, see Migratory Bird Permit | What We Do | U.S. Fish & Wildlife Service (fws.gov).

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures, see https://www.fws.gov/library/collections/threats-birds.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/partner/council-conservation-migratory-birds.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of

this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Southern Illinois Sub-Office
Southern Illinois Sub-office
8588 Route 148
Marion, IL 62959-5822
(618) 998-5945

PROJECT SUMMARY

Project Code: 2024-0060982
Project Name: North Sun LLC
Project Type: Power Gen - Solar
Project Description: On behalf of 22c, Kimley-Horn is initiating consultation with the USFWS to determine potential impacts to federally listed threatened and endangered species for a proposed solar facility, referred to as North Sun LLC. The site primarily consists of cropland. The solar facility will include access roads and associated utilities.

Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@39.30697395,-89.49759760940339,14z

Counties: Montgomery County, Illinois

ENDANGERED SPECIES ACT SPECIES

There is a total of 4 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

MAMMALS

NAME	STATUS
Indiana Bat *Myotis sodalis* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/5949	Endangered
Tricolored Bat *Perimyotis subflavus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10515	Proposed Endangered

BIRDS

NAME	STATUS
Whooping Crane *Grus americana* Population: U.S.A. (AL, AR, CO, FL, GA, ID, IL, IN, IA, KY, LA, MI, MN, MS, MO, NC, NM, OH, SC, TN, UT, VA, WI, WV, western half of WY) No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/758	Experimental Population, Non-Essential

INSECTS

NAME	STATUS
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

CRITICAL HABITATS

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

IPAC USER CONTACT INFORMATION

Agency: Kimley-Horn and Associates
Name: Amanda Guerra
Address: 570 Lake Cook Road
City: Deerfield
State: IL
Zip: 60015
Email amanda.guerra@kimley-horn.com
Phone: 3313003377

EXHIBIT H: STATE HISTORIC PRESERVATION OFFICE (SHPO) SUBMITTAL CONFIRMATION

Boyke, Michael

From:	Boyke, Michael
Sent:	Monday, April 1, 2024 11:19 AM
To:	SHPO.Review@Illinois.gov
Cc:	Hickey, Sean
Subject:	North Sun LLC, Raymond Township, Montgomery County, IL - SHPO Review
Attachments:	North Sun SHPO Review.pdf

Hello,

Kimley-Horn, on behalf of North Sun, LLC, is requesting a review of the SHPO review application for the North Sun, Solar Project, located in Raymond Township, Montgomery County, IL.

Please let us know of any questions or additional information in order to complete your review.

Thank you,

Michael Boyke, EIT | Energy Analyst
Kimley-Horn | 570 Lake Cook Road, Suite 200, Deerfield, IL 60015
Direct: 224-214-4574 | Mobile: 224-772-3173

Boyke, Michael

From:	DNR.SHPO.Review <SHPO.Review@Illinois.gov>
Sent:	Monday, April 1, 2024 11:30 AM
To:	Boyke, Michael
Subject:	Automatic reply: North Sun LLC, Raymond Township, Montgomery County, IL - SHPO Review
Follow Up Flag:	Follow up
Flag Status:	Flagged

Thank you for your submittal to the Illinois State Historic Preservation Office (SHPO).
We are no longer requiring or receiving paper reviews or surveys. All projects must be submitted digitally.

The SHPO response for your project will be found at the SHPO Correspondence Tracking System (CTS) at https://dnr2.illinois.gov/cts/ to read, download, and/or print our comments (allow 30 days for a SHPO response). SHPO comments for all items linked to your password from 2018 to present are located here.

If you do not already have a password to access comments at the link (or if you have forgotten), email SHPO.Review@Illinois.gov and type "**PASSWORD REQUEST"** in the subject line.

To access comments prior to 2018, please email SHPO.Review@Illinois.gov.

EXHIBIT I: FEDERAL AVIATION AGENCY (FAA) NOTICE OF CRITERIA

Federal Aviation Administration

« OE/AAA

Notice Criteria Tool

Notice Criteria Tool - Desk Reference Guide V_2018.2.0

The requirements for filing with the Federal Aviation Administration for proposed structures vary based on a number of factors: height, proximity to an airport, location, and frequencies emitted from the structure, etc. For more details, please reference CFR Title 14 Part 77.9.

You must file with the FAA at least 45 days prior to construction if:

- your structure will exceed 200ft above ground level
- your structure will be in proximity to an airport and will exceed the slope ratio
- your structure involves construction of a traverseway (i.e. highway, railroad, waterway etc...) and once adjusted upward with the appropriate vertical distance would exceed a standard of 77.9(a) or (b)
- your structure will emit frequencies, and does not meet the conditions of the FAA Co-location Policy
- your structure will be in an instrument approach area and might exceed part 77 Subpart C
- your proposed structure will be in proximity to a navigation facility and may impact the assurance of navigation signal reception
- your structure will be on an airport or heliport
- filing has been requested by the FAA

If you require additional information regarding the filing requirements for your structure, please identify and contact the appropriate FAA representative using the Air Traffic Areas of Responsibility map for Off Airport construction, or contact the FAA Airports Region / District Office for On Airport construction.

The tool below will assist in applying Part 77 Notice Criteria.

* **Structure Type:**	SOLAR | Solar Panel Please select structure type and complete location point information.
Latitude:	39 Deg 18 M 26.54 S N
Longitude:	89 Deg 29 M 43.11 S W
Horizontal Datum:	NAD83
Site Elevation (SE):	687 (nearest foot)
Structure Height :	35 (nearest foot)
Is structure on airport:	(●) No ( ) Yes

Results

You do not exceed Notice Criteria.

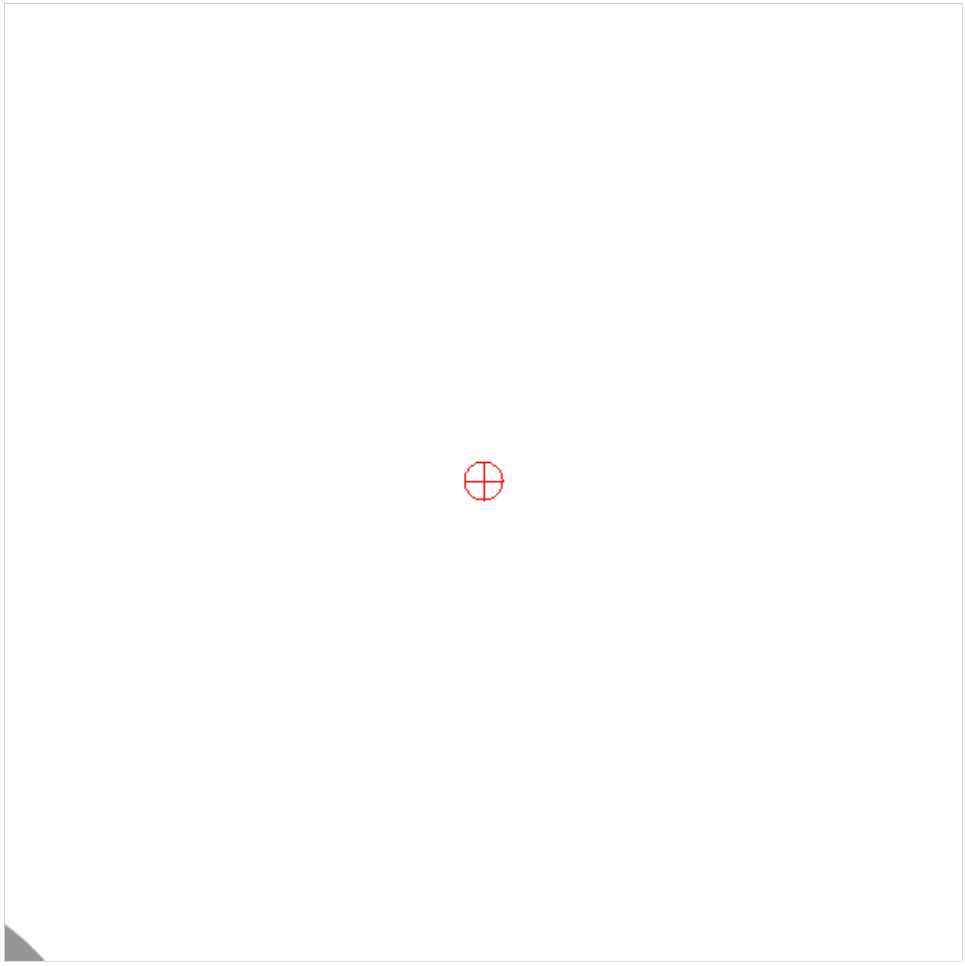
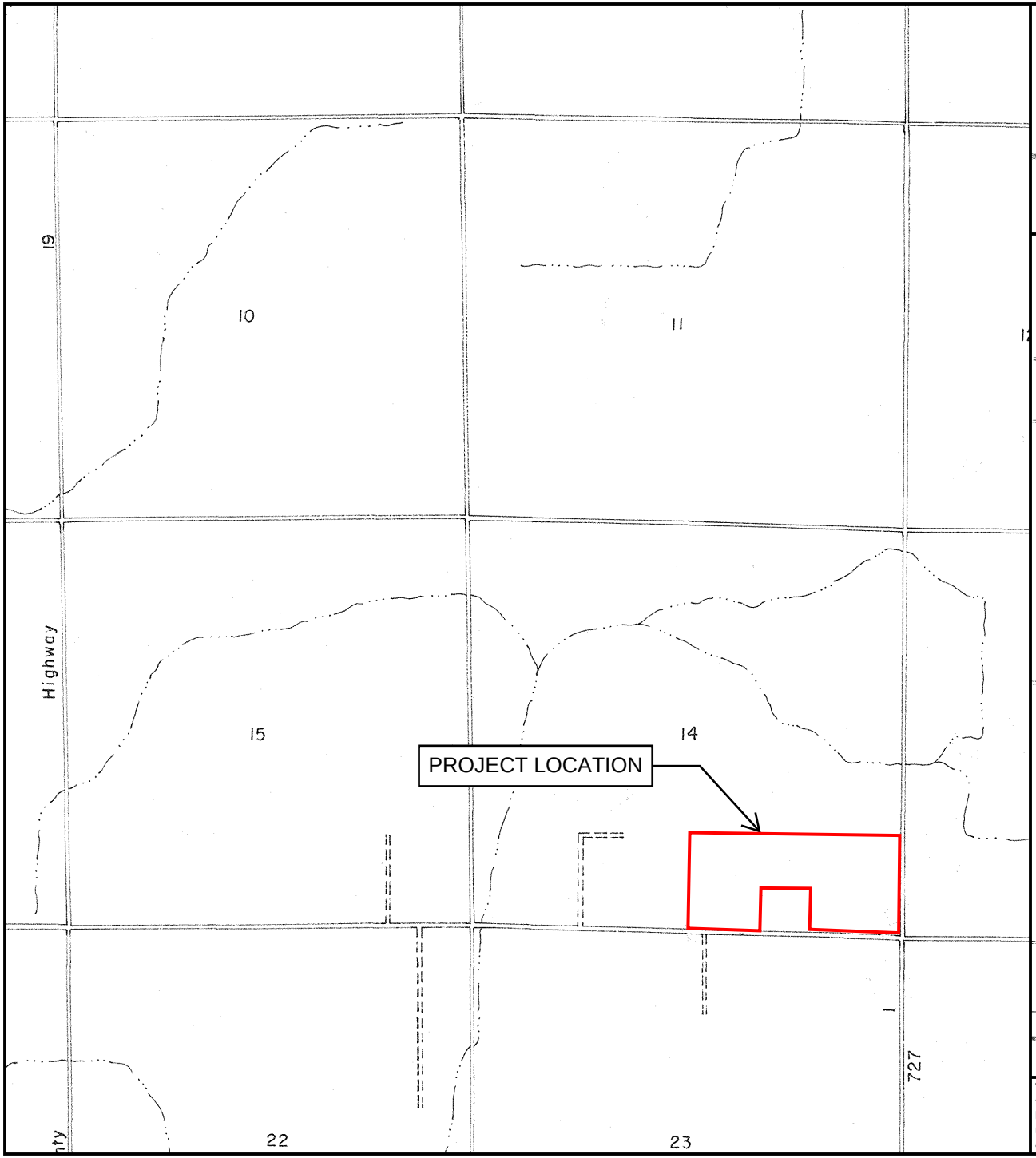
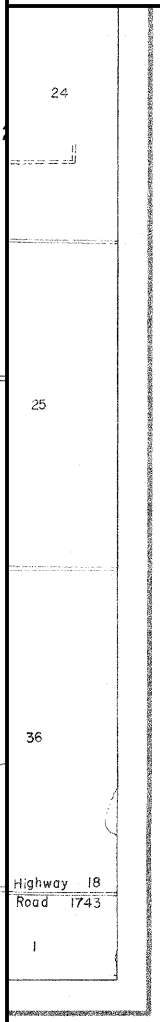


EXHIBIT J: FEMA FIRMETTE



APPROXIMATE SCALE IN FEET

2000 0 2000



NATIONAL FLOOD INSURANCE PROGRAM

FHBM

FLOOD HAZARD BOUNDARY MAP

MONTGOMERY COUNTY, ILLINOIS

UNINCORPORATED AREA

PANEL 2 OF 9

(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER

170992 0002 A

EFFECTIVE DATE:

JANUARY 9, 1981

federal emergency management agency
federal insurance administration

EXHIBIT K: HEALTH AND SAFETY STUDIES

WHITE PAPER

Health and Safety Impacts of Solar Photovoltaics

By Tommy Cleveland
May 2017

NC CLEAN ENERGY TECHNOLOGY CENTER

NC STATE UNIVERSITY

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1.2 • System Components | 1.2.1 Solar Panels: Construction and Durability.....5
1.2.2 • Photovoltaic (PV) Technologies.....7
1.2.3. • Panel End-of-Life Management.....10
1.2.4 • Non-Panel System Components (racking, wiring, inverter, transformer)..12
1.4 • Operations and Maintenance – Panel Washing and Vegetation Control....13
2 • Electromagnetic Fields (EMF).....14
3 • Electric Shock and Arc Flash Hazards 16
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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 (SO2), nitrogen oxides (NOx), and fine particulate matter (PM2.5). 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 MWAC) 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.

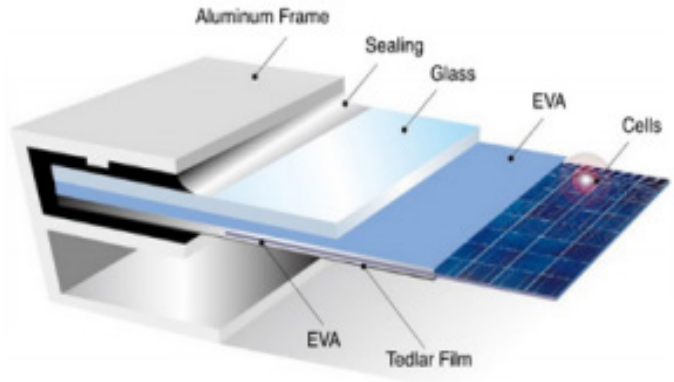

Figure 2: Components of crystalline silicon panels. The vast majority of silicon panels consist of a glass sheet on the topside with an aluminum frame providing structural support. Image Source: www.riteksolar.com.tw

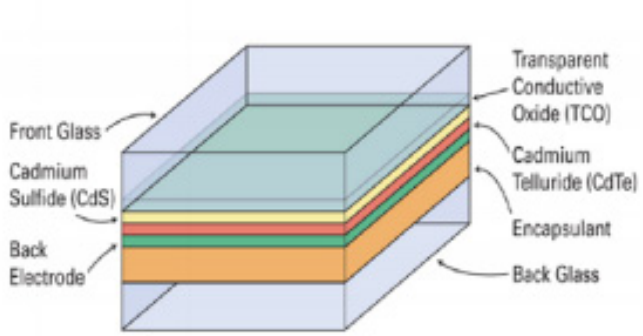

Figure 3: Layers of a common frameless thin-film panel (CdTe). Many thin film panels are frameless, including the most common thin-film panels, First Solar's CdTe. Frameless panels have protective glass on both the front and back of the panel. Layer thicknesses not to scale. Image Source: www.homepower.com

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 industrystandard 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 (SiO2) 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 leadbased 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 MWAC, which is generally 7 MWDC) 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 1/100th 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, costeffectively 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 nontoxic 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 injury when hazardous voltages and/or currents are present. Untrained individuals should not attempt to inspect, test, or repair any aspect of a PV system due to the potential for injury or death due to electric shock and arc flash, The National Electric Code (NEC) requires appropriate levels of warning signs on all electrical components based on the level of danger determined by the voltages and current potentials. The national electric code also requires the site to be secured from unauthorized visitors with either a six-foot chain link fence with three strands of barbed wire or an eight-foot fence, both with adequate hazard warning signs.

4. Fire Safety

The possibility of fires resulting from or intensified by PV systems may trigger concern among the general public as well as among firefighters. However, concern over solar fire hazards should be limited because only a small portion of materials in the panels are flammable, and those components cannot self-support a significant fire. Flammable components of PV panels include the thin layers of polymer encapsulates surrounding the PV cells, polymer backsheets (framed panels only), plastic junction boxes on rear of panel, and insulation on wiring. The rest of the panel is composed of non-flammable components, notably including one or two layers of protective glass that make up over three quarters of the panel's weight.

Heat from a small flame is not adequate to ignite a PV panel, but heat from a more intense fire or energy from an electrical fault can ignite a PV panel.[80] One real-world example of this occurred during July 2015 in an arid area of California. Three acres of grass under a thin film PV facility burned without igniting the panels mounted on fixed-tilt racks just above the grass.[81] While it is possible for electrical faults in PV systems on homes or commercial buildings to start a fire, this is extremely rare.[82] Improving understanding of the PV-specific risks, safer system designs, and updated fire-related codes and standards will continue to reduce the risk of fire caused by PV systems.

PV systems on buildings can affect firefighters in two primary ways, 1) impact their methods of fighting the fire, and 2) pose safety hazard to the firefighters. One of the most important techniques that firefighters use to suppress fire is ventilation of a building's roof. This technique allows superheated toxic gases to quickly exit the building. By doing so, the firefighters gain easier and safer access to the building, Ventilation of the roof also makes the challenge of putting out the fire easier. However, the placement of rooftop PV panels may interfere with ventilating the roof by limiting access to desired venting locations.

New solar-specific building code requirements are working to minimize these concerns. Also, the

latest National Electric Code has added requirements that make it easier for first responders to safely and effectively turn off a PV system. Concern for firefighting a building with PV can be reduced with proper fire fighter training, system design, and installation. Numerous organizations have studied fire fighter safety related to PV. Many organizations have published valuable guides and training programs. Some notable examples are listed below.

- The International Association of Fire Fighters (IAFF) and International Renewable Energy Council (IREC) partnered to create an online training course that is far beyond the PowerPoint click-andview model. The self-paced online course, "Solar PV Safety for Fire Fighters," features rich video content and simulated environments so fire fighters can practice the knowledge they've learned. www.iaff.org/pvsafetytraining
- Photovoltaic Systems and the Fire Code: Office of NC Fire Marshal
- Fire Service Training, Underwriter's Laboratory
- Firefighter Safety and Response for Solar Power Systems, National Fire Protection Research Foundation
- Bridging the Gap: Fire Safety & Green Buildings, National Association of State Fire Marshalls
- Guidelines for Fire Safety Elements of Solar Photovoltaic Systems, Orange County Fire Chiefs Association
- Solar Photovoltaic Installation Guidelines, California Department of Forestry & Fire Protection, Office of the State Fire Marshall
- PV Safety & Firefighting, Matthew Paiss, Homepower Magazine
- PV Safety and Code Development: Matthew Paiss, Cooperative Research Network

Summary

The purpose of this paper is to address and alleviate concerns of public health and safety for utility-scale solar PV projects. Concerns of public health and safety were divided and discussed in the four following sections: (1) Toxicity, (2) Electromagnetic Fields, (3) Electric Shock and Arc Flash, and (4) Fire. In each of these sections, the negative health and safety impacts of utility-scale PV development were shown to be negligible, while the public health and safety benefits of installing these facilities are significant and far outweigh any negative impacts.

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1 Wiser, Ryan, Trieu Mai, Dev Millstein, Jordan Macknick, Alberta Carpenter, Stuart Cohen, Wesley Cole, Bethany Frew, and Garvin A. Heath. 2016. On the Path to SunShot: The Environmental and Public Health Benefits of Achieving High Penetrations of Solar Energy in the United States. Golden, CO: National Renewable Energy Laboratory. Accessed March 2017, www.nrel.gov/docs/fy16osti/65628.pdf

2 IRENA and IEA-PVPS (2016), "End-of-Life Management: Solar Photovoltaic Panels," International Renewable Energy Agency and International Energy Agency Photovoltaic Power Systems.

3 National Renewable Energy Laboratory, *Overview of Field Experience – Degradation Rates & Lifetimes*. September 14, 2015. Solar Power International Conference. Accessed March 2017, www.nrel.gov/docs/fy15osti/65040.pdf

4 Miesel et al. *SolarCity Photovoltaic Modules with 35 Year Useful Life*. June 2016. Accessed March 2017. http://www.solarcity.com/newsroom/reports/solarcity-photovoltaic-modules-35-year-useful-life

5 David Unger. *Are Renewables Stormproof? Hurricane Sandy Tests Solar, Wind*. November 2012. Accessed March 2017. http://www.csmonitor.com/Environment/Energy-Voices/2012/1119/Are-renewables-stormproof-Hurricane-Sandy-tests-solarwind & http://www.csmonitor.com/Environment/Energy-Voices/2012/1119/Are-renewables-stormproof-Hurricane-Sandytests-solar-wind

6 NEXTracker and 365 Pronto, *Tracking Your Solar Investment: Best Practices for Solar Tracker O&M*.

Accessed March 2017.
www.nextracker.com/content/uploads/2017/03/NEXTracker_OandM-WhitePaper_FINAL_March-2017.pdf
7 Christiana Honsberg, Stuart Bowden. *Overview of Screen Printed Solar Cells*. Accessed January 2017.
www.pveducation.org/pvcdrom/manufacturing/screen-printed
8 Silicon Valley Toxics Coalition. *2015 Solar Scorecard*. Accessed August 2016.
www.solarscorecard.com/2015/2015-SVTC-Solar-Scorecard.pdf
9 European Commission. *Recast of Reduction of Hazardous Substances (RoHS) Directive*. September 2016. Accessed August 2016.
http://ec.europa.eu/environment/waste/rohs_eee/index_en.htm
10 Official Journal of the European Union, *DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011* on the restriction of the use of certain hazardous substances in electrical and electronic equipment. June 2011. Accessed May 2017.
http://eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:32011L0065&from=en
11 Giancarlo Giacchetta, Mariella Leporini, Barbara Marchetti. *Evaluation of the Environmental Benefits of New High Value Process for the Management of the End of Life of Thin Film Photovoltaic Modules*. July 2013. Accessed August 2016.
www.researchgate.net/publication/257408804_Evaluation_of_the_environmental_benefits_of_new_high_value_process_for_the_management_of_the_end_of_life_of_thin_film_photovoltaic_modules
12 European Commission. *Study on Photovoltaic Panels Supplementing The Impact Assessment for a Recast of the Weee Directive*. April 2011. Accessed August 2016.
http://ec.europa.eu/environment/waste/weee/pdf/Study%20on%20PVs%20Bio%20final.pdf
14 The amount of lead in a typical car battery is 21.4 pounds. Waste 360. Chaz Miller. *Lead Acid Batteries*. March 2006. Accessed August 2016.
http://waste360.com/mag/waste_leadacid_batteries_3
15 Okkenhaug G. *Leaching from CdTe PV module material results from batch, column and availability tests*. Norwegian Geotechnical Institute, NGI report No. 20092155-00-6-R; 2010
16 International Journal of Advanced Applied Physics Research. Renate Zapf-Gottwick1, et al. *Leaching Hazardous Substances out of Photovoltaic Modules*. January 2015. Accessed January 2016.
www.cosmosscholars.com/phms/index.php/ijaapr/article/download/485/298
17 ibid
18 Parikhit Sinha, et al. Evaluation of Potential Health and Environmental Impacts from End-Of-Life Disposal of Photovoltaics, Photovoltaics, 2014. Accessed May 2016
19 Bonnet, D. and P. Meyers. 1998. *Cadmium-telluride—Material for thin film solar cells*. J. Mater. Res., Vol. 13, No. 10, pp. 2740-2753
20 V. Fthenakis, K. Zweibel. *CdTe PV: Real and Perceived EHS Risks*. National Center ofr Photovoltaics and Solar Program Review Meeting, March 24-26, 2003. www.nrel.gov/docs/fy03osti/33561.pdf. Accessed May 2017
21 International Energy Agency Photovoltaic Power Systems Programme. *Life Cycle Inventories and Life Cycle Assessments of Photovoltaic Systems*. March 2015. Accessed August 2016.
http://iea-pvps.org/index.php?id=315
22 Data not available on fraction of various generation sources offset by solar generation in NC, but this is believed to be a reasonable rough estimate. The SunShot report entitled The Environmental and Public Health Benefits of Achieving High Penetrations of Solar Energy in the United States analysis contributes significant (% not provided) offsetting of coal-fired generation by solar PV energy in the southeast.
23 7 MWDC * 1.5 GWh/MWDC * 25 years * 0.93 degradation factor * (0.1 *4.65 grams/GWh + 0.9*0.2 grams/GWh)
24 Vasilis Fthenakis. *CdTe PV: Facts and Handy Comparisons*. January 2003. Accessed March 2017.
https://www.bnl.gov/pv/files/pdf/art_165.pdf
25 Kaczmar, S., *Evaluating the Read-Across Approach on CdTe Toxicity for CdTe Photovoltaics*, SETAC North America 32nd Annual Meeting, Boston, MA, November 2011. Available at:
ftp://ftp.co.imperial.ca.us/icpds/eir/campo-verdesolar/final/evaluating-toxicity.pdf, Accessed May 2017
27 V. M. Fthenakis et al, *Emissions and Encapsulation of Cadmium in CdTe PV Modules During Fires* Renewable Progress in Photovoltaics: Research and Application: Res. Appl. 2005; 13:1–11, Accessed March 2017, www.bnl.gov/pv/files/pdf/abs_179.pdf
28 Fthenakis V.M., *Life Cycle Impact Analysis of Cadmium in CdTe Photovoltaic Production*, Renewable

and Sustainable Energy Reviews, 8, 303-334, 2004. www.clca.columbia.edu/papers/Life_Cycle_Impact_Analysis_Cadmium_CdTe_Photovoltaic_production.pdf, Accessed May 2017
29 International Renewable Energy Agency. Stephanie Weckend, Andreas Wade, Garvin Heath. *End of Life Management: Solar Photovoltaic Panels*. June 2016. Accessed November 2016.
30 International Journal of Advanced Applied Physics Research. Renate Zapf-Gottwick1, et al. *Leaching Hazardous Substances out of Photovoltaic Modules*. January 2015. Accessed January 2016. www.cosmosscholars.com/phms/index.php/ijaapr/article/download/485/298
31 Cunningham D., Discussion about TCLP protocols, Photovoltaics and the Environment Workshop, July 23-24, 1998, Brookhaven National Laboratory, BNL-52557
32 Parikhit Sinha, et al. Evaluation of Potential Health and Environmental Impacts from End-Of-Life Disposal of Photovoltaics, Photovoltaics, 2014. Accessed May 2016
33 Practical Handbook of Photovoltaics: Fundamentals and Applications. T. Markvart and L. Castaner. *Chapter VII-2: Overview of Potential Hazards*. December 2003. Accessed August 2016. https://www.bnl.gov/pv/files/pdf/art_170.pdf
34 Norwegian Geotechnical Institute. *Environmental Risks Regarding the Use and End-of-Life Disposal of CdTe PV Modules*. April 2010. Accessed August 2016. https://www.dtsc.ca.gov/LawsRegsPolicies/upload/Norwegian-Geotechnical-InstituteStudy.pdf
35 First Solar. Dr. Yasunari Matsuno. December 2013. August 2016. *Environmental Risk Assessment of CdTe PV Systems to be considered under Catastrophic Events in Japan*. http://www.firstsolar.com/-/media/Documents/Sustainability/PeerReviews/Japan_Peer-Review_Matsuno_CdTe-PV-Tsunami.ashx
36 First Solar. Parikhit Sinha, Andreas Wade. *Assessment of Leaching Tests for Evaluating Potential Environmental Impacts of PV Module Field Breakage*. 2015 IEEE
37 See p. 22 of First Solar, Sustainability Report. Available at: www.firstsolar.com/-/media/FirstSolar/Sustainability-Documents/03801_FirstSolar_SustainabilityReport_08MAR16_Web.ashx, Accessed May 2017
38 40 CFR §261.24. *Toxicity Characteristic*. May 2017. Accessed May 2017. https://www.ecfr.gov/cgi-bin/textidx-?node=se40.26.261_124&rgn=div8
39 Office of Energy Efficiency & Renewable Energy. *Copper Indium Gallium Diselenide*. Accessed March 2017. https://www.energy.gov/eere/sunshot/copper-indium-gallium-diselenide
40 Mathias Maehlum. *Best Thin Film Solar Panels – Amorphous, Cadmium Telluride or CIGS?* April 2015. Accessed March 2017. http://energyinformative.org/best-thin-film-solar-panels-amorphous-cadmium-telluride-cigs/
41 RoHS tested certificate for Solar Frontier PV modules. TUVRheinland, signed 11.11.2013
42 International Renewable Energy Agency. Stephanie Weckend, Andreas Wade, Garvin Heath. *End of Life Management: Solar Photovoltaic Panels.* June 2016. Accessed November 2016. http://www.irena.org/DocumentDownloads/Publications/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf
43 40 C.F.R. §261.10. *Identifying the Characteristics of Hazardous Waste and for Listing Hazardous Waste*. November 2016. Accessed November 2016 http://www.ecfr.gov/cgi-bin/textidx?SID=ce0006d-66da40146b490084ca2816143&mc=true&node=pt40.26.261&rgn=div5#sp40.28.261.b
44 40 C.F.R. §261.24 *Toxicity Characteristic*. November 2016. Accessed November 2016. http://www.ecfr.gov/cgi-bin/textidx?SID=ce0006d-66da40146b490084ca2816143&mc=true&node=pt40.26.261&rgn=div5#se40.28.261_124
45 International Renewable Energy Agency. Stephanie Weckend, Andreas Wade, Garvin Heath. *End of Life Management: Solar Photovoltaic Panels*. June 2016. Accessed November 2016. http://www.irena.org/DocumentDownloads/Publications/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf
46 TLCP test results from third-party laboratories for REC, Jinko, and Canadian Solar silicon-based panels. Provided by PV panel manufacturers directly or indirectly to authors
47 Sinovoltaics, Introduction to *Solar Panel Recycling*, March 2014. Accessed October 2016. http://sinovoltaics.com/solarbasics/introduction-to-solar-panel-recycling/
48 Brookhaven National Laboratory. Vasilis Fthenakis,

Regulations on Photovoltaic Module Disposal and Recycling. January 29, 2001.
49 Parikhit Sinha, et al. Evaluation of Potential Health and Environmental Impacts from End-Of-Life Disposal of Photovoltaics, Photovoltaics, 2014.
50 First Solar. Parikhit Sinha, Andreas Wade. *Assessment of Leaching Tests for Evaluating Potential Environmental Impacts of PV Module Field Breakage*. October 2015. Accessed August 2016. http://www.firstsolar.com/-/media/Documents/Sustainability/PVSC42-Manuscript-20150912--Assessment-of-Leaching-Tests-for-Evaluating-PotentialEnvironmental-Impa.ashx
51 First Solar. Dr. Yasunari Matsuno. December 2013. *Environmental Risk Assessment of CdTe PV Systems to be considered under Catastrophic Events in Japan*. http://www.firstsolar.com/-/media/Documents/Sustainability/PeerReviews/Japan_Peer-Review_Matsuno_CdTe-PV-Tsunami.ashx
52 Phone interview, February 3, 2016, TT&E Iron & Metal, Garner, NC www.ncscrapmetal.com
53 Wen-His Huang, et al. *Strategy and Technology To Recycle Water-silicon Solar Modules*. Solar Energy, Volume 144, March 2017, Pages 22-31
54 International Renewable Energy Agency. Stephanie Weckend, Andreas Wade, Garvin Heath. *End of Life Management: Solar Photovoltaic Panels*. June 2016. Accessed November 2016. http://www.irena.org/DocumentDownloads/Publications/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf
55 Official Journal of the European Union. *Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on Waste Electrical and Electronic Equipment*. July 2012. Accessed November 2016. http://eurlex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0019
56 PV CYCLE. *Annual Report 2015*. Accessed November 2016. https://pvcyclepublications.cld.bz/Annual-Report-PV-CYCLE-2015/6-7
57 Official Journal of the European Union. *Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on Waste Electrical and Electronic Equipment*. July 2012. Accessed November 2016. http://eurlex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0019
58 SEIA National PV Recycling Program: www.seia.org/seia-national-pv-recycling-program
59 RBI Solar, Decommissioning Plan submitted to Catawba County associated with permitting of a 5MW solar project in June 2016. Accessed April 2017. www.catawbacountync.gov/Planning/Projects/Rezonings/RZ2015-05_DecommissioningPlan.pdf
60 Birdseye Renewables, Decommissioning Plan submitted to Catawba County associated with permitting of a 5MW solar project in May 2015. Accessed April 2017. www.catawbacountync.gov/Planning/Projects/Rezonings/RZ2015-04_DecommissioningPlan.pdf
61 Cypress Creek Renewables, Decommissioning Plan submitted to Catawba County associated with permitting of a 5MW solar project in September 2016. Accessed April 2017. www.catawbacountync.gov/Planning/Projects/Rezonings/RZ2016-06decommission.pdf
62 Sun Raised Farms: http://sunraisedfarms.com/index.html
63 National Institute of Environmental Health Sciences and National Institutes of Health, EMF: Electric and Magnetic Fields Associated with Electric Power: Questions and Answers, June 2002
64 World Health Organization. *Electromagnetic Fields and Public Health: Exposure to Extremely Low Frequency Fields*. June 2007. Accessed August 2016. http://www.who.int/peh-emf/publications/facts/fs322/en/
65 Committee on the Possible Effects of Electromagnetic Fields on Biologic Systems, National Research Council, Possible Health Effects of Exposure to Residential Electric and Magnetic Fields, ISBN: 0-309-55671-6, 384 pages, 6 x 9, (1997) This PDF is available from the National Academies Press at: http://www.nap.edu/catalog/5155.html
66 World Health Organization. *Electromagnetic Fields and Public Health: Exposure to Extremely Low Frequency Fields*. June 2007. Accessed August 2016. http://www.who.int/peh-emf/publications/facts/fs322/en/
67 World Health Organization. *Electromagnetic Fields and Public Health: Static Electric and Magnetic Fields*. March 2006. Accessed August 2016. http://www.who.int/peh-emf/publications/facts/fs299/en/
68 Asher Sheppard, Health Issues Related to the Static and Power-Frequency Electric and Magnetic Fields (EMFs) of the Soitec Solar Energy Farms, April

30, 2014. Accessed March 2017: www.sandiegocounty.gov/content/dam/sdc/pds/ceqa/Soitec-Documents/Final-EIR-Files/Appendix_9.0-1_EMF.pdf
69 Massachusetts Clean Energy Center. *Study of Acoustic and EMF Levels from Solar Photovoltaic Projects*. December 2012. Accessed August 2016.
70 Duke Energy Corporation. *Frequently Asked Questions: Electric and Magnetic Fields*. Accessed August 2016. https://www.duke-energy.com/about-energy/frequently_asked_questions.asp
71 National Institute of Environmental Health Sciences, *Electric and Magnetic Fields Associate with the use of Electric Power: Questions and Answers*, 2002. Accessed November 2016 www.niehs.nih.gov/health/materials/electric_and_magnetic_fields
72 Duke Energy Corporation. *Frequently Asked Questions: Electric and Magnetic Fields*. Accessed August 2016. https://www.duke-energy.com/about-energy/frequently_asked_questions.asp
73 R.A. Tell et al, *Electromagnetic Fields Associated with Commercial Solar Photovoltaic Electric Power Generating Facilities*, Journal of Occupational and Environmental Hygiene, Volume 12, 2015,- Issue 11. Abstract Accessed March 2016: http://www.tandfonline.com/doi/full/10.1080/15459624.2015.1047021
74 Massachusetts Department of Energy Resources, Massachusetts Department of Environmental Protection, and Massachusetts Clean Energy Center. *Questions & Answers: Ground-Mounted Solar Photovoltaic Systems*. June 2015. Accessed August 2016. http://www.mass.gov/eea/docs/doer/renewables/solar/solar-pv-guide.pdf
75 Ibid.
76 Ibid.
77 *EMFs and medical devices*, Accessed March 2017. www.emfs.info/effects/medical-devices/
78 ibid.
79 Damon McCluer. *Electrical Construction & Maintenance: NFPA 70E's Approach to Considering DC Hazards*. September 2013. Accessed October 2016. http://ecmweb.com/safety/nfpa-70e-s-approach-considering-dc-hazards
80 Hong-Yun Yang, et. al. *Experimental Studies on the Flammability and Fire Hazards of Photovoltaic Modules, Materials*. July 2015. Accessed August 2016. http://www.mdpi.com/1996-1944/8/7/4210/pdf
81 Matt Fountain. The Tribune. *Fire breaks out at Topaz Solar Farm*. July 2015. Accessed August 2016. www.sanluisobispo.com/news/local/article39055539.html
82 Cooperative Research Network. Matthew Paiss. *Tech Surveillance: PV Safety & Code Developments*. October 2014. Accessed August 2016. http://www.nreca.coop/wp-content/uploads/2013/06/ts_pv_fire_safety_oct_2014.pdf

Solar Panels. Photo by Mariana Proenca on Unsplash

"Clean Energy in Michigan" Series, Number 12

Facts about solar panels: PFAS contamination

By Dr. Annick Anctil, Michigan State University

Q: Do solar panels contribute to PFAS contamination?

Multiple states have raised concerns about PFAS contamination from solar farms, largely citing academic research on how PFAS could *potentially* be used in photovoltaic (PV) solar panels.[1] The fact is that PFAS is *not* customarily used in solar panels because safer, effective alternatives have already been developed and commercialized. Moreover, no studies have shown the presence or leaching of PFAS from PV panels—either while they are in active use or at the end of their life (e.g., in a landfill).

Anatomy of a solar panel

These three parts of a solar panel cause confusion about the presence of PFAS.

Self-Cleaning Coat

A self-cleaning coating on the top of a solar panel helps reduce dust, pollen, and snow adhesion, extending both the power output and the lifetime of the panel.[2] Multiple self-cleaning coating options are available on the market, many of which make use of non-hazardous silicon-based chemistry.[3] Confusion comes from the fact that some other commercialized self-cleaning coating options do make use of PFAS-based chemicals, although even those do not degrade under normal use.

Adhesives

PV panels are sealed from the elements to maximize power output and lifetime. While PFAS chemicals are found in certain adhesives, such as carpentry glues, they are not typically used in sealant adhesives for solar panels.[4] Instead, solar adhesives are based on silicone polymers, which are well known for their lack of negative health impacts and remarkable stability.[5]

Substrate

PV modules are housed in a weather-resistant substrate that offers additional protection from the elements. Thin-film PV units use glass as the substrate, while crystalline silicon PV units use a polymer substrate, which has led to the rumors of

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Find this document and more about the project online at graham.umich.edu/climate-energy/energy-futures.

potential PFAS use in solar panels. The most common polymer used in silicon PV units is Tedlar, a weather resistant polymer that is *not* a PFAS compound itself and makes no use of PFAS during its manufacturing process.[6] Far more common materials, like those used in construction projects and weather resistant fabrics, present a higher risk of PFAS exposure than PV. In fact, a recent study found that these more common materials release PFAS under conditions where solar panels do not, indicating that PFAS exposure risk may be higher sitting on outdoor furniture, for example, than living next to a solar farm.[7]

What is PFAS anyway?

Per/Poly Fluoro-Alkyl Substances, PFAS for short, are a class of chemical compounds. PFAS are used in several industries for their unique properties, notably their ability to create coatings that are highly water repellent.

PFAS are extremely persistent within the environment, not breaking down over time. Certain PFAS compounds have been linked to human health issues–notably low infant birth weights, increased risk of certain cancers, and thyroid issues. As a result of their persistence and toxicity, those PFAS compounds that pose a significant risk have been banned from use and production, and subsequently replaced with safer alternatives.

It's important to note that not all PFAS compounds are dangerous. Some PFAS compounds, such as Teflon, are much more stable and present no risk to human health under normal conditions of use.[8]

1 S. Maharjan *et al.*, "Self-cleaning hydrophobic nanocoating on glass: A scalable manufacturing process," Mater. Chem. Phys., vol. 239, Jan. 2020.; . Son *et al.*, "A practical superhydrophilic self cleaning and antireflective surface for outdoor photovoltaic applications," *Sol. Energy Mater. Sol. Cells*, 2012.; H. C. Han *et al.*, "Enhancing efficiency with fluorinated interlayers in small molecule organic solar cells," *J. Mater. Chem.*, vol. 22, no. 43, 2012.

2 "How a solar cell works – American Chemical Society." [Online]; H. C. Han *et al.*, "Enhancing efficiency with fluorinated interlayers in small molecule organic solar cells," *J. Mater. Chem.*, vol. 22, no. 43, 2012.; M. Simon and E. L. Meyer, "Detection and analysis of hot-spot formation in solar cells," Solar Energy Materials and Solar Cells. pp. 106–113, 2010.

3 "Say Goodbye To Solar Panel Cleaning | Ultimate Efficiency | Solar Sharc®." [Online].

4 "Electronics Product Catalog | Dow Inc." [Online]; B. J. Henry *et al.*, "A critical review of the application of polymer of low concern and regulatory criteria to fluoropolymers," Integrated Environmental Assessment and Management, vol. 14, no. 3. pp. 316–334, May-2018.

5 "Electronics Product Catalog | Dow Inc."; "Properties of Silicones." [Online]; A. M. Bueche, "The curing of silicone rubber with benzoyl peroxide," *J. Polym. Sci.*, vol. 15, no. 79, pp. 105–120, Jan. 1955.

6 M. H. Alaaeddin, S. M. Sapuan, M. Y. . Zuhri, E. . Zainudin, and F. M. AL-Oqla, "Polyvinyl fluoride (PVF); Its Properties, Applications, and Manufacturing Prospects," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 538, p. 012010, Jun. 2019.

7 R. M. Janousek, S. Lebertz, and T. P. Knepper, "Previously unidentified sources of perfluoroalkyl and polyfluoroalkyl substances from building materials and industrial fabrics," *Environ. Sci. Process. Impacts*, vol. 21, no. 11, pp. 1936–1945, Nov. 2019.

8 "Per- and Polyfluoroalkyl Substances (PFAS) | US EPA." [Online].; B. J. Henry *et al.*, "A critical review of the application of polymer of low concern and regulatory criteria to fluoropolymers"

Health and Safety Impacts of Solar Photovoltaics:

A California-Focused Forward to the Health and Safety Impacts of Solar Photovoltaics white paper published by the N.C. Clean Energy Technology Center at North Carolina State University in May 2017

By: Thomas H. Cleveland, P.E., lead author of the North Carolina white paper
RE: Soscol Ferry Road Solar, a proposed 1.98 MW_{AC} PV facility in Napa, CA
Date: July 31, 2019

For the last several years North Carolina (NC) has trailed only California in the capacity of annual solar photovoltaic (PV) installed. For most of that time North Carolina's PV development was nearly entirely distribution-connected ground-mounted solar facilities, most commonly 5 MW_{AC} projects. More recently, North Carolina is developing a mixture of transmission-connected PV facilities between 20 and 75 MW_{AC} and distribution-connected facilities of 1 to 5 MW_{AC}, but still has relatively few commercial or residential PV projects. As the state quickly transitioned from zero utility-scale solar facilities to over 400 utility-scale solar facilities concerns about the health and safety impacts of photovoltaics were raised at countless public hearings across the state and in many meetings of state officials and regulators, including several NC general assembly committee meetings. These concerns led to several years of engagement on this topic by the NC Clean Energy Technology Center at North Carolina State University that resulted in a detailed, peer-reviewed university white paper on the latest scientific understanding regarding PV health and safety impacts, with a focus on North Carolina.

Naturally, there is also interest in the potential health and safety impacts of PV in California, where there is significantly more installed solar capacity than in North Carolina, in a mixture of residential, commercial, and small- and large-scale ground-mounted utility-scale solar projects. While there are massive similarities between the PV installations and their potential health and safety impacts in each state, there are some differences in policy, climate, industry practices, electricity regulation, and more that are worth highlighting. This forward is an attempt by the lead researcher and author of the North Carolina white paper to provide a supplement to the original paper that clearly demonstrates the applicability of the paper to PV in California and to offer California-specific supplements or modifications where the original paper had a North Carolina focus.

Most importantly, all the white paper's conclusions about the negligible negative health and safety impacts of photovoltaics apply fully in California, as well as anywhere in the United States. Similarly, there is nothing unique about the 1.98 MW_{AC} Soscol Ferry Road Solar project that would cause any health or safety impacts different than those discussed in the N.C. white paper.

Throughout the white paper there are instances of North Carolina-specific information, or issues where the situation in California is different than it is in North Carolina. The following is a list of the significant instances of either situation, in the order they appear in the white paper, along with the relevant California-specific information.

- Type of PV Technology Used: Crystalline silicon, Cadmium Telluride (CdTe), and CIGS are all being installed in California as they are in N.C. Since the publication of the N.C. report the author has confirmed the recent installation of utility-scale projects using CIGS modules, but these are still not common. Like in NC, the majority of the current PV installation capacity in California is crystalline silicon, also like NC these are generally Tier I modules. The Soscol Ferry Rd. project will use Tier I crystalline silicon modules.
- Design Wind Speed: The ASCE 7-2016 design wind speed in the vast majority of California, including in Napa County where the Soscol Ferry Road Solar project is located, is 90-95 MPH, which is much lower than the design wind speeds of hurricane-prone eastern N.C. where most PV development in the state is located. A few mountainous regions of California have design wind speeds over 100 MPG, however these extreme

terrains are unlikely to install ground-mounted PV systems.

- Offset Electricity Fuel Mix: The white paper includes a rough estimation that the fuel mix of the generators offset by PV energy production in N.C. is 90% natural gas and 10% coal. From this mix an estimate of the reduction in cadmium emissions due to PV was calculated. The 10% coal estimate is certainly too high for California. An offset fuel mix for California could be reasonably estimated as 100% natural gas, resulting in about 75% of the cadmium emissions savings calculated for NC.

- PV Module Recycling: The white paper included local reports from PV developers in North Carolina of recycling damaged PV modules. It is quite possible that the same is occurring in California, but the author does not have data on the current common waste management practices for damaged PV modules in California. The Electric Power Research Institute (EPRI) published two extensive reports on the Photovoltaic Module Recycling in the United States (April 2018) and Insights in Photovoltaic Recycling Processes in Europe (December 2017), which are great sources for current information on PV module recycling. The EPRI report on recycling in the U.S. states that there are commercial recyclers in the U.S. accepting and recycling PV modules, using processes not unlike those described in the white paper.

- PV Module Washing: Unlike North Carolina, many regions of California regularly experience long periods of time with little to no rain, which can result in enough accumulation of dirt on the PV modules that it justifies occasionally washing the modules to renew their performance. In North Carolina there is generally a heavy rain often enough to keep the panels clean enough to not require manual panel washing. This difference does not have an impact on the health or safety impact of the photovoltaic modules other than perhaps some increased risk of electric shock when washing the modules. Proper installation, maintenance, and washing techniques should reduce this risk to near zero.

- Vegetation Maintenance: The climate in many regions of California, including Napa County where the Soscol Ferry Road Solar project is located, cause the growth of vegetation requiring maintenance to be less vigorous than the vegetation in moist North Carolina. Thus, PV sites in California use similar vegetation maintenance techniques to North Carolina however they need to spend less time and make fewer trips to adequately maintain vegetation on site.

- California Hazardous Waste Policy:
  - As explained in the white paper, in the United States a waste material is considered hazardous waste if the results of a Toxicity Characteristic Leaching Procedure (TCLP) test find concentrations of any of 40 hazardous chemicals above the allowed EPA concentration limit for that chemical. However, in California, materials must additionally meet the more stringent Hazardous Waste Control Law (HWCL), which is like the Reduction of Hazardous Substances (ROHS) directive, adopted in February 2003 by the European Union (EU).[i]
  - In 2015, California passed SB-489 directing the CA DTSC (Department of Toxic Substances Control) to write rules to reclassify PV modules as universal waste, even if they fail TCLP. These rules exclude physically damaged, fractured, or fragmented PV modules that are no longer recognizable as PV modules.[ii] A primary goal of the legislation is to allow producers of waste PV modules to avoid difficult and costly waste determination procedures. In April 2019 the CA DTSC proposed rules to implement SB-489. After the public comment period that ended in June 2019 DTSC may adjust and adopt the rules.[iii]

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[i] *Program on Technology Innovation: Feasibility Study on Photovoltaic Module Recycling in the United States, Technical Update, April 2018*; Electric Power Research Institute (EPRI); April 2018.

[ii] ibid

[iii] (webpage) Beveridge & Diamond law firm; News alert: California Department of Toxic Substances Control Proposes Regulation Classifying Discarded Solar Panels as Universal Waste ; https://www.bdlaw.com/publications/california-department-of-toxic-substances-control-proposes-regulation-classifying-discarded-solar-panels-as-universal-waste/ (last accessed 7/22/2019)

NC CLEAN ENERGY
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Health and Safety Impacts of Solar Photovoltaics

MAY 2017

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.

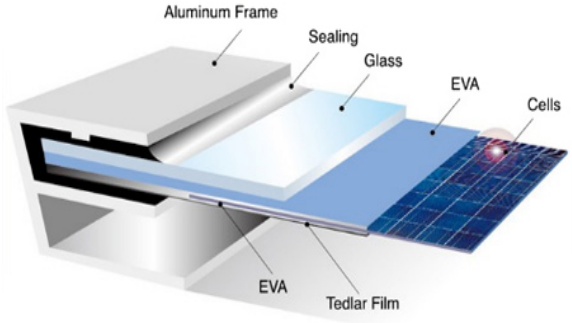

Figure 2: Components of crystalline silicon panels. The vast majority of silicon panels consist of a glass sheet on the topside with an aluminum frame providing structural support. Image Source: www.riteksolar.com.tw

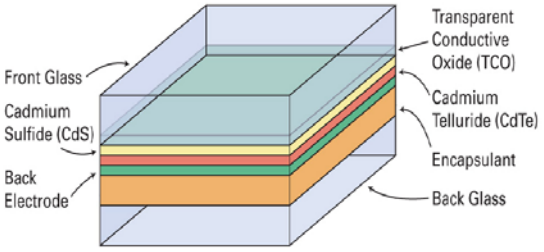

Figure 3: Layers of a common frameless thin-film panel (CdTe). Many thin film panels are frameless, including the most common thin-film panels, First Solar's CdTe. Frameless panels have protective glass on both the front and back of the panel. Layer thicknesses not to scale. Image Source: www.homepower.com

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

injury when hazardous voltages and/or currents are present. Untrained individuals should not attempt to inspect, test, or repair any aspect of a PV system due to the potential for injury or death due to electric shock and arc flash, The National Electric Code (NEC) requires appropriate levels of warning signs on all electrical components based on the level of danger determined by the voltages and current potentials. The national electric code also requires the site to be secured from unauthorized visitors with either a six-foot chain link fence with three strands of barbed wire or an eight-foot fence, both with adequate hazard warning signs.

4. Fire Safety

The possibility of fires resulting from or intensified by PV systems may trigger concern among the general public as well as among firefighters. However, concern over solar fire hazards should be limited because only a small portion of materials in the panels are flammable, and those components cannot self-support a significant fire. Flammable components of PV panels include the thin layers of polymer encapsulates surrounding the PV cells, polymer backsheets (framed panels only), plastic junction boxes on rear of panel, and insulation on wiring. The rest of the panel is composed of non-flammable components, notably including one or two layers of protective glass that make up over three quarters of the panel's weight.

Heat from a small flame is not adequate to ignite a PV panel, but heat from a more intense fire or energy from an electrical fault can ignite a PV panel.[80] One real-world example of this occurred during July 2015 in an arid area of California. Three acres of grass under a thin film PV facility burned without igniting the panels mounted on fixed-tilt racks just above the grass.[81] While it is possible for electrical faults in PV systems on homes or commercial buildings to start a fire, this is extremely rare.[82] Improving understanding of the PV-specific risks, safer system designs, and updated fire-related codes and standards will continue to reduce the risk of fire caused by PV systems.

PV systems on buildings can affect firefighters in two primary ways, 1) impact their methods of fighting the fire, and 2) pose safety hazard to the firefighters. One of the most important techniques that firefighters use to suppress fire is ventilation of a building's roof. This technique allows superheated toxic gases to quickly exit the building. By doing so, the firefighters gain easier and safer access to the building, Ventilation of the roof also makes the challenge of putting out the fire easier. However, the placement of rooftop PV panels may interfere with ventilating the roof by limiting access to desired venting locations.

New solar-specific building code requirements are working to minimize these concerns. Also, the latest National Electric Code has added requirements that make it easier for first responders to safely and effectively turn off a PV system. Concern for firefighting a building with PV can be reduced with proper fire fighter training, system design, and installation. Numerous organizations have studied fire fighter safety related to PV. Many organizations have published valuable guides and training programs. Some notable examples are listed below.

- The International Association of Fire Fighters (IAFF) and International Renewable Energy Council (IREC) partnered to create an online training course that is far beyond the PowerPoint click-and-view model. The self-paced online course, "Solar PV Safety for Fire Fighters," features rich video content and simulated environments so fire fighters can practice the knowledge they've learned. www.iaff.org/pvsafetytraining
- Photovoltaic Systems and the Fire Code: Office of NC Fire Marshal
- Fire Service Training, Underwriter's Laboratory

- Firefighter Safety and Response for Solar Power Systems, National Fire Protection Research Foundation
- Bridging the Gap: Fire Safety & Green Buildings, National Association of State Fire Marshalls
- Guidelines for Fire Safety Elements of Solar Photovoltaic Systems, Orange County Fire Chiefs Association
- Solar Photovoltaic Installation Guidelines, California Department of Forestry & Fire Protection, Office of the State Fire Marshall
- PV Safety & Firefighting, Matthew Paiss, Homepower Magazine
- PV Safety and Code Development: Matthew Paiss, Cooperative Research Network

Summary

The purpose of this paper is to address and alleviate concerns of public health and safety for utility-scale solar PV projects. Concerns of public health and safety were divided and discussed in the four following sections: (1) Toxicity, (2) Electromagnetic Fields, (3) Electric Shock and Arc Flash, and (4) Fire. In each of these sections, the negative health and safety impacts of utility-scale PV development were shown to be negligible, while the public health and safety benefits of installing these facilities are significant and far outweigh any negative impacts.

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[1] Wiser, Ryan, Trieu Mai, Dev Millstein, Jordan Macknick, Alberta Carpenter, Stuart Cohen, Wesley Cole, Bethany Frew, and Garvin A. Heath. 2016. On the Path to SunShot: The Environmental and Public Health Benefits of Achieving High Penetrations of Solar Energy in the United States. Golden, CO: National Renewable Energy Laboratory. Accessed March 2017, www.nrel.gov/docs/fy16osti/65628.pdf

[2] IRENA and IEA-PVPS (2016), "End-of-Life Management: Solar Photovoltaic Panels," International Renewable Energy Agency and International Energy Agency Photovoltaic Power Systems.

[3] National Renewable Energy Laboratory, *Overview of Field Experience – Degradation Rates & Lifetimes*. September 14, 2015. Solar Power International Conference. Accessed March 2017, www.nrel.gov/docs/fy15osti/65040.pdf

[4] Miesel et al. *SolarCity Photovoltaic Modules with 35 Year Useful Life.* June 2016. Accessed March 2017. http://www.solarcity.com/newsroom/reports/solarcity-photovoltaic-modules-35-year-useful-life

[5] David Unger. *Are Renewables Stormproof? Hurricane Sandy Tests Solar, Wind.* November 2012. Accessed March 2017. http://www.csmonitor.com/Environment/Energy-Voices/2012/1119/Are-renewables-stormproof-Hurricane-Sandy-tests-solar-wind & http://www.csmonitor.com/Environment/Energy-Voices/2012/1119/Are-renewables-stormproof-Hurricane-Sandy-tests-solar-wind

[6] NEXTracker and 365 Pronto, *Tracking Your Solar Investment: Best Practices for Solar Tracker O&M*. Accessed March 2017. www.nextracker.com/content/uploads/2017/03/NEXTracker_OandM-WhitePaper_FINAL_March-2017.pdf

[7] Christiana Honsberg, Stuart Bowden. *Overview of Screen Printed Solar Cells*. Accessed January 2017. www.pveducation.org/pvcdrom/manufacturing/screen-printed

[8] Silicon Valley Toxics Coalition. *2015 Solar Scorecard.* Accessed August 2016. www.solarscorecard.com/2015/2015-SVTC-Solar-Scorecard.pdf

[9] European Commission. *Recast of Reduction of Hazardous Substances (RoHS) Directive*. September 2016. Accessed August 2016. http://ec.europa.eu/environment/waste/rohs_eee/index_en.htm

[10] Official Journal of the European Union, *DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.* June 2011. Accessed May 2017. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011L0065&from=en

[11] Giancarlo Giacchetta, Mariella Leporini, Barbara Marchetti. *Evaluation of the Environmental Benefits of New High Value Process for the Management of the End of Life of Thin Film Photovoltaic Modules.* July 2013. Accessed August 2016. www.researchgate.net/publication/257408804_Evaluation_of_the_environmental_benefits_of_new_high_value_process_for_the_management_of_the_end_of_life_of_thin_film_photovoltaic_modules

[12] European Commission. *Study on Photovoltaic Panels Supplementing The Impact Assessment for a Recast of the Weee Directive.* April 2011. Accessed August 2016. http://ec.europa.eu/environment/waste/weee/pdf/Study%20on%20PVs%20Bio%20final.pdf

[14] The amount of lead in a typical car battery is 21.4 pounds. Waste 360. Chaz Miller. *Lead Acid Batteries.* March 2006. Accessed August 2016. http://waste360.com/mag/waste_leadacid_batteries_3

[15] Okkenhaug G. *Leaching from CdTe PV module material results from batch, column and availability tests.* Norwegian Geotechnical Institute, NGI report No. 20092155-00-6-R; 2010

[16] International Journal of Advanced Applied Physics Research. Renate Zapf-Gottwick1, et al. *Leaching Hazardous Substances out of Photovoltaic Modules*. January 2015. Accessed January 2016. www.cosmosscholars.com/phms/index.php/ijaapr/article/download/485/298

[17] ibid

[18] Parikhit Sinha, et al. Evaluation of Potential Health and Environmental Impacts from End-Of-Life Disposal of Photovoltaics, Photovoltaics, 2014. Accessed May 2016

[19] Bonnet, D. and P. Meyers. 1998. *Cadmium-telluride—Material for thin film solar cells.* J. Mater. Res., Vol. 13, No. 10, pp. 2740-2753

[20] V. Fthenakis, K. Zweibel. *CdTe PV: Real and Perceived EHS Risks*. National Center ofr Photovoltaics and Solar Program Review Meeting, March 24-26, 2003. www.nrel.gov/docs/fy03osti/33561.pdf. Accessed May 2017

[21] International Energy Agency Photovoltaic Power Systems Programme. *Life Cycle Inventories and Life Cycle Assessments of Photovoltaic Systems*. March 2015. Accessed August 2016. http://iea-pvps.org/index.php?id=315

[22] Data not available on fraction of various generation sources offset by solar generation in NC, but this is believed to be a reasonable rough estimate. The SunShot report entitled The Environmental and Public Health Benefits of Achieving High Penetrations of Solar Energy in the United States analysis contributes significant (% not provided) offsetting of coal-fired generation by solar PV energy in the southeast.

[23] 7 MW_{DC} * 1.5 GWh/MW_{DC} * 25 years * 0.93 degradation factor * (0.1 *4.65 grams/GWh + 0.9*0.2 grams/GWh)

[24] Vasilis Fthenakis. *CdTe PV: Facts and Handy Comparisons.* January 2003. Accessed March 2017. https://www.bnl.gov/pv/files/pdf/art_165.pdf

[25] Kaczmar, S., *Evaluating the Read-Across Approach on CdTe Toxicity for CdTe Photovoltaics*, SETAC North America 32nd Annual Meeting, Boston, MA, November 2011. Available at: ftp://ftp.co.imperial.ca.us/icpds/eir/campo-verde-solar/final/evaluating-toxicity.pdf, Accessed May 2017

[27] V. M. Fthenakis et al, *Emissions and Encapsulation of Cadmium in CdTe PV Modules During Fires* Renewable Progress in Photovoltaics: Research and Application: Res. Appl. 2005; 13:1–11, Accessed March 2017, www.bnl.gov/pv/files/pdf/abs_179.pdf

[28] Fthenakis *V.M., Life Cycle Impact Analysis of Cadmium in CdTe Photovoltaic Production*, Renewable and Sustainable Energy Reviews, 8, 303-334, 2004. www.clca.columbia.edu/papers/Life_Cycle_Impact_Analysis_Cadmium_CdTe_Photovoltaic_production.pdf, Accessed May 2017

[29] International Renewable Energy Agency. Stephanie Weckend, Andreas Wade, Garvin Heath. *End of Life Management: Solar Photovoltaic Panels*. June 2016. Accessed November 2016.

[30] International Journal of Advanced Applied Physics Research. Renate Zapf-Gottwick1, et al. *Leaching Hazardous Substances out of Photovoltaic Modules*. January 2015. Accessed January 2016. www.cosmosscholars.com/phms/index.php/ijaapr/article/download/485/298

[31] Cunningham D., Discussion about TCLP protocols, Photovoltaics and the Environment Workshop, July 23-24, 1998, Brookhaven National Laboratory, BNL-52557

[32] Parikhit Sinha, et al. Evaluation of Potential Health and Environmental Impacts from End-Of-Life Disposal of Photovoltaics, Photovoltaics, 2014. Accessed May 2016

[33] Practical Handbook of Photovoltaics: Fundamentals and Applications. T. Markvart and L. Castaner. *Chapter VII-2: Overview of Potential Hazards*. December 2003. Accessed August 2016. https://www.bnl.gov/pv/files/pdf/art_170.pdf

[34] Norwegian Geotechnical Institute. *Environmental Risks Regarding the Use and End-of-Life Disposal of CdTe PV Modules*. April 2010. Accessed August 2016. https://www.dtsc.ca.gov/LawsRegsPolicies/upload/Norwegian-Geotechnical-Institute-Study.pdf

[35] First Solar. Dr. Yasunari Matsuno. December 2013. August 2016. *Environmental Risk Assessment of CdTe PV Systems to be considered under Catastrophic Events in Japan*. http://www.firstsolar.com/-/media/Documents/Sustainability/Peer-Reviews/Japan_Peer-Review_Matsuno_CdTe-PV-Tsunami.ashx

[36] First Solar. Parikhit Sinha, Andreas Wade. *Assessment of Leaching Tests for Evaluating Potential Environmental Impacts of PV Module Field Breakage*. 2015 IEEE

[37] See p. 22 of First Solar, Sustainability Report. Available at: www.firstsolar.com/-/media/First-Solar/Sustainability-Documents/03801_FirstSolar_SustainabilityReport_08MAR16_Web.ashx, Accessed May 2017

[38] 40 CFR §261.24. *Toxicity Characteristic*. May 2017. Accessed May 2017. https://www.ecfr.gov/cgi-bin/text-idx?node=se40.26.261_124&rgn=div8
[39] Office of Energy Efficiency & Renewable Energy. *Copper Indium Gallium Diselenide.* Accessed March 2017. https://www.energy.gov/eere/sunshot/copper-indium-gallium-diselenide
[40] Mathias Maehlum. *Best Thin Film Solar Panels – Amorphous, Cadmium Telluride or CIGS?* April 2015. Accessed March 2017. http://energyinformative.org/best-thin-film-solar-panels-amorphous-cadmium-telluride-cigs/
[41] RoHS tested certificate for Solar Frontier PV modules. TUVRheinland, signed 11.11.2013
[42] International Renewable Energy Agency. Stephanie Weckend, Andreas Wade, Garvin Heath. *End of Life Management: Solar Photovoltaic Panels*. June 2016. Accessed November 2016. http://www.irena.org/DocumentDownloads/Publications/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf
[43] 40 C.F.R. §261.10. *Identifying the Characteristics of Hazardous Waste and for Listing Hazardous Waste*. November 2016. Accessed November 2016 http://www.ecfr.gov/cgi-bin/text-idx?SID=ce0006d66da40146b490084ca2816143&mc=true&node=pt40.26.261&rgn=div5#sp40.28.261.b
[44] 40 C.F.R. §261.24 *Toxicity Characteristic.* November 2016. Accessed November 2016. http://www.ecfr.gov/cgi-bin/text-idx?SID=ce0006d66da40146b490084ca2816143&mc=true&node=pt40.26.261&rgn=div5#se40.28.261_124
[45] International Renewable Energy Agency. Stephanie Weckend, Andreas Wade, Garvin Heath. *End of Life Management: Solar Photovoltaic Panels*. June 2016. Accessed November 2016. http://www.irena.org/DocumentDownloads/Publications/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf
[46] TLCP test results from third-party laboratories for REC, Jinko, and Canadian Solar silicon-based panels. Provided by PV panel manufacturers directly or indirectly to authors
[47] Sinovoltaics, *Introduction to Solar Panel Recycling*, March 2014. Accessed October 2016. http://sinovoltaics.com/solar-basics/introduction-to-solar-panel-recycling/
[48] Brookhaven National Laboratory. Vasilis Fthenakis, *Regulations on Photovoltaic Module Disposal and Recycling.* January 29, 2001.
[49] Parikhit Sinha, et al. Evaluation of Potential Health and Environmental Impacts from End-Of-Life Disposal of Photovoltaics, Photovoltaics, 2014.
[50] First Solar. Parikhit Sinha, Andreas Wade. *Assessment of Leaching Tests for Evaluating Potential Environmental Impacts of PV Module Field Breakage.* October 2015. Accessed August 2016. http://www.firstsolar.com/-/media/Documents/Sustainability/PVSC42-Manuscript-20150912--Assessment-of-Leaching-Tests-for-Evaluating-Potential-Environmental-Impa.ashx
[51] First Solar. Dr. Yasunari Matsuno. December 2013. *Environmental Risk Assessment of CdTe PV Systems to be considered under Catastrophic Events in Japan*. http://www.firstsolar.com/-/media/Documents/Sustainability/Peer-Reviews/Japan_Peer-Review_Matsuno_CdTe-PV-Tsunami.ashx
[52] Phone interview, February 3, 2016, TT&E Iron & Metal, Garner, NC www.ncscrapmetal.com/
[53] Wen-His Huang, et al. *Strategy and Technology To Recycle Water-silicon Solar Modules*. Solar Energy, Volume 144, March 2017, Pages 22-31
[54] International Renewable Energy Agency. Stephanie Weckend, Andreas Wade, Garvin Heath. *End of Life Management: Solar Photovoltaic Panels*. June 2016. Accessed November 2016. http://www.irena.org/DocumentDownloads/Publications/IRENA_IEAPVPS_End-of-Life_Solar_PV_Panels_2016.pdf
[55] Official Journal of the European Union. *Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on Waste Electrical and Electronic Equipment*. July 2012. Accessed November 2016. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0019
[56] PV CYCLE. *Annual Report 2015.* Accessed November 2016. https://pvcyclepublications.cld.bz/Annual-Report-PV-CYCLE-2015/6-7
[57] Official Journal of the European Union. *Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on Waste Electrical and Electronic Equipment*. July 2012. Accessed November 2016. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0019
[58] SEIA National PV Recycling Program: www.seia.org/seia-national-pv-recycling-program
[59] RBI Solar, Decommissioning Plan submitted to Catawba County associated with permitting of a 5MW solar project in June 2016. Accessed April 2017. www.catawbacountync.gov/Planning/Projects/Rezonings/RZ2015-05_DecommissioningPlan.pdf
[60] Birdseye Renewables, Decommissioning Plan submitted to Catawba County associated with permitting of a 5MW solar project in May 2015. Accessed April 2017. www.catawbacountync.gov/Planning/Projects/Rezonings/RZ2015-04_DecommissioningPlan.pdf
[61] Cypress Creek Renewables, Decommissioning Plan submitted to Catawba County associated with permitting of a 5MW solar project in September 2016. Accessed April 2017. www.catawbacountync.gov/Planning/Projects/Rezonings/RZ2016-06decommission.pdf
[62] Sun Raised Farms: http://sunraisedfarms.com/index.html
[63] National Institute of Environmental Health Sciences and National Institutes of Health, EMF: Electric and Magnetic Fields Associated with Electric Power: Questions and Answers, June 2002

[64] World Health Organization. *Electromagnetic Fields and Public Health: Exposure to Extremely Low Frequency Fields*. June 2007. Accessed August 2016. http://www.who.int/peh-emf/publications/facts/fs322/en/
[65] Committee on the Possible Effects of Electromagnetic Fields on Biologic Systems, National Research Council, Possible Health Effects of Exposure to Residential Electric and Magnetic Fields, ISBN: 0-309-55671-6, 384 pages, 6 x 9, (1997) This PDF is available from the National Academies Press at: http://www.nap.edu/catalog/5155.html
[66] World Health Organization. *Electromagnetic Fields and Public Health: Exposure to Extremely Low Frequency Fields*. June 2007. Accessed August 2016. http://www.who.int/peh-emf/publications/facts/fs322/en/
[67] World Health Organization. *Electromagnetic Fields and Public Health: Static Electric and Magnetic Fields*. March 2006. Accessed August 2016. http://www.who.int/peh-emf/publications/facts/fs299/en/
[68] Asher Sheppard, Health Issues Related to the Static and Power-Frequency Electric and Magnetic Fields (EMFs) of the Soitec Solar Energy Farms, April 30, 2014. Accessed March 2017: www.sandiegocounty.gov/content/dam/sdc/pds/ceqa/Soitec-Documents/Final-EIR-Files/Appendix_9.0-1_EMF.pdf
[69] Massachusetts Clean Energy Center. *Study of Acoustic and EMF Levels from Solar Photovoltaic Projects*. December 2012. Accessed August 2016.
[70] Duke Energy Corporation. *Frequently Asked Questions: Electric and Magnetic Fields*. Accessed August 2016. https://www.duke-energy.com/about-energy/frequently_asked_questions.asp
[71] National Institute of Environmental Health Sciences, *Electric and Magnetic Fields Associate with the use of Electric Power: Questions and Answers*, 2002. Accessed November 2016 www.niehs.nih.gov/health/materials/electric_and_magnetic_fields
[72] Duke Energy Corporation. *Frequently Asked Questions: Electric and Magnetic Fields*. Accessed August 2016. https://www.duke-energy.com/about-energy/frequently_asked_questions.asp
[73] R.A. Tell et al, *Electromagnetic Fields Associated with Commercial Solar Photovoltaic Electric Power Generating Facilities*, Journal of Occupational and Environmental Hygiene, Volume 12, 2015,- Issue 11. Abstract Accessed March 2016: http://www.tandfonline.com/doi/full/10.1080/15459624.2015.1047021
[74] Massachusetts Department of Energy Resources, Massachusetts Department of Environmental Protection, and Massachusetts Clean Energy Center. *Questions & Answers: Ground-Mounted Solar Photovoltaic Systems*. June 2015. Accessed August 2016. http://www.mass.gov/eea/docs/doer/renewables/solar/solar-pv-guide.pdf
[75] Ibid.
[76] Ibid.
[77] *EMFs and medical devices*, Accessed March 2017. www.emfs.info/effects/medical-devices/
[78] ibid.
[79] Damon McCluer. *Electrical Construction & Maintenance: NFPA 70E's Approach to Considering DC Hazards*. September 2013. Accessed October 2016. http://ecmweb.com/safety/nfpa-70e-s-approach-considering-dc-hazards,
[80] Hong-Yun Yang, et. al. *Experimental Studies on the Flammability and Fire Hazards of Photovoltaic Modules, Materials.* July 2015. Accessed August 2016. http://www.mdpi.com/1996-1944/8/7/4210/pdf
[81] Matt Fountain. The Tribune. *Fire breaks out at Topaz Solar Farm*. July 2015. Accessed August 2016. www.sanluisobispo.com/news/local/article39055539.html
[82] Cooperative Research Network. Matthew Paiss. *Tech Surveillance: PV Safety & Code Developments*. October 2014. Accessed August 2016. http://www.nreca.coop/wp-content/uploads/2013/06/ts_pv_fire_safety_oct_2014.pdf

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EXHIBIT L: HYDROLOGIC RESPONSE TO SOLAR FARMS

Hydrologic Response of Solar Farms

Lauren M. Cook, S.M.ASCE[1]; and Richard H. McCuen, M.ASCE[2]

Abstract: Because of the benefits of solar energy, the number of solar farms is increasing; however, their hydrologic impacts have not been studied. The goal of this study was to determine the hydrologic effects of solar farms and examine whether or not storm-water management is needed to control runoff volumes and rates. A model of a solar farm was used to simulate runoff for two conditions: the pre- and postpaneled conditions. Using sensitivity analyses, modeling showed that the solar panels themselves did not have a significant effect on the runoff volumes, peaks, or times to peak. However, if the ground cover under the panels is gravel or bare ground, owing to design decisions or lack of maintenance, the peak discharge may increase significantly with storm-water management needed. In addition, the kinetic energy of the flow that drains from the panels was found to be greater than that of the rainfall, which could cause erosion at the base of the panels. Thus, it is recommended that the grass beneath the panels be well maintained or that a buffer strip be placed after the most downgradient row of panels. This study, along with design recommendations, can be used as a guide for the future design of solar farms. **DOI: 10.1061/(ASCE)HE.1943-5584.0000530.**

CE Database subject headings: Hydrology; Land use; Solar power; Floods; Surface water; Runoff; Stormwater management.

Author keywords: Hydrology; Land use change; Solar energy; Flooding; Surface water runoff; Storm-water management.

Introduction

Storm-water management practices are generally implemented to reverse the effects of land-cover changes that cause increases in volumes and rates of runoff. This is a concern posed for new types of land-cover change such as the solar farm. Solar energy is a renewable energy source that is expected to increase in importance in the near future. Because solar farms require considerable land, it is necessary to understand the design of solar farms and their potential effect on erosion rates and storm runoff, especially the impact on offsite properties and receiving streams. These farms can vary in size from 8 ha (20 acres) in residential areas to 250 ha (600 acres) in areas where land is abundant.

The solar panels are impervious to rain water; however, they are mounted on metal rods and placed over pervious land. In some cases, the area below the panel is paved or covered with gravel. Service roads are generally located between rows of panels. Although some panels are stationary, others are designed to move so that the angle of the panel varies with the angle of the sun. The angle can range, depending on the latitude, from 22° during the summer months to 74° during the winter months. In addition, the angle and direction can also change throughout the day. The issue posed is whether or not these rows of impervious panels will change the runoff characteristics of the site, specifically increase runoff volumes or peak discharge rates. If the increases are hydrologically significant, storm-water management facilities may be needed. Additionally, it is possible that the velocity of water draining from the edge of the panels is sufficient to cause erosion of the soil below the panels, especially where the maintenance roadways are bare ground.

The outcome of this study provides guidance for assessing the hydrologic effects of solar farms, which is important to those who plan, design, and install arrays of solar panels. Those who design solar farms may need to provide for storm-water management. This study investigated the hydrologic effects of solar farms, assessed whether or not storm-water management might be needed, and if the velocity of the runoff from the panels could be sufficient to cause erosion of the soil below the panels.

Model Development

Solar farms are generally designed to maximize the amount of energy produced per unit of land area, while still allowing space for maintenance. The hydrologic response of solar farms is not usually considered in design. Typically, the panels will be arrayed in long rows with separations between the rows to allow for maintenance vehicles. To model a typical layout, a unit width of one panel was assumed, with the length of the downgradient strip depending on the size of the farm. For example, a solar farm with 30 rows of 200 panels each could be modeled as a strip of 30 panels with space between the panels for maintenance vehicles. Rainwater that drains from the upper panel onto the ground will flow over the land under the 29 panels on the downgradient strip. Depending on the land cover, infiltration losses would be expected as the runoff flows to the bottom of the slope.

To determine the effects that the solar panels have on runoff characteristics, a model of a solar farm was developed. Runoff in the form of sheet flow without the addition of the solar panels served as the prepaneled condition. The paneled condition assumed a downgradient series of cells with one solar panel per ground cell. Each cell was separated into three sections: wet, dry, and spacer.

The dry section is that portion directly underneath the solar panel, unexposed directly to the rainfall. As the angle of the panel from the horizontal increases, more of the rain will fall directly onto

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the ground; this section of the cell is referred to as the wet section. The spacer section is the area between the rows of panels used by maintenance vehicles. Fig. 1 is an image of two solar panels and the spacer section allotted for maintenance vehicles. Fig. 2 is a schematic of the wet, dry, and spacer sections with their respective dimensions. In Fig. 1, tracks from the vehicles are visible on what is modeled within as the spacer section. When the solar panel is horizontal, then the length longitudinal to the direction that runoff will occur is the length of the dry and wet sections combined. Runoff from a dry section drains onto the downgradient spacer section. Runoff from the spacer section flows to the wet section of the next downgradient cell. Water that drains from a solar panel falls directly onto the spacer section of that cell.

The length of the spacer section is constant. During a storm event, the loss rate was assumed constant for the 24-h storm because a wet antecedent condition was assumed. The lengths of the wet and dry sections changed depending on the angle of the solar panel. The total length of the wet and dry sections was set equal to the length of one horizontal solar panel, which was assumed to be 3.5 m. When a solar panel is horizontal, the dry section length would equal 3.5 m and the wet section length would be zero. In the paneled condition, the dry section does not receive direct rainfall because the rain first falls onto the solar panel then drains onto the spacer section. However, the dry section does infiltrate some of the runoff that comes from the upgradient wet section. The wet section was modeled similar to the spacer section with rain falling directly onto the section and assuming a constant loss rate.

For the presolar panel condition, the spacer and wet sections are modeled the same as in the paneled condition; however, the cell does not include a dry section. In the prepaneled condition, rain falls directly onto the entire cell. When modeling the prepaneled condition, all cells receive rainfall at the same rate and are subject to losses. All other conditions were assumed to remain the same such that the prepaneled and paneled conditions can be compared.

Rainfall was modeled after an natural resources conservation service (NRCS) Type II Storm (McCuen 2005) because it is an accurate representation of actual storms of varying characteristics that are imbedded in intensity-duration-frequency (IDF) curves. For each duration of interest, a dimensionless hyetograph was developed using a time increment of 12 s over the duration of the storm (see Fig. 3). The depth of rainfall that corresponds to each storm magnitude was then multiplied by the dimensionless hyetograph. For a 2-h storm duration, depths of 40.6, 76.2, and 101.6 mm were used for the 2-, 25-, and 100-year events. The 2- and 6-h duration hyetographs were developed using the center portion of the 24-h storm, with the rainfall depths established with the Baltimore IDF curve. The corresponding depths for a 6-h duration were 53.3, 106.7, and 132.1 mm, respectively. These magnitudes were chosen to give a range of storm conditions.

During each time increment, the depth of rain is multiplied by the cell area to determine the volume of rain added to each section of each cell. This volume becomes the storage in each cell. Depending on the soil group, a constant volume of losses was subtracted from the storage. The runoff velocity from a solar panel was calculated using Manning's equation, with the hydraulic radius for sheet flow assumed to equal the depth of the storage on the panel (Bedient and Huber 2002). Similar assumptions were made to compute the velocities in each section of the surface sections.

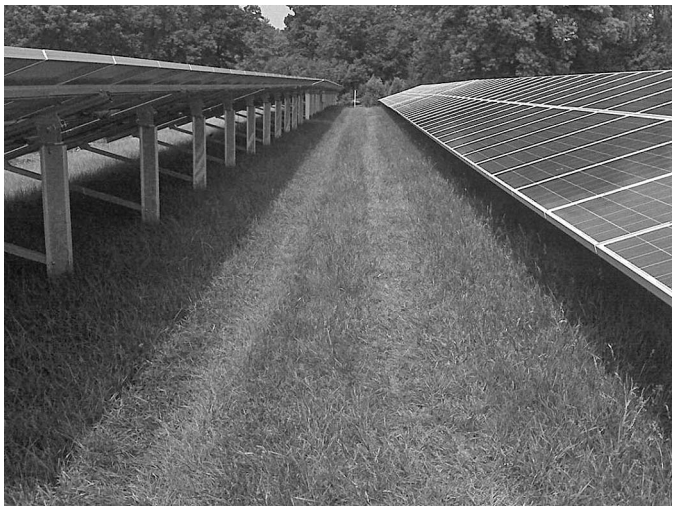

Fig. 1. Maintenance or "spacer" section between two rows of solar panels (photo by John E. Showler, reprinted with permission)

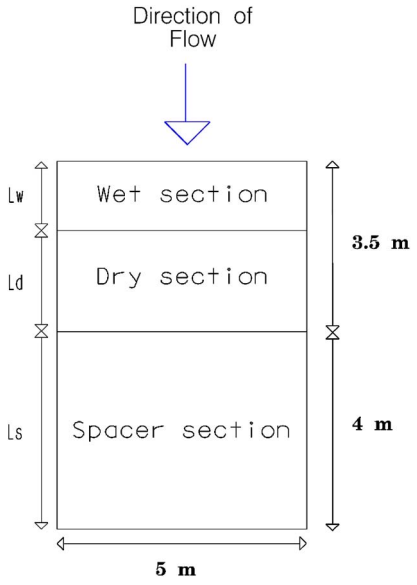

Fig. 2. Wet, dry, and spacer sections of a single cell with lengths *Lw*, *Ls*, and *Ld* with the solar panel covering the dry section

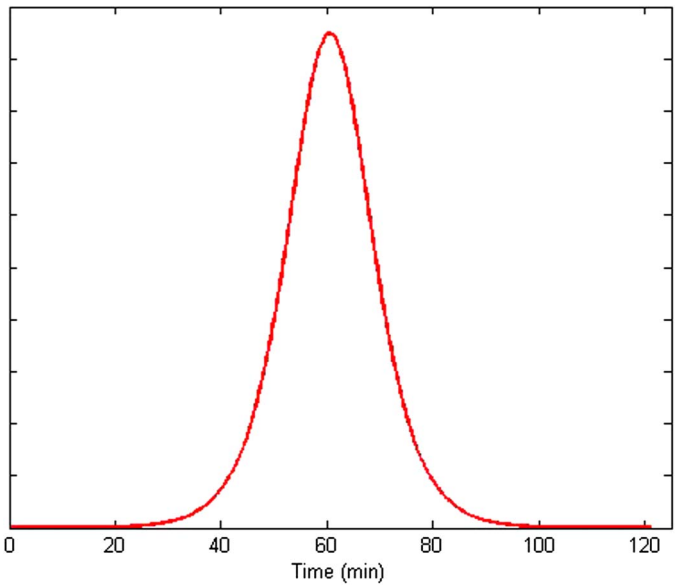

Fig. 3. Dimensionless hyetograph of 2-h Type II storm

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Runoff from one section to the next and then to the next downgradient cell was routed using the continuity of mass. The routing coefficient depended on the depth of flow in storage and the velocity of runoff. Flow was routed from the wet section to the dry section to the spacer section, with flow from the spacer section draining to the wet section of the next cell. Flow from the most downgradient cell was assumed to be the outflow. Discharge rates and volumes from the most downgradient cell were used for comparisons between the prepaneled and paneled conditions.

Alternative Model Scenarios

To assess the effects of the different variables, a section of 30 cells, each with a solar panel, was assumed for the base model. Each cell was separated individually into wet, dry, and spacer sections. The area had a total ground length of 225 m with a ground slope of 1% and width of 5 m, which was the width of an average solar panel. The roughness coefficient (Engman 1986) for the silicon solar panel was assumed to be that of glass, 0.01. Roughness coefficients of 0.15 for grass and 0.02 for bare ground were also assumed. Loss rates of 0.5715 cm/h (0.225 in./h) and 0.254 cm/h (0.1 in./h) for B and C soils, respectively, were assumed.

The prepaneled condition using the 2-h, 25-year rainfall was assumed for the base condition, with each cell assumed to have a good grass cover condition. All other analyses were made assuming a paneled condition. For most scenarios, the runoff volumes and peak discharge rates from the paneled model were not significantly greater than those for the prepaneled condition. Over a total length of 225 m with 30 solar panels, the runoff increased by 0.26 m^3, which was a difference of only 0.35%. The slight increase in runoff volume reflects the slightly higher velocities for the paneled condition. The peak discharge increased by 0.0013 m^3, a change of only 0.31%. The time to peak was delayed by one time increment, i.e., 12 s. Inclusion of the panels did not have a significant hydrologic impact.

Storm Magnitude

The effect of storm magnitude was investigated by changing the magnitude from a 25-year storm to a 2-year storm. For the 2-year storm, the rainfall and runoff volumes decreased by approximately 50%. However, the runoff from the paneled watershed condition increased compared to the prepaneled condition by approximately the same volume as for the 25-year analysis, 0.26 m^3. This increase represents only a 0.78% increase in volume. The peak discharge and the time to peak did not change significantly. These results reflect runoff from a good grass cover condition and indicated that the general conclusion of very minimal impacts was the same for different storm magnitudes.

Ground Slope

The effect of the downgradient ground slope of the solar farm was also examined. The angle of the solar panels would influence the velocity of flows from the panels. As the ground slope was increased, the velocity of flow over the ground surface would be closer to that on the panels. This could cause an overall increase in discharge rates. The ground slope was changed from 1 to 5%, with all other conditions remaining the same as the base conditions.

With the steeper incline, the volume of losses decreased from that for the 1% slope, which is to be expected because the faster velocity of the runoff would provide less opportunity for infiltration. However, between the prepaneled and paneled conditions, the increase in runoff volume was less than 1%. The peak discharge and the time to peak did not change. Therefore, the greater ground slope did not significantly influence the response of the solar farm.

Soil Type

The effect of soil type on the runoff was also examined. The soil group was changed from B soil to C soil by varying the loss rate. As expected, owing to the higher loss rate for the C soil, the depths of runoff increased by approximately 7.5% with the C soil when compared with the volume for B soils. However, the runoff volume for the C soil condition only increased by 0.17% from the prepaneled condition to the paneled condition. In comparison with the B soil, a difference of 0.35% in volume resulted between the two conditions. Therefore, the soil group influenced the actual volumes and rates, but not the relative effect of the paneled condition when compared to the prepaneled condition.

Panel Angle

Because runoff velocities increase with slope, the effect of the angle of the solar panel on the hydrologic response was examined. Analyses were made for angles of 30° and 70° to test an average range from winter to summer. The hydrologic response for these angles was compared to that of the base condition angle of 45°. The other site conditions remained the same. The analyses showed that the angle of the panel had only a slight effect on runoff volumes and discharge rates. The lower angle of 30° was associated with an increased runoff volume, whereas the runoff volume decreased for the steeper angle of 70° when compared with the base condition of 45°. However, the differences (~0.5%) were very slight. Nevertheless, these results indicate that, when the solar panel was closer to horizontal, i.e., at a lower angle, a larger difference in runoff volume occurred between the prepaneled and paneled conditions. These differences in the response result are from differences in loss rates.

The peak discharge was also lower at the lower angle. At an angle of 30°, the peak discharge was slightly lower than at the higher angle of 70°. For the 2-h storm duration, the time to peak of the 30° angle was 2 min delayed from the time to peak of when the panel was positioned at a 70° angle, which reflects the longer travel times across the solar panels.

Storm Duration

To assess the effect of storm duration, analyses were made for 6-h storms, testing magnitudes for 2-, 25-, and 100-year return periods, with the results compared with those for the 2-h rainfall events. The longer storm duration was tested to determine whether a longer duration storm would produce a different ratio of increase in runoff between the prepaneled and paneled conditions. When compared to runoff volumes from the 2-h storm, those for the 6-h storm were 34% greater in both the paneled and prepaneled cases. However, when comparing the prepaneled to the paneled condition, the increase in the runoff volume with the 6-h storm was less than 1% regardless of the return period. The peak discharge and the time-to-peak did not differ significantly between the two conditions. The trends in the hydrologic response of the solar farm did not vary with storm duration.

Ground Cover

The ground cover under the panels was assumed to be a native grass that received little maintenance. For some solar farms, the area beneath the panel is covered in gravel or partially paved because the panels prevent the grass from receiving sunlight. Depending on the

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volume of traffic, the spacer cell could be grass, patches of grass, or bare ground. Thus, it was necessary to determine whether or not these alternative ground-cover conditions would affect the runoff characteristics. This was accomplished by changing the Manning's n for the ground beneath the panels. The value of n under the panels, i.e., the dry section, was set to 0.015 for gravel, with the value for the spacer or maintenance section set to 0.02, i.e., bare ground. These can be compared to the base condition of a native grass ($n = 0.15$). A good cover should promote losses and delay the runoff.

For the smoother surfaces, the velocity of the runoff increased and the losses decreased, which resulted in increasing runoff volumes. This occurred both when the ground cover under the panels was changed to gravel and when the cover in the spacer section was changed to bare ground. Owing to the higher velocities of the flow, runoff rates from the cells increased significantly such that it was necessary to reduce the computational time increment. Fig. 4(a) shows the hydrograph from a 30-panel area with a time increment of 12 s. With a time increment of 12 s, the water in each cell is discharged at the end of every time increment, which results in no attenuation of the flow; thus, the undulations shown in Fig. 4(a) result. The time increment was reduced to 3 s for the 2-h storm, which resulted in watershed smoothing and a rational hydrograph shape [Fig. 4(b)]. The results showed that the storm runoff

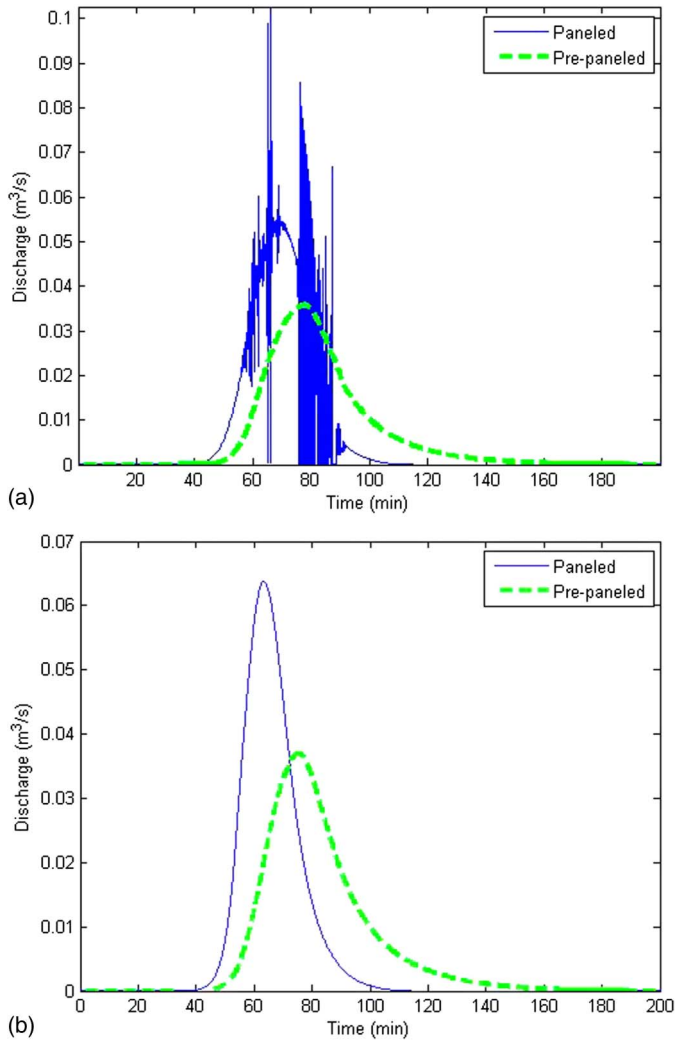

Fig. 4. Hydrograph with time increment of (a) 12 s; (b) 3 s with Manning's n for bare ground

increased by 7% from the grass-covered scenario to the scenario with gravel under the panel. The peak discharge increased by 73% for the gravel ground cover when compared with the grass cover without the panels. The time to peak was 10 min less with the gravel than with the grass, which reflects the effect of differences in surface roughness and the resulting velocities.

If maintenance vehicles used the spacer section regularly and the grass cover was not adequately maintained, the soil in the spacer section would be compacted and potentially the runoff volumes and rates would increase. Grass that is not maintained has the potential to become patchy and turn to bare ground. The grass under the panel may not get enough sunlight and die. Fig. 1 shows the result of the maintenance trucks frequently driving in the spacer section, which diminished the grass cover.

The effect of the lack of solar farm maintenance on runoff characteristics was modeled by changing the Manning's n to a value of 0.02 for bare ground. In this scenario, the roughness coefficient for the ground under the panels, i.e., the dry section, as well as in the spacer cell was changed from grass covered to bare ground ($n = 0.02$).The effects were nearly identical to that of the gravel. The runoff volume increased by 7% from the grass-covered to the bare-ground condition. The peak discharge increased by 72% when compared with the grass-covered condition. The runoff for the bare-ground condition also resulted in an earlier time to peak by approximately 10 min. Two other conditions were also modeled, showing similar results. In the first scenario, gravel was placed directly under the panel, and healthy grass was placed in the spacer section, which mimics a possible design decision. Under these conditions, the peak discharge increased by 42%, and the volume of runoff increased by 4%, which suggests that storm-water management would be necessary if gravel is placed anywhere.

Fig. 5 shows two solar panels from a solar farm in New Jersey. The bare ground between the panels can cause increased runoff rates and reductions in time of concentration, both of which could necessitate storm-water management. The final condition modeled involved the assumption of healthy grass beneath the panels and bare ground in the spacer section, which would simulate the condition of unmaintained grass resulting from vehicles that drive over the spacer section. Because the spacer section is 53% of the cell, the change in land cover to bare ground would reduce losses and decrease runoff travel times, which would cause runoff to amass as it

Fig. 5. Site showing the initiation of bare ground below the panels, which increases the potential for erosion (photo by John Showler, reprinted with permission)

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moves downgradient. With the spacer section as bare ground, the peak discharge increased by 100%, which reflected the increases in volume and decrease in timing. These results illustrate the need for maintenance of the grass below and between the panels.

Design Suggestions

With well-maintained grass underneath the panels, the solar panels themselves do not have much effect on total volumes of the runoff or peak discharge rates. Although the panels are impervious, the rainwater that drains from the panels appears as runoff over the downgradient cells. Some of the runoff infiltrates. If the grass cover of a solar farm is not maintained, it can deteriorate either because of a lack of sunlight or maintenance vehicle traffic. In this case, the runoff characteristics can change significantly with both runoff rates and volumes increasing by significant amounts. In addition, if gravel or pavement is placed underneath the panels, this can also contribute to a significant increase in the hydrologic response.

If bare ground is foreseen to be a problem or gravel is to be placed under the panels to prevent erosion, it is necessary to counteract the excess runoff using some form of storm-water management. A simple practice that can be implemented is a buffer strip (Dabney et al. 2006) at the downgradient end of the solar farm. The buffer strip length must be sufficient to return the runoff characteristics with the panels to those of runoff experienced before the gravel and panels were installed. Alternatively, a detention basin can be installed.

A buffer strip was modeled along with the panels. For approximately every 200 m of panels, or 29 cells, the buffer must be 5 cells long (or 35 m) to reduce the runoff volume to that which occurred before the panels were added. Even if a gravel base is not placed under the panels, the inclusion of a buffer strip may be a good practice when grass maintenance is not a top funding priority. Fig. 6 shows the peak discharge from the graveled surface versus the length of the buffer needed to keep the discharge to prepaneled peak rate.

Water draining from a solar panel can increase the potential for erosion of the spacer section. If the spacer section is bare ground, the high kinetic energy of water draining from the panel can cause soil detachment and transport (Garde and Raju 1977; Beuselinck et al. 2002). The amount and risk of erosion was modeled using the velocity of water coming off a solar panel compared with the velocity and intensity of the rainwater. The velocity of panel runoff was calculated using Manning's equation, and the velocity of falling rainwater was calculated using the following:

$$V_t = 120\, d_r^{0.35} \tag{1}$$

where d_r = diameter of a raindrop, assumed to be 1 mm. The relationship between kinetic energy and rainfall intensity is

$$K_e = 916 + 330 \log_{10} i \tag{2}$$

where i = rainfall intensity (in./h) and K_e = kinetic energy (ft-tons per ac-in. of rain) of rain falling onto the wet section and the panel, as well as the water flowing off of the end of the panel (Wischmeier and Smith 1978). The kinetic energy (Salles et al. 2002) of the rainfall was greater than that coming off the panel, but the area under the panel (i.e., the product of the length, width, and cosine of the panel angle) is greater than the area under the edge of the panel where the water drains from the panel onto the ground. Thus, dividing the kinetic energy by the respective areas gives a more accurate representation of the kinetic energy experienced by the soil. The energy of the water draining from the panel onto the ground can be nearly 10 times greater than the rain itself falling onto the ground area. If the solar panel runoff falls onto an unsealed soil, considerable detachment can result (Motha et al. 2004). Thus, because of the increased kinetic energy, it is possible that the soil is much more prone to erosion with the panels than without. Where panels are installed, methods of erosion control should be included in the design.

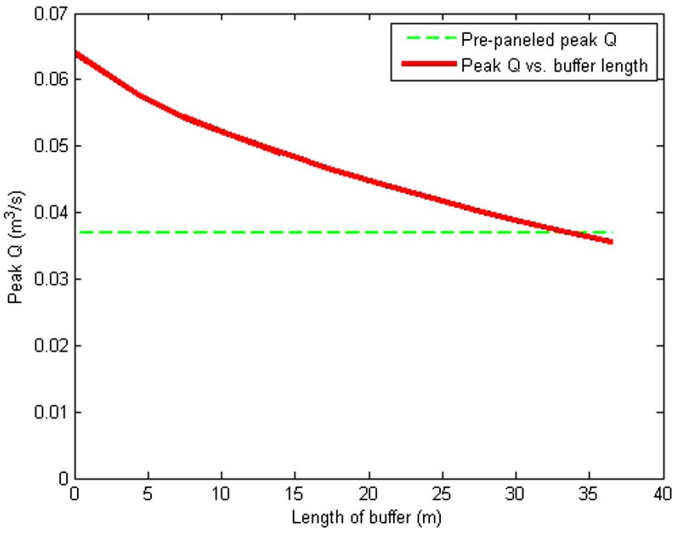

Fig. 6. Peak discharge over gravel compared with buffer length

Conclusions

Solar farms are the energy generators of the future; thus, it is important to determine the environmental and hydrologic effects of these farms, both existing and proposed. A model was created to simulate storm-water runoff over a land surface without panels and then with solar panels added. Various sensitivity analyses were conducted including changing the storm duration and volume, soil type, ground slope, panel angle, and ground cover to determine the effect that each of these factors would have on the volumes and peak discharge rates of the runoff.

The addition of solar panels over a grassy field does not have much of an effect on the volume of runoff, the peak discharge, nor the time to peak. With each analysis, the runoff volume increased slightly but not enough to require storm-water management facilities. However, when the land-cover type was changed under the panels, the hydrologic response changed significantly. When gravel or pavement was placed under the panels, with the spacer section left as patchy grass or bare ground, the volume of the runoff increased significantly and the peak discharge increased by approximately 100%. This was also the result when the entire cell was assumed to be bare ground.

The potential for erosion of the soil at the base of the solar panels was also studied. It was determined that the kinetic energy of the water draining from the solar panel could be as much as 10 times greater than that of rainfall. Thus, because the energy of the water draining from the panels is much higher, it is very possible that soil below the base of the solar panel could erode owing to the concentrated flow of water off the panel, especially if there is bare ground in the spacer section of the cell. If necessary, erosion control methods should be used.

Bare ground beneath the panels and in the spacer section is a realistic possibility (see Figs. 1 and 5). Thus, a good, well-maintained grass cover beneath the panels and in the spacer section is highly recommended. If gravel, pavement, or bare ground is

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deemed unavoidable below the panels or in the spacer section, it may necessary to add a buffer section to control the excess runoff volume and ensure adequate losses. If these simple measures are taken, solar farms will not have an adverse hydrologic impact from excess runoff or contribute eroded soil particles to receiving streams and waterways.

Acknowledgments

The authors appreciate the photographs (Figs. 1 and 5) of Ortho Clinical Diagnostics, 1001 Route 202, North Raritan, New Jersey, 08869, provided by John E. Showler, Environmental Scientist, New Jersey Department of Agriculture. The extensive comments of reviewers resulted in an improved paper.

References

Bedient, P. B., and Huber, W. C. (2002). *Hydrology and floodplain analysis*, Prentice-Hall, Upper Saddle River, NJ.

Beuselinck, L., Govers, G., Hairsince, P. B., Sander, G. C., and Breynaert, M. (2002). "The influence of rainfall on sediment transport by overland flow over areas of net deposition." *J. Hydrol.*, 257(1–4), 145–163.

Dabney, S. M., Moore, M. T., and Locke, M. A. (2006). "Integrated management of in-field, edge-of-field, and after-field buffers." *J. Amer. Water Resour. Assoc.*, 42(1), 15–24.

Engman, E. T. (1986). "Roughness coefficients for routing surface runoff." *J. Irrig. Drain. Eng.*, 112(1), 39–53.

Garde, R. J., and Raju, K. G. (1977). *Mechanics of sediment transportation and alluvial stream problems*, Wiley, New York.

McCuen, R. H. (2005). *Hydrologic analysis and design*, 3rd Ed., Pearson/Prentice-Hall, Upper Saddle River, NJ.

Motha, J. A., Wallbrink, P. J., Hairsine, P. B., and Grayson, R. B. (2004). "Unsealed roads as suspended sediment sources in agricultural catchment in south-eastern Australia." *J. Hydrol.*, 286(1–4), 1–18.

Salles, C., Poesen, J., and Sempere-Torres, D. (2002). "Kinetic energy of rain and its functional relationship with intensity." *J. Hydrol.*, 257(1–4), 256–270.

Wischmeier, W. H., and Smith, D. D. (1978). *Predicting rainfall erosion losses: A guide to conservation planning, USDA Handbook 537*, U.S. Government Printing Office, Washington, DC.

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EXHIBIT M: STRUCTURAL ENGINEER'S CERTIFICATE

Kimley»Horn

March 11, 2024

Montgomery County, IL
#1 Courthouse Square
Hillsboro, IL 62049

Re: Special Use Permit Application
North Sun LLC
Structural Engineer's Certificate

To Whom it May Concern,

Kimley-Horn and Associates, Inc., serves as the engineering consultant for 22c Development. 22c Development is seeking a Special Use Permit to build a commercial solar energy facility in Montgomery County, Illinois. The Project, North Sun LLC, is sited northwest of the intersection of North Road and N 21st Ave. The Project is a proposed 10 MWAC commercial solar energy facility.

As required by the local ordinance, a structural engineer registered in the State of Illinois must certify that the soils and subsurface conditions at the site can support the apparatus, given local soil, subsurface and climate conditions. We are writing today to state that it is our professional opinion that the soil conditions at the site are satisfactory for development and construction of a typical ground-mount solar facility. The soils fall into the NRCS unified soil classifications of 50A, 113B, 127C2, 882B2, 885A, 894A, and 993A which are mostly comprised of silt loam clay.

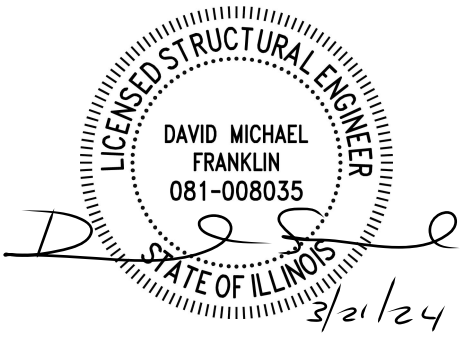
The foundations at a solar facility are most often driven steel piles and concrete slabs. The piles are used to support the solar racking and solar modules and the slabs are used to support larger equipment such as inverters, transformers and other electrical equipment as required. The foundations will be designed per a site-specific geotechnical report that contains foundation requirements. For weaker soils, the piles are often larger and driven deeper than for strong soils. The slabs will be designed to avoid settlement and often require subgrade preparation such as replacement of soils near the surface, placing structural fill/gravel, and compaction. The subgrade recommendations will also be provided in the final geotechnical report.

Kimley-Horn has provided engineering on over 1,500 solar projects across the country. Our experience from these projects suggests that the soils at the proposed solar site are satisfactory for construction of a solar facility. The final details of the foundations will be determined after the geotechnical investigation and after final engineering design.

If you have any questions based on the notes above, please let us know.

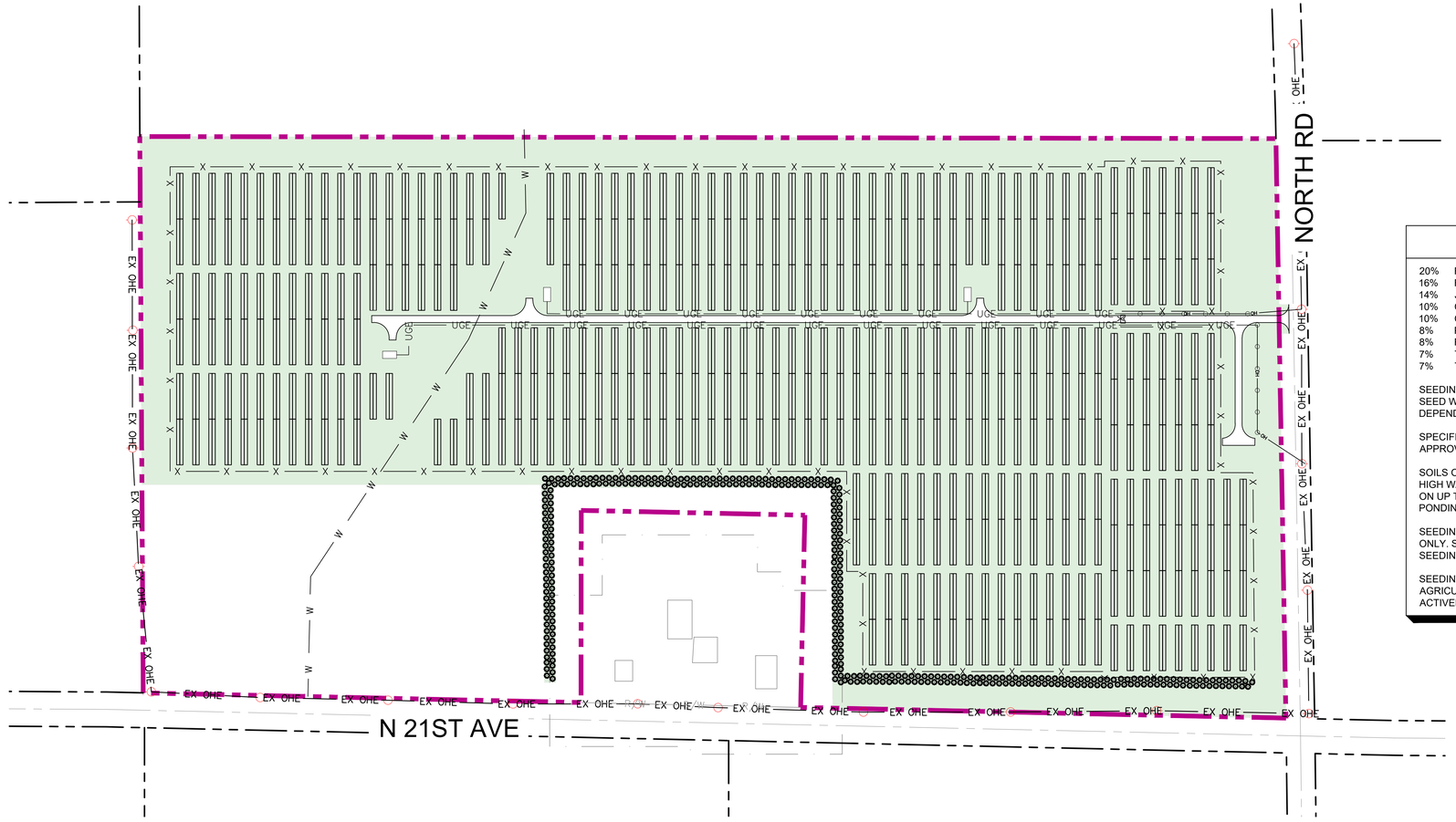
Sincerely,

Kimley-Horn and Associates, Inc.



David Franklin, IL SE
Structural Engineer
David.Franklin@kimley-horn.com

EXHIBIT N: VEGETATION MANAGEMENT PLAN



NORTH

GRAPHIC SCALE IN FEET
0 75 150 300

SOLAR FARM SEED MIX

20%	FESTUCA RUBRA	CREEPING RED FESCUE
16%	FESTUCA OVINA	SHEEP FESCUE
14%	JUNCUS EFFUSUS	SOFT RUSH
10%	CAREX VULPINOIDEA	FOX SEDGE
10%	CAREX MOLESTA	FIELD OVAL SEDGE
8%	POA PRATENSE	KENTUCKY BLUEGRASS
8%	FESTUCA RUBRA SSP. COMMUTATA	CHEWINGS FESCUE
7%	TRIFOLIUM PRATENSE	RED CLOVER
7%	TRIFOLIUM REPENS, 'DUTCH'	DUTCH WHITE CLOVER

SEEDING RATE: 28 LB PER ACRE
SEED WITH COVER CROP OF OATS, JAPANESE MILLET, WINTER PEA, OR ANNUAL RYE DEPENDENT ON SEASON AT A RATE OF 32 LB PER ACRE.

SPECIFIED MIX SUBJECT TO AVAILABILITY DURING TIME OF CONSTRUCTION, OR APPROVED EQUAL.

SOILS ON SITE IDENTIFIED AS A MAJORITY OF SOMEWHAT POORLY DRAINED WITH A HIGH WATER TABLE BETWEEN 12 AND 24 INCHES IN DEPTH. HYDRIC SOILS IDENTIFIED ON UP TO 20% OF THE SITE WITH POOR DRAINAGE AND FREQUENT FREQUENCY OF PONDING.

SEEDING LIMITS SHOWN ON EXHIBIT PLAN ARE APPROXIMATE AND FOR CONVENIENCE ONLY. SEED QUANTITIES ARE TO BE DETERMINED BY FINAL SEEDING LAYOUT AND SEEDING RATE.

SEEDING SHOULD OCCUR IN ALL AREAS OF DISTURBED SOILS OR EXISTING AGRICULTURAL LAND IDENTIFIED AS EITHER INACCESSIBLE OR TO BE NO LONGER ACTIVELY FARMED.

Call Before You Dig
JULIE
1-800-892-0123

No.	REVISIONS	DATE

Kimley»Horn

570 LAKE COOK RD SUITE 200
DEERFIELD, IL 60015
WWW.KIMLEY-HORN.COM

PRELIMINARY - NOT FOR CONSTRUCTION

KHA PROJECT	268330024
DATE	04/05/2024
SCALE	AS SHOWN
DESIGNED BY	HLL
DRAWN BY	HLL
CHECKED BY	SMH

SEEDING EXHIBIT

NORTH SUN LLC.

MONTGOMERY COUNTY, IL

SHEET NUMBER
LX1.0

GROUND COVER MAINTENANCE REQUIREMENTS

MAINTENANCE PROGRAMS SHALL BE SITE SPECIFIC AND COORDINATED WITH THE LANDSCAPE CONTRACTOR AND COUNTY FOR ADEQUATE MAINTENANCE PROCEDURES. A FIVE YEAR STEWARDSHIP PROGRAM IS NECESSARY TO ENSURE PROPER ESTABLISHMENT AND HEALTH OF GROUND COVER, TO CONTROL INVASIVE SPECIES, AND TO PREVENT OVERGROWTH AND SHADING OF EQUIPMENT. AFTER THE FIFTH GROWING SEASON, PROGRAM IS TO BE REDUCED TO TWO VISITS PER YEAR, DEPENDENT UPON SITE CONDITIONS AND REQUIRED STRATEGIES TO MAINTAIN GOOD HEALTH OF THE SITE SUCH AS DETHACHING, ADDITIONAL MOWING, OR HERBICIDE TREATMENTS.

FIRST YEAR

SPRING:
-EARLIEST POSSIBLE INSTALLATION MAY OCCUR IN THE SPRING OF THE FIRST YEAR, AFTER THE LAST FORECASTED FROST OF THE SEASON. NO MAINTENANCE ACTIONS ARE REQUIRED TO BE PERFORMED DURING THE FIRST SEASON OF INSTALL. IF SEED APPLICATION TAKES PLACE IN SUMMER OR FALL OF THE FIRST YEAR, MAINTENANCE AND MONITORING SHOULD START THE FOLLOWING SEASON.

SUMMER:
-SITE VISITS ARE TO BE PERFORMED AT A MINIMUM OF THREE TIMES THROUGHOUT THE SUMMER; AT THE MIDDLE OR END OF EACH MONTH, WITH MONITORING AND EVALUATION OF VEGETATION HEIGHT AND PRESENCE OF INVASIVE SPECIES OCCURRING AT EACH VISIT. AREAS OF HIGH CONCENTRATIONS OF INVASIVE SPECIES SHOULD BE RECORDED.
-CONTROL INVASIVE WOODY AND HERBACEOUS FLORA THROUGH PHYSICAL REMOVAL AND/OR SPOT *HERBICIDE TREATMENTS. AS NEEDED. INVASIVE VEGETATION EXTRACTED PHYSICALLY SHOULD BE REMOVED FROM THE SITE TO PREVENT RE-ESTABLISHMENT AND SPREAD. INVASIVE VEGETATION SHOULD BE REMOVED WITH THE BULK OF THE ROOT STRUCTURE WHERE POSSIBLE.
-CONDUCT MOWING UP TO THREE TIMES MAXIMUM DURING THE SUMMER IN AREAS OF THE SITE IDENTIFIED TO HAVE VEGETATION OVER 9 INCHES IN HEIGHT. AREAS WITH HEIGHT UNDER 9 INCHES MAY REMAIN UNTIL THE NEXT SCHEDULED MONITORING VISIT. NEWLY SEEDED AREAS SHOULD BE CUT BACK TO 6 INCHES IN HEIGHT.

FALL:
-SITE VISITS ARE TO BE PERFORMED AT A MINIMUM OF THREE TIMES THROUGHOUT THE FALL; AT THE MIDDLE OR END OF EACH MONTH, WITH MONITORING AND EVALUATION OF VEGETATION HEIGHT AND PRESENCE OF INVASIVE SPECIES OCCURRING AT EACH VISIT. AREAS OF HIGH CONCENTRATIONS OF INVASIVE SPECIES SHOULD BE RECORDED.
-CONTROL INVASIVE WOODY AND HERBACEOUS FLORA THROUGH PHYSICAL REMOVAL AND/OR SPOT *HERBICIDE TREATMENTS. AS NEEDED. INVASIVE VEGETATION EXTRACTED PHYSICALLY SHOULD BE REMOVED FROM THE SITE TO PREVENT RE-ESTABLISHMENT AND SPREAD. INVASIVE VEGETATION SHOULD BE REMOVED WITH THE BULK OF THE ROOT STRUCTURE WHERE POSSIBLE.
-CONDUCT MOWING UP TO THREE TIMES MAXIMUM DURING THE FALL IN AREAS OF THE SITE IDENTIFIED TO HAVE VEGETATION OVER 10 INCHES IN HEIGHT. AREAS WITH HEIGHT UNDER 10 INCHES MAY REMAIN UNTIL THE NEXT SCHEDULED MONITORING VISIT. NEWLY SEEDED AREAS SHOULD BE CUT BACK TO 6 INCHES IN HEIGHT.

SECOND YEAR

SPRING:
-SITE VISITS ARE TO BE PERFORMED AT A MINIMUM OF THREE TIMES THROUGHOUT THE SPRING; AT THE MIDDLE OR END OF EACH MONTH, WITH MONITORING AND EVALUATION OF VEGETATION HEIGHT AND PRESENCE OF INVASIVE SPECIES OCCURRING AT EACH VISIT. AREAS OF HIGH CONCENTRATIONS OF INVASIVE SPECIES SHOULD BE RECORDED.
-DURING THE FIRST VISIT, MOWING SHOULD OCCUR TO CUT BACK ANY VEGETATION TO A HEIGHT OF 4 INCHES AND REMOVE DEAD STALKS AND SEED HEADS FROM THE PREVIOUS GROWING SEASON.
-CONTROL INVASIVE WOODY AND HERBACEOUS FLORA THROUGH PHYSICAL REMOVAL AND/OR SPOT *HERBICIDE TREATMENTS. AS NEEDED. INVASIVE VEGETATION EXTRACTED PHYSICALLY SHOULD BE REMOVED FROM THE SITE TO PREVENT RE-ESTABLISHMENT AND SPREAD. INVASIVE VEGETATION SHOULD BE REMOVED WITH THE BULK OF THE ROOT STRUCTURE WHERE POSSIBLE.
-CONDUCT MOWING UP TO THREE TIMES MAXIMUM DURING THE SPRING IN AREAS OF THE SITE IDENTIFIED TO HAVE VEGETATION OVER 10 INCHES IN HEIGHT. AREAS WITH HEIGHT UNDER 10 INCHES MAY REMAIN UNTIL THE NEXT SCHEDULED MONITORING VISIT. NEWLY SEEDED AREAS SHOULD BE CUT BACK TO 6 INCHES IN HEIGHT.
-PLANT SUPPLEMENTAL SEED AS NEEDED TO ADDRESS AREAS OF POOR COVERAGE AND TO INCREASE COMPETITION AND BIO-DIVERSITY.

SUMMER:
-SITE VISITS ARE TO BE PERFORMED AT A MINIMUM OF THREE TIMES THROUGHOUT THE SUMMER; AT THE MIDDLE OR END OF EACH MONTH, WITH MONITORING AND EVALUATION OF VEGETATION HEIGHT AND PRESENCE OF INVASIVE SPECIES OCCURRING AT EACH VISIT. AREAS OF HIGH CONCENTRATIONS OF INVASIVE SPECIES SHOULD BE RECORDED.
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-CONDUCT MOWING UP TO THREE TIMES MAXIMUM DURING THE SUMMER IN AREAS OF THE SITE IDENTIFIED TO HAVE VEGETATION OVER 9 INCHES IN HEIGHT. AREAS WITH HEIGHT UNDER 9 INCHES MAY REMAIN UNTIL THE NEXT SCHEDULED MONITORING VISIT. NEWLY SEEDED AREAS SHOULD BE CUT BACK TO 6 INCHES IN HEIGHT.

FALL:
-SITE VISITS ARE TO BE PERFORMED AT A MINIMUM OF TWO TIMES THROUGHOUT THE FALL; AT THE MIDDLE OR END OF EACH MONTH, WITH MONITORING AND EVALUATION OF VEGETATION HEIGHT AND PRESENCE OF INVASIVE SPECIES OCCURRING AT EACH VISIT. AREAS OF HIGH CONCENTRATIONS OF INVASIVE SPECIES SHOULD BE RECORDED.
-CONTROL INVASIVE WOODY AND HERBACEOUS FLORA THROUGH PHYSICAL REMOVAL AND/OR SPOT *HERBICIDE TREATMENTS. AS NEEDED. INVASIVE VEGETATION EXTRACTED PHYSICALLY SHOULD BE REMOVED FROM THE SITE TO PREVENT RE-ESTABLISHMENT AND SPREAD. INVASIVE VEGETATION SHOULD BE REMOVED WITH THE BULK OF THE ROOT STRUCTURE WHERE POSSIBLE.
-CONDUCT MOWING UP TO THREE TIMES MAXIMUM DURING THE FALL IN AREAS OF THE SITE IDENTIFIED TO HAVE VEGETATION OVER 12 INCHES IN HEIGHT. AREAS WITH HEIGHT UNDER 12 INCHES MAY REMAIN UNTIL THE NEXT SCHEDULED MONITORING VISIT. NEWLY SEEDED AREAS SHOULD BE CUT BACK TO 6 INCHES IN HEIGHT.

THIRD AND FOURTH YEAR

SPRING:
-SITE VISITS ARE TO BE PERFORMED AT A MINIMUM OF ONE TIME DURING THE SPRING; WITH MONITORING AND EVALUATION OF VEGETATION HEIGHT AND PRESENCE OF INVASIVE SPECIES OCCURRING AT EACH VISIT. AREAS OF HIGH CONCENTRATIONS OF INVASIVE SPECIES SHOULD BE RECORDED.
-DURING THE FIRST VISIT, MOWING SHOULD OCCUR TO CUT BACK ANY VEGETATION TO A HEIGHT OF 4 INCHES AND REMOVE DEAD STALKS AND SEED HEADS FROM THE PREVIOUS GROWING SEASON.
-CONTROL INVASIVE WOODY AND HERBACEOUS FLORA THROUGH PHYSICAL REMOVAL AND/OR SPOT *HERBICIDE TREATMENTS. AS NEEDED. INVASIVE VEGETATION EXTRACTED PHYSICALLY SHOULD BE REMOVED FROM THE SITE TO PREVENT RE-ESTABLISHMENT AND SPREAD. INVASIVE VEGETATION SHOULD BE REMOVED WITH THE BULK OF THE ROOT STRUCTURE WHERE POSSIBLE.
-CONDUCT MOWING UP TO ONE TIME MAXIMUM DURING THE SPRING IN AREAS OF THE SITE IDENTIFIED TO HAVE VEGETATION OVER 12 INCHES IN HEIGHT. AREAS WITH HEIGHT UNDER 12 INCHES MAY REMAIN UNTIL THE NEXT SCHEDULED MONITORING VISIT. NEWLY SEEDED AREAS SHOULD BE CUT BACK TO 6 INCHES IN HEIGHT.

SUMMER:
-SITE VISITS ARE TO BE PERFORMED AT A MINIMUM OF ONE TIME DURING THE SUMMER; WITH MONITORING AND EVALUATION OF VEGETATION HEIGHT AND PRESENCE OF INVASIVE SPECIES OCCURRING AT EACH VISIT. AREAS OF HIGH CONCENTRATIONS OF INVASIVE SPECIES SHOULD BE RECORDED.
-CONTROL INVASIVE WOODY AND HERBACEOUS FLORA THROUGH PHYSICAL REMOVAL AND/OR SPOT *HERBICIDE TREATMENTS. AS NEEDED. INVASIVE VEGETATION EXTRACTED PHYSICALLY SHOULD BE REMOVED FROM THE SITE TO PREVENT RE-ESTABLISHMENT AND SPREAD. INVASIVE VEGETATION SHOULD BE REMOVED WITH THE BULK OF THE ROOT STRUCTURE WHERE POSSIBLE.
-CONDUCT MOWING UP TO ONE TIME MAXIMUM DURING THE SUMMER IN AREAS OF THE SITE IDENTIFIED TO HAVE VEGETATION OVER 12 INCHES IN HEIGHT. AREAS WITH HEIGHT UNDER 12 INCHES MAY REMAIN UNTIL THE NEXT SCHEDULED MONITORING VISIT. NEWLY SEEDED AREAS SHOULD BE CUT BACK TO 6 INCHES IN HEIGHT.

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-SITE VISITS ARE TO BE PERFORMED AT A MINIMUM OF ONE TIME DURING THE FALL; WITH MONITORING AND EVALUATION OF VEGETATION HEIGHT AND PRESENCE OF INVASIVE SPECIES OCCURRING AT EACH VISIT. AREAS OF HIGH CONCENTRATIONS OF INVASIVE SPECIES SHOULD BE RECORDED.
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FIFTH YEAR AND FOLLOWING

-SITE VISITS ARE TO BE PERFORMED AT A MINIMUM OF TWICE A YEAR, DURING THE EARLY SPRING AND FALL; WITH MONITORING AND EVALUATION OF VEGETATION HEIGHT AND PRESENCE OF INVASIVE SPECIES OCCURRING AT EACH VISIT.
-DURING THE SPRING, MOWING SHOULD OCCUR TO CUT BACK ANY VEGETATION TO A HEIGHT OF 4 INCHES AND REMOVE DEAD STALKS AND SEED HEADS FROM THE PREVIOUS GROWING SEASON.
-DURING THE FALL, MOWING SHOULD OCCUR IN AREAS OF THE SITE IDENTIFIED TO HAVE VEGETATION OVER 12 INCHES IN HEIGHT. AREAS WITH HEIGHT UNDER 12 INCHES MAY REMAIN UNTIL THE NEXT SCHEDULED MONITORING VISIT. SEEDED AREAS SHOULD BE CUT BACK TO 6 INCHES IN HEIGHT.
-IF INVASIVE WOODY AND HERBACEOUS FLORA HAVE BEEN IDENTIFIED, PHYSICAL REMOVAL OR SPOT *HERBICIDE TREATMENTS ARE REQUIRED.

*ALL HERBICIDES ARE TO BE ANIMAL FRIENDLY AND APPLIED BY A TRAINED PERSONNEL.

PERFORMANCE STANDARDS

SATISFACTORY LANDSCAPE DEVELOPMENT ASSOCIATED WITH NATURALIZED VEGETATION WILL BE BASED ON THE FOLLOWING ITEMS.

FIRST YEAR:

WITHIN THREE MONTHS OF SEED INSTALLATION (OR THREE MONTHS AFTER THE START OF THE GROWING SEASON FOLLOWING DORMANT SEEDING), APPROXIMATELY 90 PERCENT OF THE SEEDED AREA, AS MEASURED BY AERIAL COVER, SHOULD BE VEGETATED OR OTHERWISE STABILIZED AGAINST EROSION. THE COVER CROP MAY BE INCLUDED IN THIS MEASUREMENT. IF MINIMUM IS NOT MET, ADDITIONAL SEEDING IS REQUIRED IN AREAS WITH POOR COVER.

SECOND YEAR:

BY THE END OF THE SECOND GROWING SEASON, THE PLANTED AREAS ARE DESIGNED TO HAVE A MINIMUM OF 50 PERCENT GROUND COVER BY SPECIES IN FINAL SEED MIX (NOT TO INCLUDE TEMPORARY COVER CROP OR UNDESIRABLE / INVASIVE SPECIES). IF LARGE AREAS OF UNDESIRABLE / INVASIVE SPECIES ARE IDENTIFIED, LOCAL APPLICATION OF HERBICIDE AND REAPPLICATION OF SEEDING MAY BE REQUIRED.

THIRD YEAR:

BY THE END OF THE THIRD GROWING SEASON, THE PLANTED AREAS ARE DESIGNED TO HAVE A MINIMUM OF 75 PERCENT GROUND COVER BY SPECIES IN FINAL SEED MIX (NOT TO INCLUDE TEMPORARY COVER CROP OR UNDESIRABLE / INVASIVE SPECIES). IF LARGE AREAS OF UNDESIRABLE / INVASIVE SPECIES ARE IDENTIFIED, LOCAL APPLICATION OF HERBICIDE AND REAPPLICATION OF SEEDING MAY BE REQUIRED.

IF PERFORMANCE STANDARD IS NOT MET AT EACH OBSERVATION, LANDSCAPE CONTRACTOR IS TO NOTIFY OWNER AND DEVELOP CORRECTIVE ACTION SUCH AS SEEDING OR HERBICIDE TREATMENT.

GENERAL LANDSCAPE NOTES

1. THE LANDSCAPE CONTRACTOR SHALL BE RESPONSIBLE FOR INSTALLING MATERIALS AND PLANTS SHOWN ON THE LANDSCAPE PLAN. THE CONTRACTOR IS RESPONSIBLE FOR THE COST TO REPAIR UTILITIES, ADJACENT LANDSCAPE, PUBLIC AND PRIVATE PROPERTY THAT IS DAMAGED BY THE CONTRACTOR OR THEIR SUBCONTRACTOR'S OPERATIONS DURING INSTALLATION OR DURING THE SPECIFIED MAINTENANCE PERIOD. CALL FOR UTILITY LOCATIONS PRIOR TO ANY EXCAVATION.
2. THE CONTRACTOR SHALL REPORT ANY DISCREPANCY IN PLAN VS. FIELD CONDITIONS IMMEDIATELY TO THE LANDSCAPE ARCHITECT, PRIOR TO CONTINUING WITH THAT PORTION OF WORK.
3. NO PLANTING WILL BE INSTALLED UNTIL ALL GRADING AND CONSTRUCTION HAS BEEN COMPLETED IN THE IMMEDIATE AREA.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE REPAIR OF ANY OF THEIR TRENCHES OR EXCAVATIONS THAT SETTLE.
5. DO NOT DISTURB THE EXISTING PAVING, LIGHTING, OR LANDSCAPING THAT EXISTS ADJACENT TO THE SITE UNLESS OTHERWISE NOTED ON PLAN.
6. PLANT QUANTITIES SHOWN ARE FOR THE CONVENIENCE OF THE OWNER AND JURISDICTIONAL REVIEW AGENCIES. THE CONTRACTOR IS RESPONSIBLE FOR VERIFYING ALL PLANT QUANTITIES AS DRAWN.
7. THE CONTINUED MAINTENANCE OF ALL REQUIRED LANDSCAPING SHALL BE THE RESPONSIBILITY OF THE OWNER OF THE PROPERTY ON WHICH SAID MATERIALS ARE REQUIRED. ALL PLANT MATERIALS REQUIRED BY THIS SECTION SHALL BE MAINTAINED AS LIVING VEGETATION AND SHALL BE PROMPTLY REPLACED IF THE PLANT MATERIAL HAS DIED PRIOR TO FINAL ACCEPTANCE.
8. NO GENERAL SPRAY OF HERBICIDES IS TO BE USED FOR ANY SEEDED AREAS.
9. ONLY HERBICIDES FORMULATED FOR ANIMAL SAFETY SHALL BE USED.
10. ALL WORK DEEMED NATURAL AREA TO BE SEEDED OR PLANTED SHALL BE PERFORMED BY A QUALIFIED LANDSCAPE CONTRACTOR.
11. SEED SHALL BE OBTAINED FROM SOURCE SPECIALIZING IN NATIVE SPECIES, WHERE AVAILABLE OR AS APPROVED BY CLIENT OR CLIENT'S REPRESENTATIVE.
12. ALL SEED MIXES SHALL BE INSTALLED WITH A COVER CROP DEPENDENT ON SEASON AND REQUIREMENTS SPECIFIED PER SEED MIX / SEED SUPPLIER.

ESTABLISHMENT NOTES AND STANDARDS

SEED AREA ESTABLISHMENT

PREPARATION

-SOIL IN AREAS OF EXISTING AGRICULTURAL USAGE IS RECOMMENDED TO BE TESTED FOR HIGH LEVELS OF HERBICIDES AND AMENDED APPROPRIATELY TO BRING CONCENTRATION DOWN TO LEVELS APPROPRIATE FOR COMMON GRASSES. SOILS IDENTIFIED TO BE HIGH IN HERBICIDES OR CONTAMINATES SHOULD BE EVALUATED BY AN ENVIRONMENTAL SPECIALIST OR SOIL SCIENTIST TO DETERMINE REQUIRED METHODS OF REMEDIATION.
-SOILS SHALL BE UNIFORM, WITHOUT EXCESSIVE FURROWS, RUTS, OR RIDGES, AND LOW AREAS WHERE WATER MAY COLLECT.
-SOILS SHOULD BE CLEARED OF TRASH, DEBRIS, AND INVASIVE SPECIES PRIOR TO FINAL SEEDING APPLICATION.
-SOIL PREPARATION SHALL OCCUR WHEN WEATHER PERMITS AND TIMING ALLOWS FOR AT LEAST A FOLLOWING 48 HOURS WHERE SEEDING AND STABILIZATION METHODS MAY TAKE PLACE.

TIMING

-TO PROMOTE EARLY AND STRONG ESTABLISHMENT OF SPECIFIED SEED MIX, DORMANT SEASON SEED APPLICATION IS RECOMMENDED IF POSSIBLE AND AS CONSTRUCTION TIMELINE PERMITS.
-DORMANT SEASON SEEDING SHOULD UTILIZE WINTER-TOLERANT SEED FROM THE SPECIFIED SEED MIX, ALONG WITH 20-30 LBS PER ACRE OF A WINTER NURSE CROP SUCH AS SECALE CEREALE, PISUM SATIVUM, OR AVENA SATIVA.
-TO APPLY DORMANT SEED, SITE SHOULD BE CLEARED OF INVASIVE WEEDS, LIGHTLY TILLED OR DISKED NO DEEPER THAN 1 AND $\frac{1}{2}$ INCHES, THEN DRILL APPLIED ACROSS THE ENTIRE AREA OF AGRICULTURAL SOIL.
-ACTIVE SEASON SEED APPLICATION SHOULD BE PERFORMED BETWEEN APRIL 1ST AND MAY 30TH, AFTER RISK OF MAJOR FREEZING CONDITIONS IS MINIMIZED, FOR IDEAL ESTABLISHMENT AND MINIMIZING INVASIVE SPECIES COMPETITION. SUMMER AND FALL SEED APPLICATION SHOULD BE AVOIDED WHERE POSSIBLE TO PREVENT NEWLY GEMINATING SEEDS FROM DYING OUT TO DROUGHT CONDITIONS, OR REQUIRING A LARGE AMOUNT OF ADDITIONAL WATERING.

APPLICATION

-SEED MIXTURES SHOULD BE MECHANICALLY DRILLED FOR BEST ESTABLISHMENT CHANCES. BROADCAST OR HYDROSEEDING MAY BE USED AS SITE CONDITIONS PERMIT.
-NO STRAW MULCH IS REQUIRED IF MECHANICALLY DRILL APPLIED, UNLESS NEEDED FOR STEEP SLOPES, SOIL STABILIZATION, OR OTHER AREAS THAT ARE IDENTIFIED FOR EROSION PREVENTION. BROADCAST OR HYDROSEEDED AREAS SHOULD INCLUDE STRAW MULCH AT A RATE OF 1 TO 2 TONS PER ACRE.
-SEED SHALL BE APPLIED AT INDICATED RATES WITH COVER CROP OATS, JAPANESE MILLET, WINTER WHEAT, ANNUAL RYE, OR SPECIFIED CROP DEPENDENT ON SEASON AND SOIL CONDITIONS.
-SEED SPECIES SHALL BE LOCALLY SOURCED WHEN FEASIBLE.
-FINAL SEED MIX MAY VARY DEPENDENT UPON SPECIFIC SPECIES AVAILABILITY AND TIME OF INSTALLATION.
-FINAL SEED MIX SHALL BE APPROVED BY OWNER, OWNER'S REPRESENTATIVE, OR LANDSCAPE ARCHITECT.
-IF SEEDING IS PERFORMED PRIOR TO FINAL SITE INSTALLATION, ADDITIONAL SEED MAY BE APPLIED BY A LOW SPREADER OR HAND BROADCAST IN AREAS THAT WERE DISTURBED.
-SITE SHOULD BE MONITORED FOLLOWING INSTALLATION FOR AREAS IDENTIFIED FOR ADDITIONAL RESEEDING UNTIL SEED MIX IS SUFFICIENTLY ESTABLISHED.

INVASIVE WEED CONTROL, MONITORING, AND MANAGEMENT

-A WORK PLAN SHOULD BE DEVELOPED TO AVOID THE SPREAD OF INVASIVE PLANTS FROM THESE AREAS.
-IF SUBSTANTIAL AREAS OF INVASIVE HERBACEOUS SPECIES ARE FOUND PRIOR TO OR AFTER PROJECT DEVELOPMENT, FOLIAR OR BROADCAST HERBICIDE APPLICATIONS MAY BE REQUIRED.
-FOR INVASIVE TREES, SHRUBS, AND VINES, MANAGEMENT MAY REQUIRE CUT-STEM HERBICIDE TREATMENTS.
-ALL INVASIVE SPECIES MANAGEMENT SHOULD BE CONDUCTED DURING THE SUMMER MONTHS WHILE THE TARGET PLANTS ARE ACTIVELY GROWING.
-TREATMENTS SHOULD BE CONDUCTED ACCORDING TO MAINTENANCE PLANS EACH YEAR AND SHOULD BE SEPARATED BY AT LEAST TWO WEEKS.
-HERBICIDE USE REPORTING WILL ADHERE TO ALL APPLICATOR LICENSING REQUIREMENTS.

TREE AND SHRUB INSTALLATION

-ALL PLANTS ARE TO BE SPECIMEN GRADE, WELL BRANCHED, HEALTHY, FULL, PRE-INOCULATED, AND FERTILIZED. PLANTS SHALL BE FREE FROM DISEASE, PESTS, WOUNDS, AND SCARS. PLANTS SHALL BE FREE FROM NOTICEABLE GAPS, HOLES, OR DEFORMITIES. PLANTS SHALL BE FREE FROM BROKEN OR DEAD BRANCHES.
-TRUNKS SHOULD BE WRAPPED IF NECESSARY TO PREVENT SUN SCALD AND INSECT DAMAGE. THE LANDSCAPE CONTRACTOR SHALL REMOVE THE WRAP AT THE PROPER TIME AS PART OF THIS CONTRACT.
-THE OWNER'S REPRESENTATIVE MAY REJECT ANY PLANT MATERIALS THAT ARE DISEASED, DEFORMED, OR OTHERWISE NOT EXHIBITING SUPERIOR QUALITY.
-ALL NURSERY STOCK SHALL BE GUARANTEED, BY THE CONTRACTOR, FOR ONE YEAR FROM DATE OF FINAL INSPECTION. THE GUARANTEE BEGINS ON THE DATE OF THE LANDSCAPE ARCHITECT'S OR OWNER'S WRITTEN ACCEPTANCE OF THE INITIAL PLANTING. REPLACEMENT PLANT MATERIAL SHALL HAVE A ONE YEAR GUARANTEE COMMENCING UPON PLANTING.
-PLANTS ARE TO MEET AMERICAN STANDARD FOR NURSERY STOCK (ANSI Z60.1-2014 OR MOST CURRENT VERSION) REQUIREMENTS FOR SIZE AND TYPE SPECIFIED.
-PRUNE PLANTS AS NECESSARY PER STANDARD NURSERY PRACTICE AND TO CORRECT POOR BRANCHING OF EXISTING AND PROPOSED TREES.
-CONTRACTOR SHALL INSTALL SHREDDED HARDWOOD MULCH AT A 3" DEPTH TO ALL TREE AND SHRUB AREAS. TREES PLACED IN AREA COVERED BY TURF SHALL RECEIVE A 4' WIDE TREE RING WITH 3" DEPTH SHREDDED HARDWOOD MULCH.

Call Before You Dig
JULIE
1-800-892-0123

No.	REVISIONS	DATE

Kimley»Horn

570 LAKE COOK RD SUITE 200
DEERFIELD, IL 60015
WWW.KIMLEY-HORN.COM

PRELIMINARY - NOT FOR CONSTRUCTION

KHA PROJECT	268330024
DATE	04/05/2024
SCALE	AS SHOWN
DESIGNED BY	HLL
DRAWN BY	HLL
CHECKED BY	SMH

MAINTENANCE AND MONITORING PLAN

NORTH SUN LLC.

MONTGOMERY COUNTY, IL

SHEET NUMBER

LX2.0

Drawing name: K:\CHS_LDEV\268330024_22c_North Sun_LL\2 Design\CAD\Exhibits\North Sun_Seeding Plan.dwg NOTES DETAILS Mar 21, 2024 4:14pm by Chris.Wilson

EXHIBIT O: LIST OF NEIGHBORS

LIST OF NEIGHBORS

- PIN: 06-14-400-004; 10289 N 21st Ave, Raymond, IL 62560; Manzer, Kenneth & Dionne
- PIN: 06-14-300-003; 10146 N 21st Ave, Raymond, IL 62560; Wood, Kevin c/o Wood Farms Inc.
- PIN: 06-14-300-002; 10103 N 21st Ave, Raymond, IL 62650; Mulch, Robert
- PIN: 06-14-400-001; North Rd, Raymond IL 62560; Mulch, Thomas Allen CO Trustee
- PIN: 06-13-300-001; North Rd, Harvel, IL 62538; Mundhenke, Steve
- PIN: 06-13-300-003; Noprth Rd, Raymond, IL 62560; Mundhenke, Steve
- PIN: 06-24-100-001; N 21st Ave, Raymond, IL 62560; Hall, Bruce A & Anita M
- PIN: 06-23-200-003; 10278 N 21st Ave, Raymond, IL62560; Hall, Anita Marie
- PIN: 06-23-200-001; N 21st Ave, Harvel, IL 52538; Webb, David L & Brenda J Trustees
- PIN: 06-23-100-002; 10146 N 21st, Raymond, IL 62560; Wood, Kevin D.

EXHIBIT P: PRELIMINARY STORM WATER POLLUTION PREVENTION PLAN

STORMWATER POLLUTION PREVENTION PLAN

North Sun LLC

Intersection of N 21st Ave and North Road

Montgomery County, IL 62560

Prepared by:
Kimley-Horn and Associates, Inc.
570 Lake Cook Road, Suite 200
Deerfield, IL 60015
Contact: Sean Hickey, P.E.
Phone: (708) 621-5007

Prepared on: April 2024

Kimley»Horn

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ATTACHMENTS

Attachment 1 – SWPPP Preparation Certification Form

Attachment 2 – Owner's Certification Form

Attachment 3 – Contractor's Certification Form

Attachment 4 – Aerial Map

Attachment 5 – Location Map

Attachment 6 – USGS Map

Attachment 7 – NRCS Soil Report

Attachment 8 – C-300 and C-500 – Erosion Control Plan and Construction Details

Attachment 9 – BMP Installation Log

Attachment 10 – Amendment Log

1. STORMWATER POLLUTION PREVENTION PLAN

The responsible party for the implementation, maintenance and inspection of all measures described in this Storm Water Pollution Prevention Plan is:

(Contractor Operator and/or Responsible Authority) **(Date)**

(Contractor Company Name)

(Contractors Address) **(Telephone)**

Project Name and location information:	North Sun LLC Intersection N 21st Ave and North Road Montgomery County, IL 62560

2. SITE DESCRIPTION

2.1. Project Description

The proposed development is approximately 75.0 acres and is located north of N 21st Ave and west of North Road in Montgomery County, IL. The project site will include solar panels, inverters, transformers, and other mechanical equipment as well as perimeter security fencing, gates, and an access road.

2.2. Existing Soils

NRCS classifies the site soils as Viden silty clay loam; 0 to 2 percent slopes (50A), Oconee silt loam; 2 to 5 percent slopes (113B), Harrison silt loam; 5 to 10 percent slopes, eroded (127C2), Oconee-Darmstadt-Coulterville silt loam; 2 to 5 percent slopes, eroded (882B2), Viden-Fosterburg silt loams; 0 to 2 percent slopes (885A), Herrick-Biddle-Piasa silt loams; 0 to 2 percent slopes (894A), and Cowden-Piasa silt loams; 0 to 2 percent slopes (993A). The hydrological soil group of the on-site soils are B, C, and D. Refer to **Attachment 7** for the NRCS Soil Map.

2.3. Existing Site Description

The existing site is currently used for agricultural purposes.

2.4. Adjacent Areas

The site is bound to the south by N 21st Ave and a residential property, east by North Road, and north by agricultural land, and west by a residential property and agricultural field.

2.5. Project Name and Location:

North Sun LLC

Intersection of N 21st Ave and North Road

Montgomery County, IL 62560

2.6. Owner Name and Location:

North Sun LLC, a subsidiary of 22c Development, LLC

4649 N Broadway

Chicago, IL 60640

3. GENERAL SOIL DISTURBING ACTIVITIES

Clearing and grubbing will occur first. Additional excavation and backfill for site access roads and electrical foundation pads, minor grading and topsoil spreading will be necessary.

4. CONSTRUCTION SEQUENCE

1. Install stabilized construction entrance.
2. Prepare temporary parking and storage areas, upon implementation and installation of the following areas: trailer, parking, lay down, porta-potty, wheel wash, concrete washout, fuel and material storage containers, solid waste containers, etc. Denote them on the site maps immediately and note any changes in the locations as they occur throughout the construction process.
3. Install filter sock, permanent diversions/earth dikes, sediment basin, or approved equivalent erosion control BMP's.
4. Clear/grub the site as necessary. Temporarily seed disturbed areas, throughout construction, that will be inactive for seven (7) days or more or as required by the general permit.
5. Stabilization of all exposed soil areas must be initiated immediately to limit soil erosion but in no case completed later than seven (7) days after the construction activity in that portion of the site has temporarily or permanently ceased.
6. Begin grading and constructing access roads, pile driving, racking installations, solar module placement, fencing, utility pole and overhead wires, and utility trenching.
7. Provide permanent seeding/stabilization per the landscape plan (by others). Install filter sock within array area once grading and seeding is complete.
8. All stockpiles are to be removed as part of the permanent stabilization of the site.
9. Remove all temporary erosion and sediment control devices (only after site is fully stabilized and approved by the county).

Note: The sequence of construction shown above is a general overview and is intended to convey the general concepts of the erosion control design and should not be relied upon for construction purposes. The contractor is solely responsible for detailed phasing and construction sequencing necessary to construct the proposed improvements included in these plans. The contractor shall notify engineer in writing immediately, prior to and/or during construction if any additional information on the construction sequence is necessary. Contractor is solely responsible for complying with the Authority Having Jurisdiction and all other applicable laws.

5. CONSTRUCTION PHASE BEST MANAGEMENT PRACTICES

During the construction phase, the General Contractor shall implement the following measures:

1. Silt fence/filter sock will be installed throughout the site to prevent soil runoff onto surrounding properties, as needed.
2. Stormwater sediment controls will be implemented at the inlets and outlets for the proposed stormwater conveyance system.
3. Appropriate sediment control measures will be implemented for construction vehicle traffic, including a stabilized construction entrance and concrete washout.
4. Materials resulting from the clearing and grubbing or excavation operations shall be stockpiled up slope from adequate sedimentation controls. Fast-germinating temporary

seed shall be installed in areas where there will be no construction for longer than 14 days. This includes any temporary soil stockpiles. Materials removed to an off-site location shall be protected with appropriate controls and properly permitted.

5. The general contractor shall designate areas for equipment cleaning, maintenance, and repair areas shall be protected by a temporary perimeter berm.
6. Use of detergents for large scale washing is prohibited (i.e., vehicles, buildings, pavement surfaces, etc.).
7. Chemicals, paints, solvents, fertilizers, and other toxic materials must be stored in weatherproof containers. Except during application, the contents must be kept in trucks or within storage facilities. Runoff containing such material must be collected removed from the site, treated, and disposed at an approved solid waste or chemical disposal facility.

6. SOIL STABILIZATION

The purpose of soil stabilization is to prevent soil from leaving the site. In the natural condition, soil is stabilized by native vegetation. The primary technique to be used at this project for stabilizing site soil will be to provide a protective cover of turf grass or asphalt access road.

1. Temporary Seeding – Within 7 days after construction activity ceases on any particular area, all disturbed ground where there will be construction longer than 14 days must be seeded with fast-germinating temporary seed or protected with mulch.
2. Permanent Seeding – All areas at final grade must be seeded within 14 days after completion of the major construction activity. Except for small level spots, seeded areas should generally be protected with mulch.

7. EROSION AND SEDIMENT CONTROLS

1. *Silt Fence* – Silt fence is a synthetic permeable mesh fabric typically incorporating wooden support stakes at intervals sufficient to support the fence and water and sediment retained by the fence. Silt fence is also available with a wire mesh backing. The fence is designed to retain sediment-laden water to allow settlement of suspended soils before filtering through the mesh fabric for discharge downstream. Silt fence shall be located to capture overland, low-velocity sheet flow. It shall be installed at the downstream location of all site runoff. Silt fence has the capacity to handle 0.25 acre per 100 feet of silt fence length.
2. *Filter Sock* – Filter sock is a sock filled with biodegradable compost material that is locked in place with wooden stakes downslope of the filter sock. Similar to silt fence, filter sock is designed to retain sediment-laden water to allow settlement of suspended soils before filtering through the compost material for discharge downstream.
3. *Construction Entrance/Exit* – All access points from the public street into the construction site shall include a construction entrance/exit composed of coarse stone to the dimensions shown on the Construction Drawings. The rough texture of the stone helps

to remove clumps of soil adhering to construction vehicle tires through the action of vibration and jarring over the rough surface and the friction of the stone matrix against soils attached to vehicle tires.

4. *Concrete Washout Area* – The concrete washout area is used to contain concrete and liquids when the concrete mixers and trucks are rinsed out after delivery. It is an onsite designated cleaning area. The washout facility consolidates solids for easier disposal and prevents runoff of liquids.
5. *Erosion Control Blanket* - A temporary degradable rolled erosion control product composed of processed natural or polymer fibers mechanically, structurally or chemically bound together to form a continuous matrix to provide erosion control and facilitate vegetation establishment.

8. WASTE DISPOSAL

8.1. Erosion and Sediment Materials

Soils that build up in silt fencing and silt dikes shall be spread on site and allowed to dry. The paved streets adjacent to the site entrance shall be swept as needed to remove mud, dirt, or rock tracked from the site. Dump trucks hauling material from the site shall be covered with a tarpaulin.

8.2. Construction Waste Materials

All construction waste materials shall be collected and stored in a securely lidded metal dumpster rented from a licensed solid waste management company. The dumpster shall meet county and state solid waste management regulations. The dumpster shall be emptied as often as necessary in a lawful manner. The Owner shall instruct all personnel on the correct procedures for disposing of waste. Notices stating the policy shall be posted on site. No solid materials are allowed to be discharged from the site via stormwater.

8.3. Hazardous Waste

All hazardous waste materials shall be disposed of in the manner specified by local and state regulations or by the manufacturer. The Owner shall instruct site personnel on these practices and the policy shall be posted on site.

8.4. Sanitary Waste

All personnel involved with construction activities must comply with state and local sanitary or septic system regulations. Temporary sanitary facilities will be provided at the site throughout the construction phase. They must be utilized by all construction personnel and will be serviced by a commercial operator.

9. MAINTENANCE PLAN

These inspection and maintenance practices shall be used to maintain erosion and sediment controls:

1. All control measures shall be inspected at least once per week and within 24 hours following a rainfall event of 0.25 inches or greater.
2. If measures are in need of repair, appropriate remedies shall be initiated immediately.
3. Silt fences shall be inspected for sediment build up, break through, and to see if they are functional.
4. Sediment shall be removed from the devices when the sediment has reached 1/2 the height of each.
5. Stabilized construction entrances/exits shall be checked for sediment clogging the rock at the entrance/exit.
6. Streets shall be checked for sediment tracking due to vehicles.
7. Inspections shall evaluate disturbed areas and areas used for storing materials that are exposed to rainfall for evidence of, or potential for, pollutants entering the drainage system or discharging from the site. If necessary, the materials must be covered or original covers must be repaired or supplemented. Also, protective berms must be constructed, if needed, in order to contain runoff from material storage areas.
8. Grassed areas shall be inspected to confirm that a healthy stand of grass is maintained. The site has achieved final stabilization once all areas are covered with access asphalt road or have stand of grass with at least 70 percent density. Areas must be watered, fertilized, and reseeded as needed to achieve this requirement.
9. All discharge points must be inspected to determine whether erosion control measures are effective in preventing significant impacts to receiving waters.

10. MATERIALS MANAGEMENT PRACTICES

10.1. Guidelines

The following are the material management practices that shall be used to reduce the risk of spills or other accidental exposure of materials and substances to stormwater runoff.

The following good housekeeping practices shall be followed onsite during the construction project:

1. An effort shall be made to store only enough products to do the job.
2. All materials stored onsite shall be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure.
3. Products shall be kept in their original containers with the original manufacturer's label.
4. Substances shall not be mixed with one another unless recommended by the manufacturer.
5. Whenever possible, all of a product shall be used up before disposing of the container.
6. Manufacturers' recommendations for proper use and disposal shall be followed.
7. The site superintendent shall inspect daily to ensure proper use and disposal of materials onsite.

These practices are used to reduce the risks associated with the products described below.

10.2. Petroleum Products and Fuels

All onsite vehicles shall be monitored for leaks and receive regular preventative maintenance. Petroleum products shall be stored in sealed containers according to local and state regulations.

10.3. Paints

All containers shall be tightly sealed and stored when not in use. Excess paint shall not be discharged to the stormwater drainage, but shall comply with local and state regulations.

10.4. Fertilizers

If needed, fertilizers shall be applied in the minimum amounts required. Storage shall be in a closed shed or trailer. Partially opened bags shall be stored in sealable plastic bins.

10.5. Concrete Trucks

Concrete trucks shall not be allowed to wash out or discharge surplus concrete or drain wash water on the site.

These practices are used to reduce the risks associated with spill management:

1. Manufacturers' recommended methods for spill cleanup shall be clearly posted and site personnel shall be made aware of the procedures and the location of the information and cleanup supplies.
2. Materials and equipment necessary for spill cleanup shall be kept in the material storage area onsite. Equipment and materials may include, but are not limited to, brooms, dust pans, mops, rags, gloves, goggles, kitty litter, sand, and plastic and metal trash containers specifically for this purpose.
3. All spills shall be cleaned up immediately after discovery.
4. The spill area shall be kept well ventilated and personnel shall wear appropriate protective clothing to prevent injury from contact with hazardous substance.
5. Spills of toxic or hazardous materials shall be reported to the appropriate authorities.
6. The spill prevention plan shall be adjusted to include measures to prevent the spill from reoccurring.
7. Site personnel shall be designated by the site superintendent to be responsible for spill cleanup. These personnel shall receive training specific to the responsibility.

11. INSPECTIONS

Qualified personnel shall inspect disturbed areas of the construction site that have not been finally stabilized, structural control measures, and locations where vehicles enter or exit the site at least once every seven calendar days and within 24 hours of the end of a storm that is 0.25 inches or greater or equivalent snowfall. Qualified personnel means a person knowledgeable in the principles and practice of erosion and sediment controls, such as a licensed professional engineer or other knowledgeable person who possesses the skills to assess conditions at the construction site that could impact stormwater quality and to assess the effectiveness of any sediment and erosion control measures selected to control the quality of stormwater discharges from the construction activities.

Disturbed areas and areas used for storage of materials that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Erosion and sediment control measures identified in the plan shall be observed to ensure that they are operating correctly. Where discharge locations or points are accessible, they shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles enter or exit shall be inspected for evidence of off-site sediment tracking.

Based on the results of the inspection, the description of potential pollutant sources identified in this plan and pollution prevention measures identified shall be revised as appropriate as soon as practicable after such inspection. Such modifications shall provide for timely implementation of any changes to the plan within 7 calendar days following inspection.

A report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the stormwater pollution prevention plan, and the actions taken shall be made and retained as part of the stormwater pollution prevention plan for at least three years from the date that the permit coverage expires or is terminated.

The permittee shall complete and submit within 5 days an “Incidence of Noncompliance” (ION) report for any violation of the stormwater pollution prevention plan observed during an inspection conducted, including those not required by the plan. Submission shall be on forms provided by the Agency and include specific information on the cause of noncompliance, actions which were taken to prevent any further causes of noncompliance, and a statement detailing any environmental impact which may have resulted from the noncompliance. All reports of the noncompliance shall be signed by a responsible authority and mailed to the Agency at the address provided on the ION form.

12. FINAL MAINTENANCE

The contractor shall maintain the erosion and sediment control measures identified on this plan until the site is stabilized to assure continued performance of their intended function.

All temporary erosion and sediment control BMPs will be removed within 30 days after final site stabilization is achieved or after the temporary BMPS are no longer needed. Trapped sediment will be removed and stabilized onsite. Disturbed soil areas resulting from removal of BMPs or vegetation will be permanently stabilized as soon as possible.

When a site has been finally stabilized and all stormwater discharges from construction sites that are authorized by this permit are eliminated, the permittee shall submit a completed “Notice of Termination” (NOT). For the purposes of this plan, elimination of stormwater discharges associated with construction activity means that all disturbed soils at the site have been finally stabilized and temporary erosion and sediment control measures have been removed or will be removed at an appropriate time, or that all stormwater discharges associated with construction activity from the site that are authorized by a NPDES general permit have otherwise been eliminated. The NOT shall be signed by a responsible authority and mailed to the Agency at the address provided on the form.

Attachment 1 – SWPPP Preparation Certification Form

SWPPP Preparer's Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature Date

Name:	Sean Hickey, P.E.
Title:	Project Manager
Company Name:	Kimley-Horn and Associates, Inc.
Address:	570 Lake Cook Road, Suite 200
City, State:	Deerfield, IL 60015
Phone Number:	708-621-5007

Attachment 2 – Owner's Certification Form

Owner's Certification

(to be duplicated and signed by the owner)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature Date

Name: _____

Title: _____

Company Name: _____

Address: _____

City, State: _____

Phone Number: _____

Attachment 3 – Contractor's Certification Form

Contractor's Certification

(to be duplicated and signed by each contractor or subcontractor)

This SWPPP must clearly identify, for each measure identified within the SWPPP, the contractor(s) or subcontractor(s) that will implement each measure. All contractor(s) and subcontractor(s) identified in the SWPPP must sign the following certification:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature Date

Name: _____

Title: _____

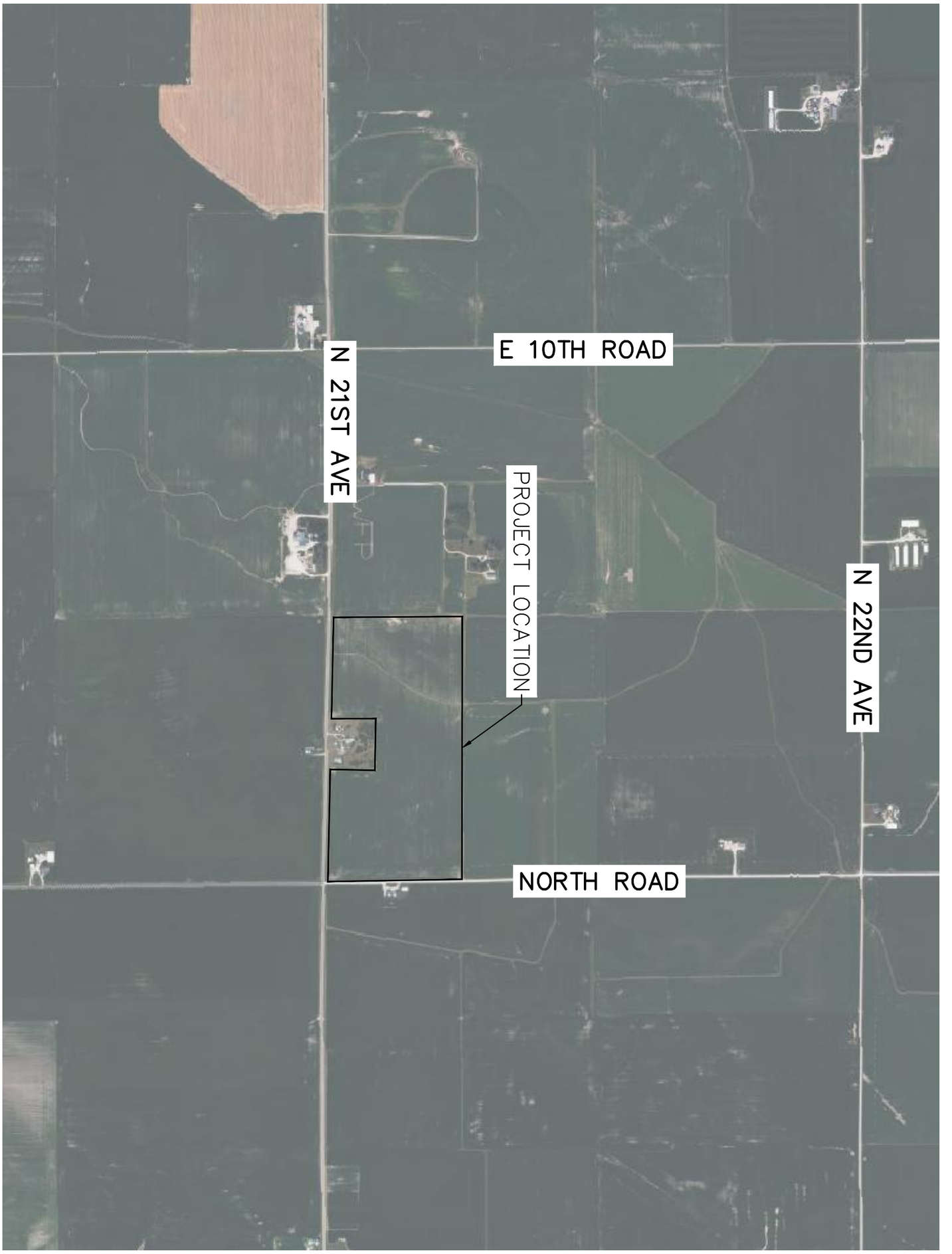
Company Name: _____

Address: _____

City, State: _____

Phone Number: _____

Attachment 4 – Aerial Map



NORTH

EX-4

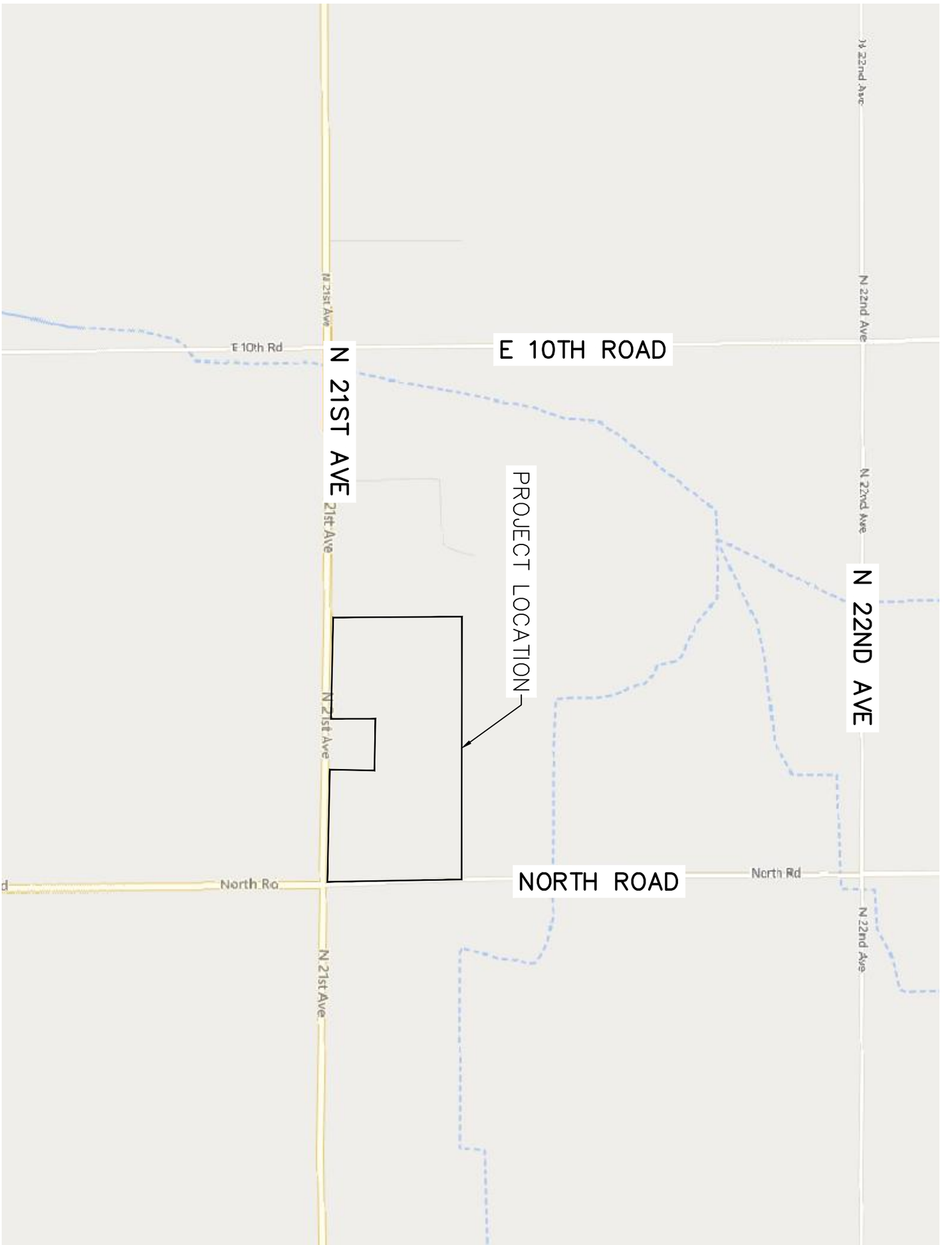
NORTH SUN LLC - AERIAL MAP (N.T.S.)

INTERSECTION N 21ST AVE AND NORTH ROAD
MONTGOMERY COUNTY, IL 62560

Kimley»Horn

570 LAKE COOK ROAD, SUITE 200, DEERFIELD, IL 60015
WWW.KIMLEY-HORN.COM

Attachment 5 – Location Map



NORTH

EX-5

NORTH SUN LLC - LOCATION MAP (N.T.S.)

INTERSECTION N 21ST AVE AND NORTH ROAD
MONTGOMERY COUNTY, IL 62560

Kimley»Horn

570 LAKE COOK ROAD, SUITE 200, DEERFIELD, IL 60015
WWW.KIMLEY-HORN.COM

Attachment 6 – USGS Map

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

The National Map
OnDemand Topo

7.5-MINUTE TOPO QUADRANGLE
Custom Extent
7.5-MINUTE TOPO

Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid:Universal Transverse Mercator, Zone 16S

Data is provided by The National Map (TNM), is the best available at the time of map generation, and includes data content from supporting themes of Elevation, Hydrography, Geographic Names, Boundaries, Transportation, Structures, Land Cover, and Orthoimagery. Refer to associated Federal Geographic Data Committee (FGDC) Metadata for additional source data information.

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands. Temporal changes may have occurred since these data were collected and some data may no longer represent actual surface conditions.

Learn About The National Map: https://nationalmap.gov

MN
GN
2°20'
41 MILS
1°35'
28 MILS

UTM GRID AND 2021 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

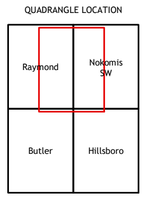
U.S. National Grid
100,000 - m Square ID
BJ
Grid Zone Designation 16S

SCALE 1:24 000

1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5 0 1
MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET

CONTOUR INTERVAL 5 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988
CONTOUR SMOOTHNESS = Medium

QUADRANGLE LOCATION



ADJOINING QUADRANGLES

ROAD CLASSIFICATION

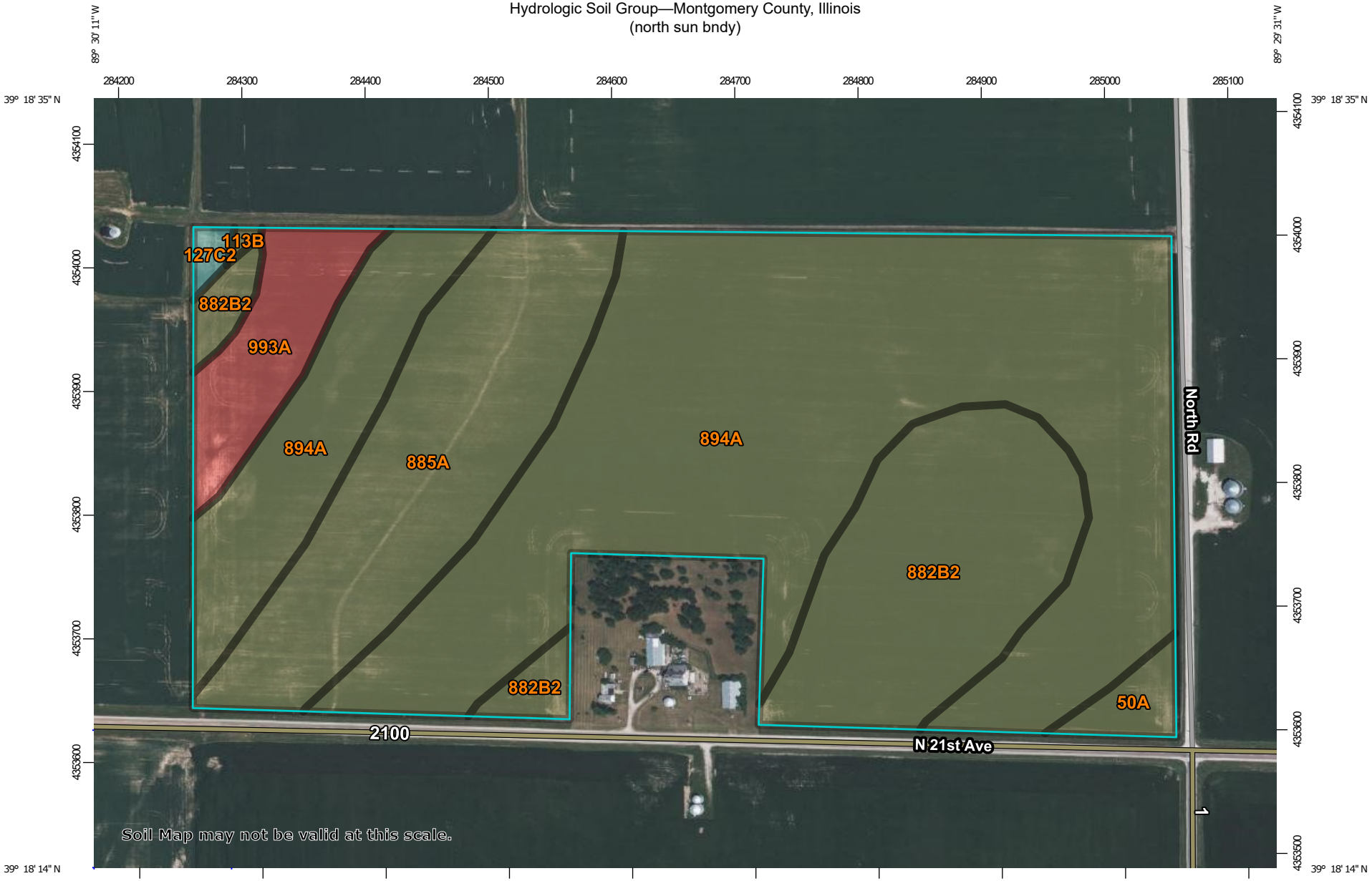
Expressway	Local Connector
Secondary Hwy	Local Road
Ramp	4WD

Interstate Route US Route State Route

7.5-MINUTE TOPO, IL
2024

Attachment 7 – NRCS Soil Report

Hydrologic Soil Group—Montgomery County, Illinois
(north sun bndy)



Map Scale: 1:4,390 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Lines

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Points

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Montgomery County, Illinois
Survey Area Data: Version 20, Aug 28, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 1, 2020—Oct 1, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
50A	Virden silty clay loam, 0 to 2 percent slopes	C/D	1.1	1.5%
113B	Oconee silt loam, 2 to 5 percent slopes	C/D	0.1	0.1%
127C2	Harrison silt loam, 5 to 10 percent slopes, eroded	C	0.3	0.4%
882B2	Oconee-Darmstadt-Coulterville silt loams, 2 to 5 percent slopes, eroded	C/D	12.5	17.1%
885A	Virden-Fosterburg silt loams, 0 to 2 percent slopes	C/D	12.6	17.3%
894A	Herrick-Biddle-Piasa silt loams, 0 to 2 percent slopes	C/D	42.8	58.5%
993A	Cowden-Piasa silt loams, 0 to 2 percent slopes	D	3.7	5.1%
Totals for Area of Interest			**73.2**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

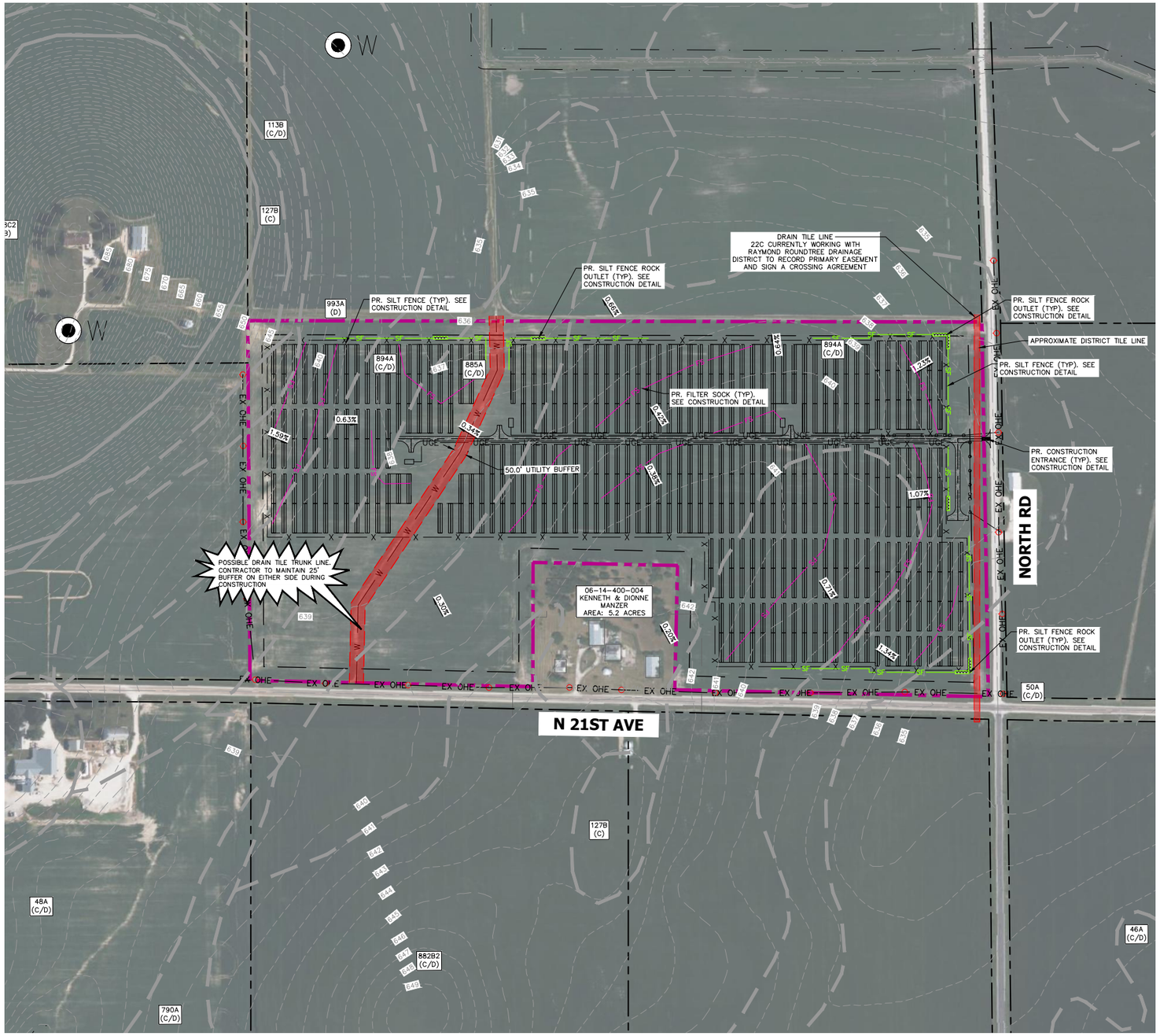
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

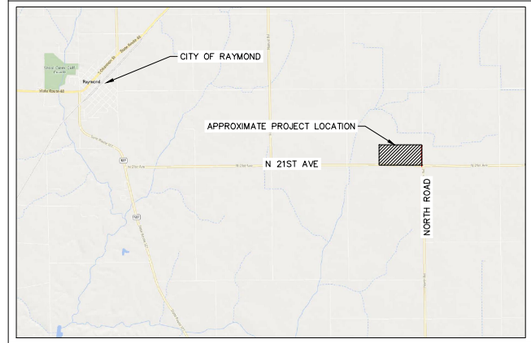
Attachment 8 – C-300 and C-500 – Erosion Control Plan and Construction Details



GRAPHIC SCALE IN FEET
0 100 200 400

NORTH

VICINITY MAP



SCALE 1" = 5000'

LEGEND

ROAD LABEL	N 2200TH ST
PROJECT BOUNDARY (ESTIMATED PER COUNTY GIS, ACCESSED 02/06/2024)	
PROPERTY LINE (PER COUNTY GIS, ACCESSED 02/06/2024)	
PROPERTY LINE SETBACKS (PER MONTGOMERY COUNTY ORDINANCE NO. 2023-23, DATED 06/13/2023)	
EX. ROAD CENTERLINE (TRACED PER AERIAL)	
ROAD RIGHT-OF-WAY (TRACED PER AERIAL)	R/W
EX. OVERHEAD ELECTRIC (TRACED PER AERIAL)	EX OHE
EX. UTILITY POLE (TRACED PER AERIAL)	
EX. OCCUPIED COMMUNITY BUILDING/DWELLING (TRACED PER AERIAL)	
EX. OCCUPIED COMMUNITY BUILDING/DWELLING OFFSET	
EX. ASSUMED DRAIN TILE	W
EX. UTILITY EASEMENT	
EX. SLOPE	XX%
EX. CONTOURS	XXX
EX. STREAM (PER NWI, ACCESSED ON 02/07/2024)	
30' WETLAND/ STREAM BUFFER	
SOIL BOUNDARY	
PR. SILT FENCE	SF
PR. FILTER SOCK	FS
PR. SILT FENCE ROCK OUTLET	
PR. CONSTRUCTION ENTRANCE	
PR. SECURITY FENCE	X
PR. UTILITY POLE	
PR. EQUIPMENT PAD	
PR. SOLAR ARRAY	
PR. PANEL EXTENTS	
PR. OVERHEAD ELECTRIC	OH
PR. UNDERGROUND ELECTRIC	UGE
PR. GRAVEL ACCESS ROAD	

NOTES

1. THE PURPOSE OF THIS PLAN IS FOR SOLAR FARM PERMIT REVIEW AND APPROVAL BY MONTGOMERY COUNTY TO CONSTRUCT A SOLAR FARM.
2. THIS PLAN WAS PRODUCED UTILIZING GIS RESOURCES AND INFORMATION FROM MULTIPLE SOURCES, INCLUDING MONTGOMERY COUNTY, GOOGLE EARTH, NATIONAL WETLANDS INVENTORY (NWI), FEMA, NRCS SOIL INFORMATION, AND USGS TOPOGRAPHIC INFORMATION.
3. SUBJECT PROPERTY DOES NOT LIE WITHIN A SPECIAL FLOOD HAZARD AS SHOWN ON THE FLOOD INSURANCE RATE MAP (COMMUNITY PANEL 1709920002A) PUBLISHED BY THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA).
4. STORMWATER MANAGEMENT FACILITIES TO BE PROVIDED AS REQUIRED BY COUNTY AND/OR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMITTING, REQUIREMENTS TO BE DETERMINED DURING FINAL ENGINEERING.
5. THE LOCATIONS OF PROPOSED IMPROVEMENTS, INCLUDING BUT NOT LIMITED TO: AGGREGATE ACCESS ROAD, FENCING, SOLAR ARRAY RACKING, INVERTER/TRANSFORMER PADS, OVERHEAD POLES AND LINES, ETC., SHOWN ARE APPROXIMATE AND ARE SUBJECT TO MODIFICATION DUE TO SITE CONDITIONS, ADDITIONAL PERMITTING REQUIREMENTS, EQUIPMENT SPECIFICATIONS, AND/OR OTHER CONSTRAINTS DURING FINAL ENGINEERING.
6. SETBACKS SHOWN ON THIS PLAN ARE BASED ON THE MONTGOMERY COUNTY CODE OF ORDINANCES #2023-23.
7. SILT FENCE HAS BEEN PLACED AT DOWNSTREAM EXTERNAL BOUNDARIES.
8. FILTER SOCK IS PROPOSED TO CHECK EROSIVE FLOWS ACROSS SITE.
9. RIP RAP OUTFALLS ARE PLACED AT CONCENTRATED FLOW POINTS IN THE PERIMETER CONTROLS.
10. ALL DIMENSIONS SHOWN ARE AT 90 DEGREES UNLESS OTHERWISE NOTED.

SITE DATA TABLE

PIN #	06-14-400-003
APPLICANT	NORTH SUN LLC
PROPERTY OWNER	KEVIN WOOD ET AL
SITE ADDRESS	NW OF INTERSECTION OF N 21ST AVE AND NORTH RD, MONTGOMERY COUNTY IL, 62560
LEGAL DESCRIPTION	SEC 27 TWP 04 RNG 01 PT E SE SW & PT NE SW (LYING S OF RR) 2023-1942 344/889--04/1983
ZONING JURISDICTION	MONTGOMERY COUNTY
CURRENT LAND USE	CROPLAND
PROPOSED AREA	SOLAR FARM
TOTAL PARCEL AREA	75.0 ± AC
PRELIMINARY DISTURBED AREA	48.4 ± AC (AREA WITHIN FENCE)
PRELIMINARY SOLAR AREA	41.2 ± AC
RIGHT-OF-WAY SETBACK	50.0'
PROPERTY LINE SETBACK	50.0'
RESIDENTIAL SETBACK	150.0'
TOTAL MODULES	27,540
TOTAL POWER OUTPUT (AC)	UP TO 10 MWac
GROUND COVER RATIO (GCR)	40%

EROSION CONTROL BMPS

DESCRIPTION	QUANTITY
SILT FENCE	3,200 LF
FILTER SOCK	5,900 LF
RIP RAP OUTFALL	7 (EACH)
CONSTRUCTION ENTRANCE	1 (EACH)

Call Before You Dig
JULIE
1-800-892-0123

No.	REVISIONS	DATE

Kimley»Horn

570 LAKE COOK RD SUITE 200
DEERFIELD, IL 60015
WWW.KIMLEY-HORN.COM

PRELIMINARY- NOT FOR CONSTRUCTION

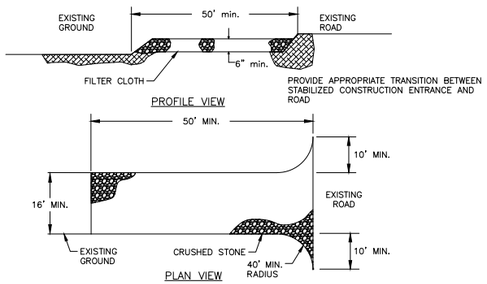
KHA PROJECT 268330024
DATE 04/05/2024
SCALE AS SHOWN
DESIGNED BY HLL
DRAWN BY HLL
CHECKED BY SMH

EROSION CONTROL PLAN

NORTH SUN LLC

MONTGOMERY COUNTY, IL

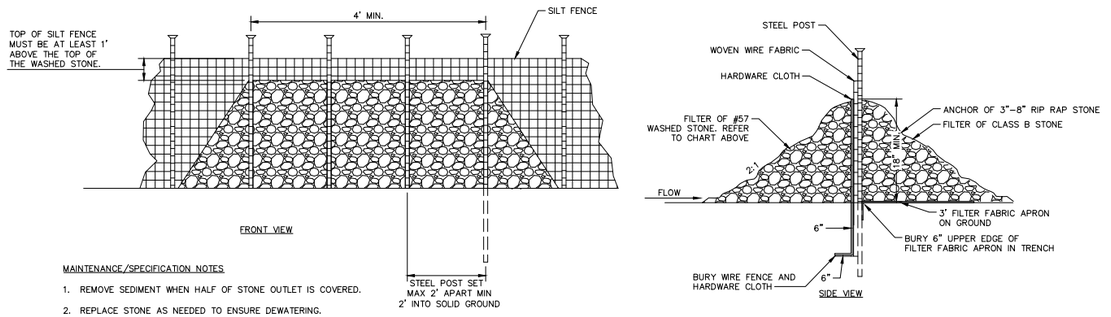
SHEET NUMBER
C-300



1. STONE FOR A STABILIZED CONSTRUCTION ENTRANCE SHALL BE 1 TO 2 INCH STONE, RECLAIMED STONE, OR RECYCLED CONCRETE EQUIVALENT.
2. THE LENGTH OF THE STABILIZED ENTRANCE SHALL NOT BE LESS THAN 50 FEET.
3. THE THICKNESS OF THE STONE FOR THE STABILIZED ENTRANCE SHALL NOT BE LESS THAN 6 INCHES.
4. THE WIDTH OF THE ENTRANCE SHALL NOT BE LESS THAN THE FULL WIDTH OF THE PROPOSED ENTRANCE.
5. GEOTEXTILE FILTER CLOTH (MIRAFI HP370 OR APPROVED EQUIVALENT) SHALL BE PLACED OVER THE ENTIRE AREA PRIOR TO PLACING THE STONE.
6. ALL SURFACE WATER THAT IS FLOWING TO OR DIVERTED TOWARDS THE CONSTRUCTION ENTRANCE SHALL BE PIPED BENEATH THE SURFACE.
7. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO EXISTING ROAD. THIS MANY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE OR ADDITIONAL LENGTH AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED, OR TRACKED ONTO EXISTING ROAD SHALL BE REMOVED IMMEDIATELY.

1 TEMPORARY STABILIZED CONSTRUCTION ENTRANCE DETAIL

SCALE: NTS

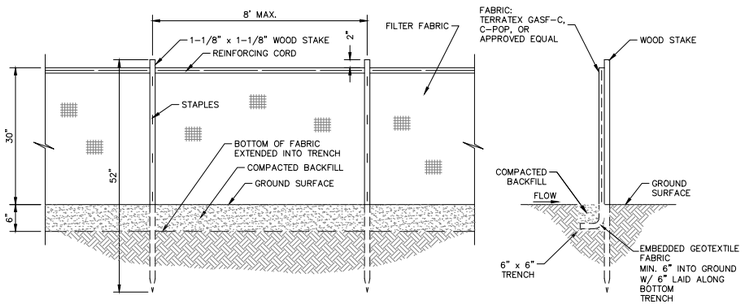


MAINTENANCE/SPECIFICATION NOTES

1. REMOVE SEDIMENT WHEN HALF OF STONE OUTLET IS COVERED.
2. REPLACE STONE AS NEEDED TO ENSURE DEWATERING.
3. SILT FENCE OUTLETS SHOULD NOT BE LOCATED WHERE THE OUTFLOW WILL ERODE THE SOIL BELOW.

2 SILT FENCE ROCK OUTLET DETAIL

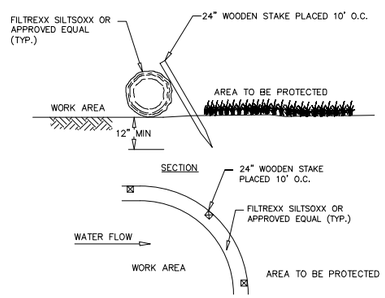
SCALE: NTS



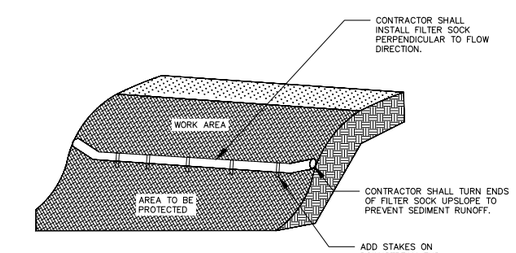
1. AASHTO M288 05 SILT FENCE OR APPROVED EQUIVALENT TO BE FASTENED SECURELY TO FENCE POSTS WITH STAPLES EVERY 24" AT TOP AND MID SECTION.
2. WHEN TWO SECTIONS OF AASHTO M288 05 SILT FENCE OR APPROVED EQUIVALENT ADJOIN EACH OTHER THEY SHALL BE OVERLAPPED BY SIX INCHES AND FOLDED.
3. MAINTENANCE SHALL BE PERFORMED AS NOTED IN THE EROSION CONTROL PLAN. COLLECTED MATERIAL SHALL BE REMOVED WHEN "BULGES" DEVELOP IN THE SILT FENCE.

3 STANDARD SILT FENCE

SCALE: NTS



1. FILTER SOCK SHALL BE 8" DIAMETER MIN.
2. SOCKS TO BE FILLED WITH BIODEGRADABLE COMPOST MATERIAL.
3. WOODEN STAKES SHALL BE PLACED DOWNSLOPE OF THE FILTER SOCK.



MAXIMUM SLOPE LENGTH (FT) ABOVE FILTER SOCK

SLOPE: PERCENT	8 INCH	12 INCH	18 INCH	24 INCH
2 (OR LESS)	300	375	500	650
5	200	250	275	325
10	100	125	150	200
15	70	85	100	160
20	50	65	70	130
22	40	50	55	100

4 FILTER SOCK SEDIMENT CONTROL

SCALE: NTS

No.	REVISIONS	DATE

Kimley»Horn
© 2024 KIMLEY-HORN AND ASSOCIATES, INC.
570 LAKE COOK RD SUITE 200
DEERFIELD, IL 60015
WWW.KIMLEY-HORN.COM

PRELIMINARY- NOT FOR CONSTRUCTION

KHA PROJECT 268330024
DATE 04/05/2024
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CONSTRUCTION DETAILS

NORTH SUN LLC
MONTGOMERY COUNTY, IL

SHEET NUMBER
C-500

Call Before You Dig
JULIE
1-800-892-0123

Attachment 9 – BMP Installation Log

BMP INSTALLATION LOG

Project: North Sun LLC

Location: Intersection of N 21st Ave and North Road
Montgomery County, IL 62560

BMP Name	Date Installed	Description of BMP Installed	Responsible Party

Attachment 10 – Amendment Log

AMENDMENT LOG

Project: North Sun LLC

Location: Intersection of N 21st Ave and North Road
Montgomery County, IL 62560

Amendment No.	Date	Description of Amendment

EXHIBIT Q: PRODUCT CUT SHEETS

Preliminary

Mono Multi Solutions

Vertex

BACKSHEET MONOCRYSTALLINE MODULE

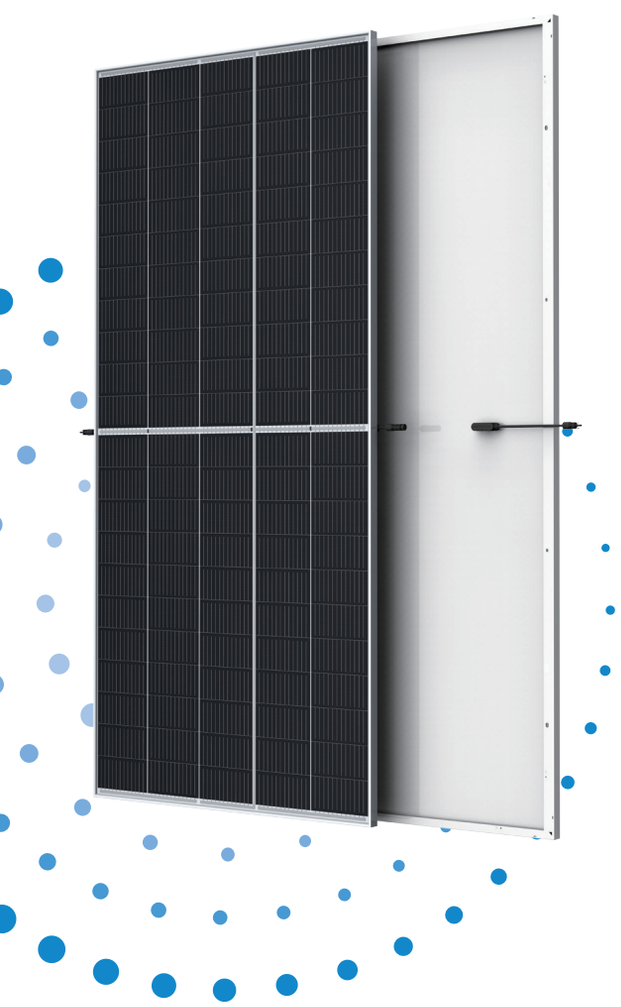
PRODUCT: TSM-DE19

PRODUCT RANGE: 530-555W

555W+
MAXIMUM POWER OUTPUT

0~+5W
POSITIVE POWER TOLERANCE

21.2%
MAXIMUM EFFICIENCY



High customer value

- Lower LCOE (Levelized Cost Of Energy), reduced BOS (Balance of System) cost, shorter payback time
- Lowest guaranteed first year and annual degradation;
- Designed for compatibility with existing mainstream system components
- Higher return on Investment

High power up to 555W

- Up to 21.2% module efficiency with high density interconnect technology
- Multi-busbar technology for better light trapping effect, lower series resistance and improved current collection

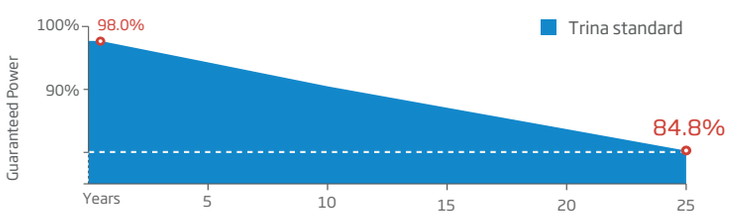
High reliability

- Minimized micro-cracks with innovative non-destructive cutting technology
- Ensured PID resistance through cell process and module material control
- Mechanical performance up to 5400 Pa positive load and 2400 Pa negative load

High energy yield

- Excellent IAM (Incident Angle Modifier) and low irradiation performance, validated by 3rd party certifications
- The unique design provides optimized energy production under inter-row shading conditions
- Lower temperature coefficient (-0.34%) and operating temperature

Trina Solar's Backsheet Performance Warranty



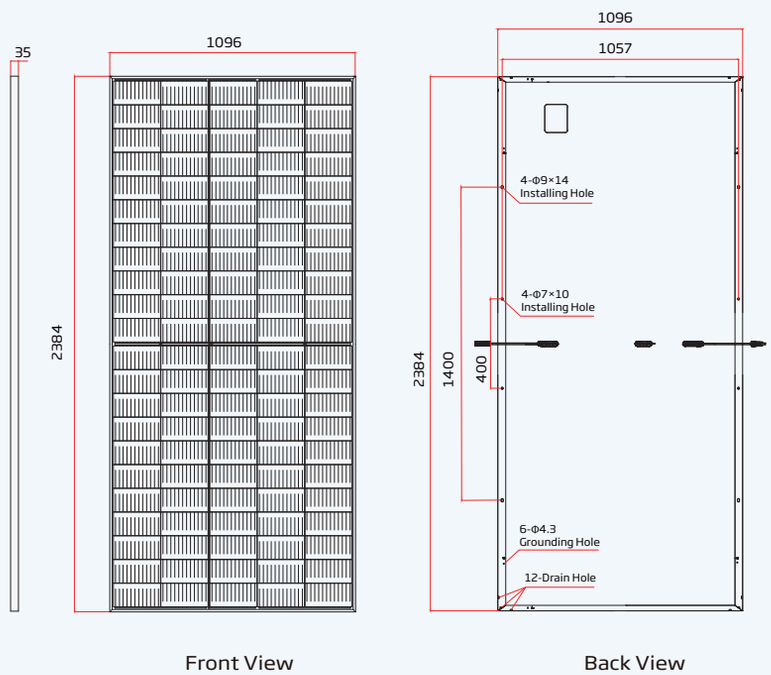
Comprehensive Products and System Certificates

IEC61215/IEC61730/IEC61701/IEC62716/UL61730
ISO 9001: Quality Management System
ISO 14001: Environmental Management System
ISO14064: Greenhouse Gases Emissions Verification
ISO45001: Occupational Health and Safety Management System

Trinasolar

Vertex BACKSHEET MONOCRYSTALLINE MODULE

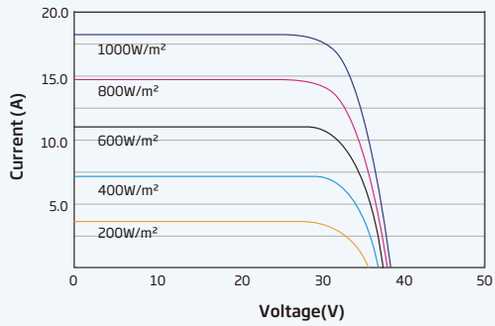
DIMENSIONS OF PV MODULE(mm)



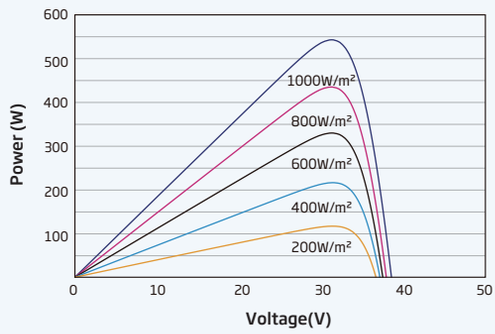
Front View

Back View

I-V CURVES OF PV MODULE(545 W)



P-V CURVES OF PV MODULE(545W)



ELECTRICAL DATA (STC)

Peak Power Watts-PMAX (Wp)*	530	535	540	545	550	555
Power Tolerance-PMAX (W)	0 ~ +5					
Maximum Power Voltage-VMPP (V)	30.8	31.0	31.2	31.4	31.6	31.8
Maximum Power Current-IMPP (A)	17.21	17.28	17.33	17.37	17.40	17.45
Open Circuit Voltage-VOC (V)	37.1	37.3	37.5	37.7	37.9	38.1
Short Circuit Current-ISC (A)	18.31	18.36	18.41	18.47	18.52	18.56
Module Efficiency η m (%)	20.3	20.5	20.7	20.9	21.0	21.2

STC: Irrdiance 1000W/m2, Cell Temperature 25°C, Air Mass AM1.5. *Measuring tolerance: ±3%.

ELECTRICAL DATA (NOCT)

Maximum Power-PMAX (Wp)	401	405	409	413	417	420
Maximum Power Voltage-VMPP (V)	28.6	28.8	29.0	29.2	29.3	29.5
Maximum Power Current-IMPP (A)	14.01	14.06	14.10	14.15	14.19	14.23
Open Circuit Voltage-VOC (V)	35.0	35.1	35.3	35.5	35.7	35.9
Short Circuit Current-ISC (A)	14.76	14.80	14.84	14.88	14.92	14.96

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

MECHANICAL DATA

Solar Cells	Monocrystalline
No. of cells	110 cells
Module Dimensions	2384×1096×35 mm (93.86×43.15×1.38 inches)
Weight	28.6 kg (63.1 lb)
Glass	3.2 mm (0.13 inches), High Transmission, AR Coated Heat Strengthened Glass
Encapsulant material	EVA/POE
Backsheet	White
Frame	35mm(1.38 inches) Anodized Aluminium Alloy
J-Box	IP 68 rated
Cables	Photovoltaic Technology Cable 4.0mm² (0.006 inches²), Portrait: 280/280 mm(11.02/11.02 inches) Landscape: 1400/1400 mm(55.12/55.12 inches)
Connector	MC4 EVO2 / TS4*

*Please refer to regional datasheet for specified connector.

TEMPERATURE RATINGS

NOCT(Nominal Operating Cell Temperature)	43°C (±2°C)
Temperature Coefficient of PMAX	- 0.34%/°C
Temperature Coefficient of VOC	- 0.25%/°C
Temperature Coefficient of ISC	0.04%/°C

MAXIMUMRATINGS

Operational Temperature	-40~+85°C
Maximum System Voltage	1500V DC (IEC)
	1500V DC (UL)
Max Series Fuse Rating	30A

WARRANTY

12 year Product Workmanship Warranty

25 year Power Warranty

2% first year degradation

0.55% Annual Power Attenuation

(Please refer to product warranty for details)

PACKAGING CONFIGUREATION

Modules per box: 31 pieces

Modules per 40' container: 620 pieces

Trinasolar

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

Version number: TSM_EN_2020_A

www.trinasolar.com

EXHIBIT R: TRANSPORTATION AND ACCESS PLAN

MEMORANDUM

To: 22c Development, LLC
Alex Farkes

From: Sean Hickey, P.E.
Kimley-Horn and Associates, Inc.

Date: April 5th, 2024

Re: ***North Sun LLC – Transportation and Access Plan***
West of North Road and North of N 21st Ave, Raymond Township, Montgomery County, IL

Introduction

Kimley-Horn and Associates, Inc. (Kimley-Horn) serves as the engineering consultant for North Sun LLC (applicant), a subsidiary of 22c Development. It is our understanding that North Sun LLC is submitting for an Application for a Solar Farm Construction Permit to construct an up to 10.0 MWac Solar Farm on parcel 06-14-400-003, located west of North Road and north of N 21st Ave.

This memorandum provides information on the proposed Construction and Operations Access as well as anticipated traffic and routes based on the project location and projects of similar size.

Pre-Development

The Project will be sited over approximately 49 acres of leased property bound to the north and west by agricultural fields, bound to the east by North Road, and bound to the south by N 21st Ave. The site has a proposed access from North Road.

See attached **Construction and Operations Access Plan** for project location.

Construction

At the time of this memorandum, it is anticipated that site access during construction will be located approximately 960 feet north of the intersection of North Road and N 21st Ave. Prior to the beginning of construction, a temporary stabilized construction entrance consisting of 1-1/2" to 3" rock a minimum of 8 inches thick, 20' wide, and 50' long will be installed to provide a stable entrance for construction traffic at the proposed entrance location.

Based on similar commercial solar energy facilities of this size, it is estimated that approximately 50 deliveries via WB-67 Semi-Tractor Trailers will be required during the construction phase to deliver the piles, racking, modules, inverters, electrical, and switchyard equipment. It is anticipated that at the peak of construction approximately 40 construction workers will be needed. Construction of the Solar Farm is projected to be completed within 6 months. Equipment deliveries will typically occur between months 2 and 4 of the construction period and taper off dramatically by the end of the 4th month. The peak for construction workers on site will occur around month 4 and will taper off by the end of month 5.

Based on the project location, we anticipate delivery trucks will access the site from Interstate 55 (IDOT District 6), east to State Route 48 (IDOT District 6), south to State Route 127 (IDOT District 6), east to N 21st Ave (IDOT District 6), and north to North Road (Raymond Township).

See attached **Construction and Operations Access Plan** for proposed access routes.

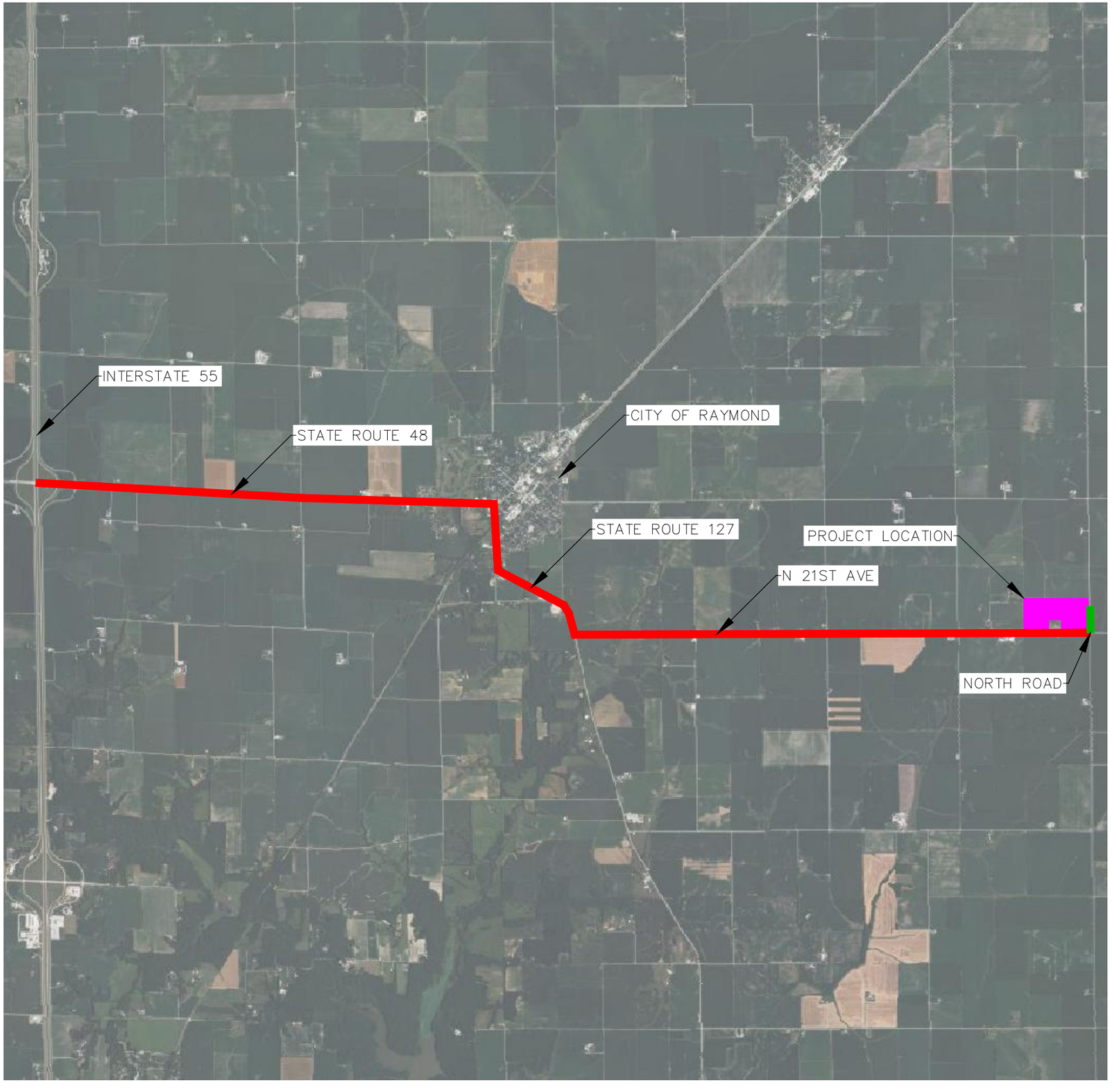
Post-Development

After construction is complete, the site will be accessed via the same entry location that was utilized during construction. Compacted earth or gravel access roads will be utilized to access the interior of the site for operations and maintenance. Once the site is fully operational, it is anticipated that no more than four vehicles will visit the site on a quarterly basis for routine maintenance.

See **Application for Solar Farm Development Permit Exhibit C: Solar Farm Development Permit Plans** for proposed access roads.

Attachments

- Road Jurisdiction Map
- Construction and Operations Access Plan



GRAPHIC SCALE IN FEET
0 1000 2000 4000

NORTH

ROAD JURISDICTION LEGEND

- STATE (IDOT)
- TOWNSHIP (RAYMOND)
- PROJECT LOCATION

ROAD JURISDICTION INFORMATION

ROAD NAME	JURISDICTION LEVEL	JURISDICTION (AHJ)	CONTACT	CONTACT PHONE NUMBER
INTERSTATE 55	STATE	IDOT	IDOT DISTRICT 6 BUREAU OF OPERATIONS	217–782–7745
STATE ROUTE 48	STATE	IDOT	IDOT DISTRICT 6 BUREAU OF OPERATIONS	217–782–7745
STATE ROUTE 127	STATE	IDOT	IDOT DISTRICT 6 BUREAU OF OPERATIONS	217–782–7745
N 21ST AVE	STATE	IDOT	IDOT DISTRICT 6 BUREAU OF OPERATIONS	217–782–7745
NORTH ROAD	TOWNSHIP	RAYMOND TOWNSHIP	HIGHWAY COMMISSIONER – KENNETH MONDHINK	217–229–3062

Call Before You Dig
JULIE
1-800-892-0123

No.	REVISIONS	DATE

Kimley»Horn

570 LAKE COOK RD SUITE 200
DEERFIELD, IL 60015
WWW.KIMLEY-HORN.COM

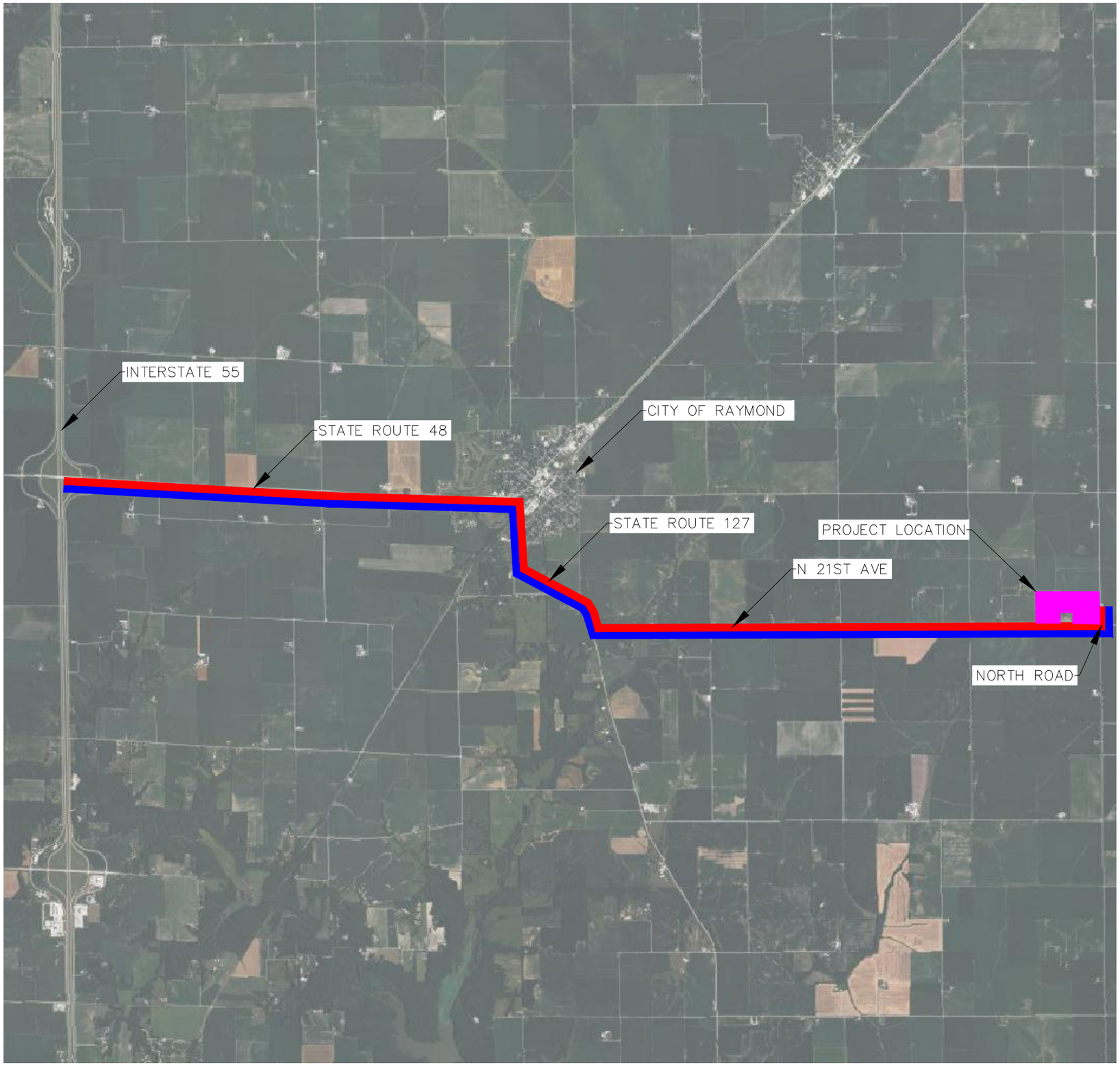
PRELIMINARY- NOT FOR CONSTRUCTION

KHA PROJECT	268330024
DATE	03/20/2024
SCALE	AS SHOWN
DESIGNED BY	HLL
DRAWN BY	HLL
CHECKED BY	SMH

ROAD JURISDICTION MAP

NORTH SUN LLC
MONTGOMERY COUNTY, IL

SHEET NUMBER
EX-01



GRAPHIC SCALE IN FEET
0 1000 2000 4000

NORTH

LEGEND

- DELIVERY TRUCK ROUTE (WB-67 SEMI)
- PASSENGER VEHICLE ROUTE (CONSTRUCTION/MAINTENANCE)
- PROPERTY LOCATION

No.	REVISIONS	DATE

Kimley»Horn

570 LAKE COOK RD SUITE 200
DEERFIELD, IL 60015
WWW.KIMLEY-HORN.COM

PRELIMINARY- NOT FOR CONSTRUCTION

KHA PROJECT	268330024
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DESIGNED BY	HLL
DRAWN BY	HLL
CHECKED BY	SMH

CONSTRUCTION AND OPERATIONS ACCESS MAP

NORTH SUN LLC

MONTGOMERY COUNTY, IL

SHEET NUMBER
EX-02

Call Before You Dig
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1-800-892-0123

EXHIBIT S: ROADWAY COORDINATION CORRESPONDENCE

April 4th, 2024

Jeffrey Myers
IDOT Region 4 Engineer
126 East Ash
Springfield, IL 62704

RE: North Sun LLC.
Intersection of N 21st Ave and North Road, Raymond Township, Montgomery County, IL

Dear Mr. Myers,

Kimley-Horn and Associates, Inc., plans to submit a Commercial Solar Development Permit Application to Montgomery County on behalf of North Sun LLC., a wholly owned entity of 22c Development, LLC (collectively the "Applicant" for the Special Use). The Project, North Sun LLC., is a proposed up to 10.0 MW_{ac} Solar Farm in Raymond Township, Montgomery County, sited on agricultural land west of North Road, north of N 21st Ave and a residential property, east of agricultural land and a residential property, and south of agricultural land. The project will have one (1) access road off North Road.

The proposed delivery truck route (assumed WB-67 Semis) will utilize Interstate 55, State Route 48, State Route 127, and N 21st Ave in IDOT District 6.

The Project aims to acquire a Solar Farm Development Permit from Montgomery County to construct the Solar Farm after the harvest of 2025. Prior to building permit application submission, the Applicant will commence discussions with yourself and provide all surveys requested, roadway route for construction, and whatever else is needed in order to get to an executable form of a roadway agreement as a building permit is issued for construction.

For any questions or concerns, please contact either myself at (779) 774-5151 or x@22c-development.com or Sean Hickey at sean.hickey@kimley-horn.com. Thank you so much for your time and looking forward to meeting more and discussing the project.

Sincerely,

Alex Farkes, Owner
North Sun, LLC
22c Development, LLC
Phone: (779) 774-5151
Email: x@22c-development.com

April 4th, 2024

Kenneth L. Mondhink
Raymond Township Highway Commissioner
7318 Mackay Ave
Raymond, IL 62560

RE: North Sun LLC.
Intersection of N 21st Ave and North Road, Raymond Township, Montgomery County, IL

Dear Mr. Mondhink,

Kimley-Horn and Associates, Inc., plans to submit a Commercial Solar Development Permit Application to Montgomery County on behalf of North Sun LLC., a wholly owned entity of 22c Development, LLC (collectively the "Applicant" for the Special Use). The Project, North Sun LLC., is a proposed up to 10.0 MW_{ac} Solar Farm in Raymond Township, Montgomery County, sited on agricultural land west of North Road, north of N 21st Ave and a residential property, east of agricultural land and a residential property, and south of agricultural land. The project will have one (1) access road off North Road.

The proposed delivery truck route (assumed WB-67 Semis) will utilize North Road, north of N 21st Ave, in Raymond Township.

The Project aims to acquire a Solar Farm Development Permit from Montgomery County to construct the Solar Farm after the harvest of 2025. Prior to building permit application submission, the Applicant will commence discussions with yourself and provide all surveys requested, roadway route for construction, and whatever else is needed in order to get to an executable form of a roadway agreement as a building permit is issued for construction.

For any questions or concerns, please contact either myself at (779) 774-5151 or x@22c-development.com or Sean Hickey at sean.hickey@kimley-horn.com. Thank you so much for your time and looking forward to meeting more and discussing the project.

Sincerely,

Alex Farkes, Owner
North Sun, LLC
22c Development, LLC
Phone: (779) 774-5151
Email: x@22c-development.com

EXHIBIT T: NOISE ANALYSIS

April 5, 2024

Alex Farkes
22c Development, LLC.
4649 N Broadway
Chicago, IL 60640

Subject: ***North Sun LLC. – Sound Study***
Montgomery County, Illinois

Executive Summary

The purpose of this technical memorandum is to summarize the evaluated sound levels associated with the operational equipment located throughout the proposed North Sun LLC. Solar Site in Montgomery County, IL. The proposed solar photovoltaic project site is approximately 4 miles east of Raymond and approximately 4 miles southeast of Harvel. The site is generally located north of N 21st Avenue (County Road 2100 N), east of Country Road 1000 E, west of North Road, and south of N 22nd Avenue. The solar site will be located on agricultural land with rural residential properties south and west of the project site. The location of the proposed North Sun LLC. Solar Site is shown in **Figure 1**.

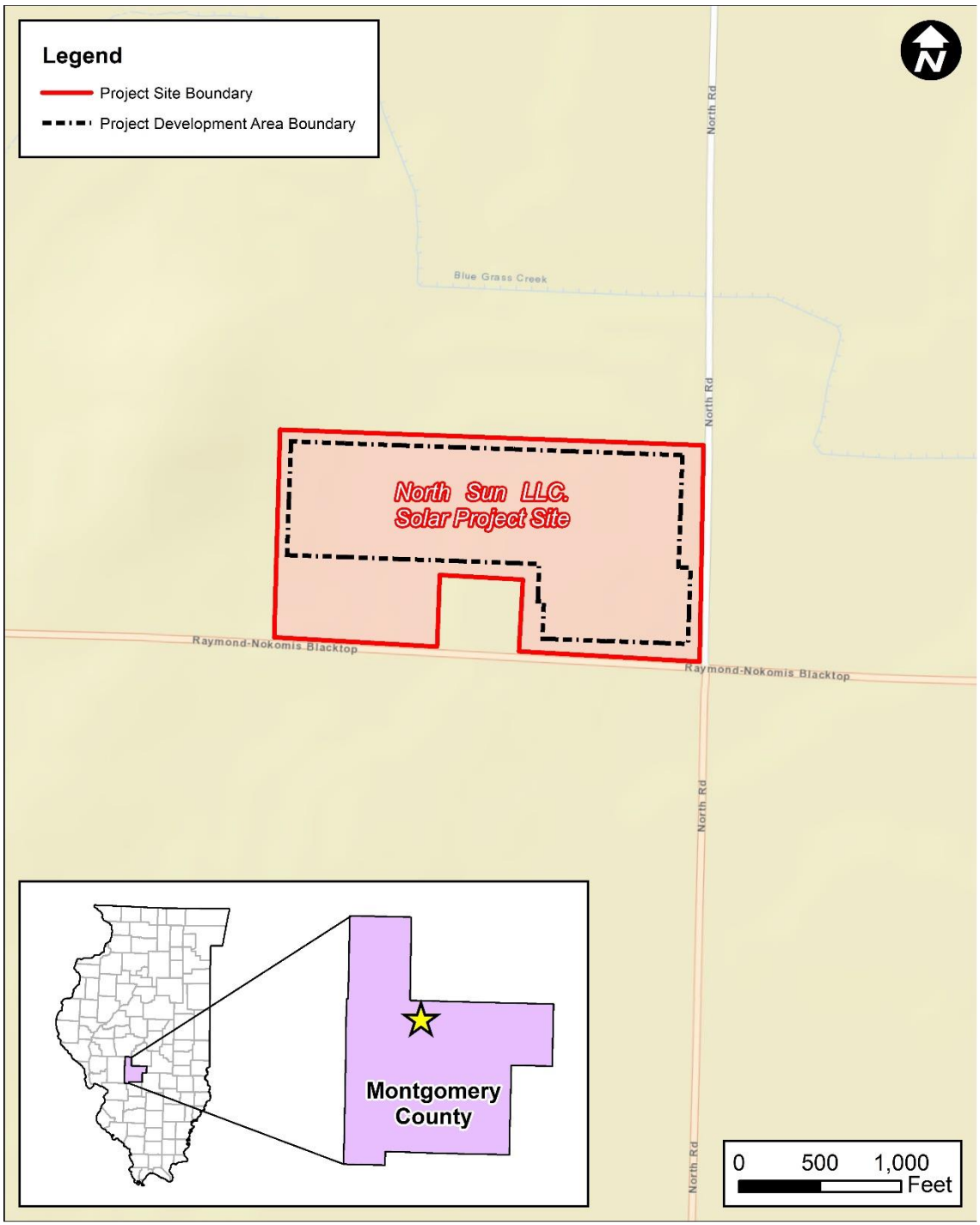
Analysis Findings

- *The solar photovoltaic project will be located on agricultural land with rural residential properties south and west of the project site. The Illinois Pollution Control Board (IPCB) noise regulations are based on allowable octave band sound pressure levels that vary depending on the category of land the noise is generated from and the category of land the noise is received at. Modeled operational octave band sound pressure levels at surrounding Class A properties (i.e., residences) are not anticipated to exceed the limits established by IPCB; therefore, noise mitigation is not recommended at this time.*

Project Description

The proposed North Sun LLC. Solar Site will be developed on approximately 49 acres of an approximately 75-acre parcel of agricultural land in an unincorporated portion of Montgomery County, IL. The solar site will consist of solar arrays throughout the project area with three (3) inverters located towards the northern portion of the site.

Figure 1: Site Location and Vicinity



Characteristics of Noise

Noise is generally defined as unwanted sound. It is emitted from many natural and man-made sources. Sound pressure levels are usually measured and expressed in decibels (dB). The decibel scale is logarithmic and expresses the ratio of the sound pressure unit being measured to a standard reference level. Most sounds occurring in the environment do not consist of a single frequency, but rather a broad band of differing frequencies. The intensities of each frequency add together to generate sound. Because the human ear does not respond to all frequencies equally, the method commonly used to quantify environmental noise consists of evaluating all of the frequencies of a sound according to a weighting system. It has been found that the A-weighted decibel [dB(A)] filter on a sound level meter, which includes circuits to differentially measure selected audible frequencies, best approximates the frequency response of the human ear.

The degree of disturbance from exposure to unwanted sound – noise – depends upon three factors:

1. The amount, nature, and duration of the intruding noise
2. The relationship between the intruding noise and the existing sound environment; and
3. The situation in which the disturbing noise is heard

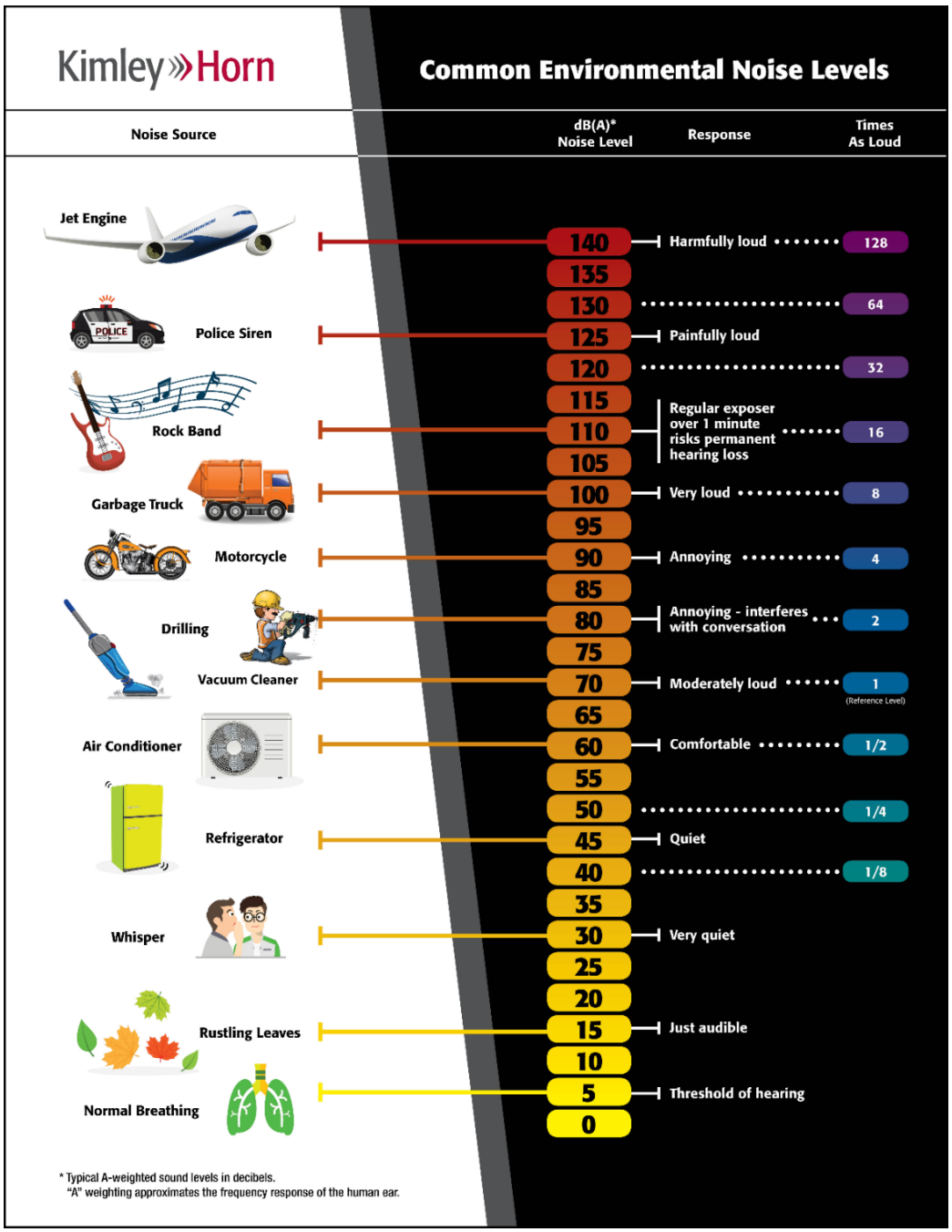
In considering the first of these factors, it is important to note that individuals have varying sensitivity to noise. Loud noises bother some people more than other people, and some individuals become increasingly upset if an unwanted noise persists. The time patterns and durations of noise(s) also affect perception as to whether or not it is offensive. For example, noises that occur during nighttime (sleeping) hours are typically considered to be more offensive than the same noises in the daytime.

With regard to the second factor, individuals tend to judge the annoyance of an unwanted noise in terms of its relationship to noise from other sources (background noise). A car horn blowing at night when background noise levels are low would generally be more objectionable than one blowing in the afternoon when background noise levels are typically higher. The response to noise stimulus is analogous to the response to turning on an interior light. During the daytime an illuminated bulb simply adds to the ambient light, but when eyes are conditioned to the dark of night, a suddenly illuminated bulb can be temporarily blinding.

The third factor – situational noise – is related to the interference of noise with activities of individuals. In a 60 dB(A) environment such as is commonly found in a large business office, normal conversation would be possible, while sleep might be difficult. Loud noises may easily interrupt activities that require a quiet setting for greater mental concentration or rest; however, the same loud noises may not interrupt activities requiring less mental focus or tranquility.

As shown in **Figure 2**, most individuals are exposed to fairly high noise levels from many sources on a regular basis. To perceive sounds of greatly varying pressure levels, human hearing has a non-linear sensitivity to sound pressure exposure. Doubling the sound pressure results in a three decibel change in the noise level; however, variations of three decibels [3 dB(A)] or less are commonly considered “barely perceptible” to normal human hearing. A five decibel [5 dB(A)] change is more readily noticeable. A ten-fold increase in the sound pressure level correlates to a 10 decibel [10 dB(A)] noise level increase; however, it is judged by most people as only sounding “twice as loud”.

Figure 2: Common Noise Levels



Over time, individuals tend to accept the noises that intrude into their lives on a regular basis. However, exposure to prolonged and/or extremely loud noise(s) can prevent use of exterior and interior spaces and has been theorized to pose health risks.

Local Regulations

The North Sun LLC. Solar Site is in Montgomery County, IL. Section F of the Montgomery County Ordinance for Solar Energy Farm and Solar Garden Installations in Unincorporated Montgomery County, Illinois states that "all solar farms shall be in compliance with all applicable local, state, and federal regulatory codes." Therefore, the Illinois Pollution Control Board (IPCB) noise level limits were used for this site.

The Illinois Pollution Control Board (IPCB) noise regulations are based on allowable octave band sound pressure levels during daytime and nighttime hours. According to Title 35 (Environmental Protection), Subtitle H (Noise), Chapter I (Pollution Control Board), Part 901 (Sound Emission Standards and Limitations for Property Line-Noise Sources), a facility operating in an agricultural field (Class C Land) cannot cause an exceedance of sound levels at any point within a residential land use (Class A Land) during daytime hours as shown in **Table 1**.

Table 1: Maximum Allowable Sound Emitted to Class A Land During Daytime Hours

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB) of Sound Emitted to any Receiving Class A Land from		
	Class C Land	Class B Land	Class A Land
31.5	**75**	72	72
63	**74**	71	71
125	**69**	65	65
250	**64**	57	57
500	**58**	51	51
1000	**52**	45	45
2000	**47**	39	39
4000	**43**	34	34
8000	**40**	32	32

The IPCB has also established the allowable octave band sound pressure levels for nighttime hours shown in **Table 2**. However, these values are not applicable to the North Sun LLC. Solar Site, as it will not be operational during nighttime hours. These values are included for reference purposes only.

Table 2: Maximum Allowable Sound Emitted to Class A Land During Nighttime Hours

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB) of Sound Emitted to any Receiving Class A Land from		
	Class C Land	Class B Land	Class A Land
31.5	**69**	63	63
63	**67**	61	61
125	**62**	55	55
250	**54**	47	47
500	**47**	40	40
1000	**41**	35	35
2000	**36**	30	30
4000	**32**	25	25
8000	**32**	25	25

Noise Analysis

Sound levels from the proposed North Sun LLC. Solar Site were evaluated using SoundPLAN. This program computes predicted sound levels at noise-sensitive areas through a series of adjustments to reference sound levels. SoundPLAN can also account for topography, groundcover type, and intervening structures. Sound levels generated from the inverter equipment is anticipated to be the main source of sound from the proposed solar photovoltaic project site.

It should be noted that noise from surrounding roadways was not modeled in this analysis, although North 21st Avenue (County Road 2100 N), Country Road 1000 E, North Road, N 22nd Avenue, and other rural roadways are anticipated to contribute to the ambient noise environment throughout the entire day.

Inverters

Photovoltaic (PV) inverter equipment generates steady, unvarying sound that can create issues when located near noise-sensitive areas. It was assumed that three (3) PV inverters would be located near the northern portion of the solar site. Based on typical noise emission levels for inverter equipment, a reference sound level of 79 dB(A) at 1 meter for the PV inverter was used. The sound from the operation of the PV inverter equipment was calculated at the closest noise-sensitive receptors surrounding the project area using SoundPLAN.

Sound generated by the inverters is not anticipated to significantly contribute to the existing environmental sound levels surrounding the site. Also, sound generated by the inverters is expected to be mitigated by providing sufficient offsets between the inverters and surrounding noise-sensitive land uses as well as by the physical presence of the solar arrays, which are anticipated to shield and disperse some of the sound generated by the inverter.

Results

The SoundPLAN-predicted maximum operational sound levels at the surrounding noise-sensitive land uses are anticipated to remain near or below approximately 41 dB(A).

The SoundPLAN-predicted maximum octave band noise levels at surrounding Class A property boundaries are not anticipated to exceed the allowable octave band sound levels established by IPCB. See **Table 3** below. The anticipated operational sound contours are shown in **Figure 3**. Since the predicted maximum octave band noise levels at surrounding noise-sensitive properties are not anticipated to exceed the limits established by IPCB, noise mitigation is not needed at this time.

Table 3: Predicted Maximum Sound Emissions at Class A Properties

Octave Band Center Frequency	31 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2kHz	4 kHz	8kHz
Maximum Octave Band SPLs from Inverters	1.3	19.3	31.1	24.5	25.5	34.3	37.2	34.8	11.6

Figure 3: Operational Sound Contours

Conclusions

The site is generally located north of N 21st Avenue (County Road 2100 N), east of Country Road 1000 E, west of North Road, and south of N 22nd Avenue. The solar site will be located on agricultural land with rural residential properties south and west of the project site.

After modeling and analyzing the anticipated operational sound levels throughout the proposed solar site, it was determined that noise mitigation measures are not needed at this time since the anticipated operational sound levels will remain below the IPCB allowable octave band sound pressure levels at the surrounding Class A land uses.