SITING BOARD 1-1:

Submit a copy of the lease or purchase agreements, including options, separate agreements, or deeds which Summer Shade has entered into in connection with the proposed solar facility, including the agreements for each of the parcels of the project.

Response: Please see attached leases which are being submitted with a Petition for Confidential Treatment. Due to file size, the leases are being submitted in separate files.

Witness: Aubree Muse

SITING BOARD 1-2:

Detail any contracts by which Summer Shade has paid, has negotiated to pay, or any compensation paid to non-participating landowners, whether cash or otherwise, near the project. Include the terms of the agreements and which properties are involved in terms of distance to the project boundaries.

Response: Please see the attached agreement, which is being filed with a Petition for Confidential Treatment. Confidential treatment is being sought for the entire agreement.

Witness: Aubree Muse

SITING BOARD 1-3:

Explain whether construction activities will occur sequentially or concurrently across the project site.

Response: Activities during the first half of construction will occur sequentially. The initial tasks are related to vegetation removal, civil works and initial setting of foundations and trackers. During the second half of construction, all the site will be an active construction site with activities happening in parallel. The main activities during the second half are the installation of modules, electrical connections (Medium and Low Voltage), and testing and commissioning. Tasks will be different in each area of the Project, but there will be activity happening across the entire project site during the second half. Refer to Exhibit "SSHKYSB_CAND27_BasicConstructionChart" in response to Item #27 for an overall perspective of main construction activities, duration, sequence and overlaps.

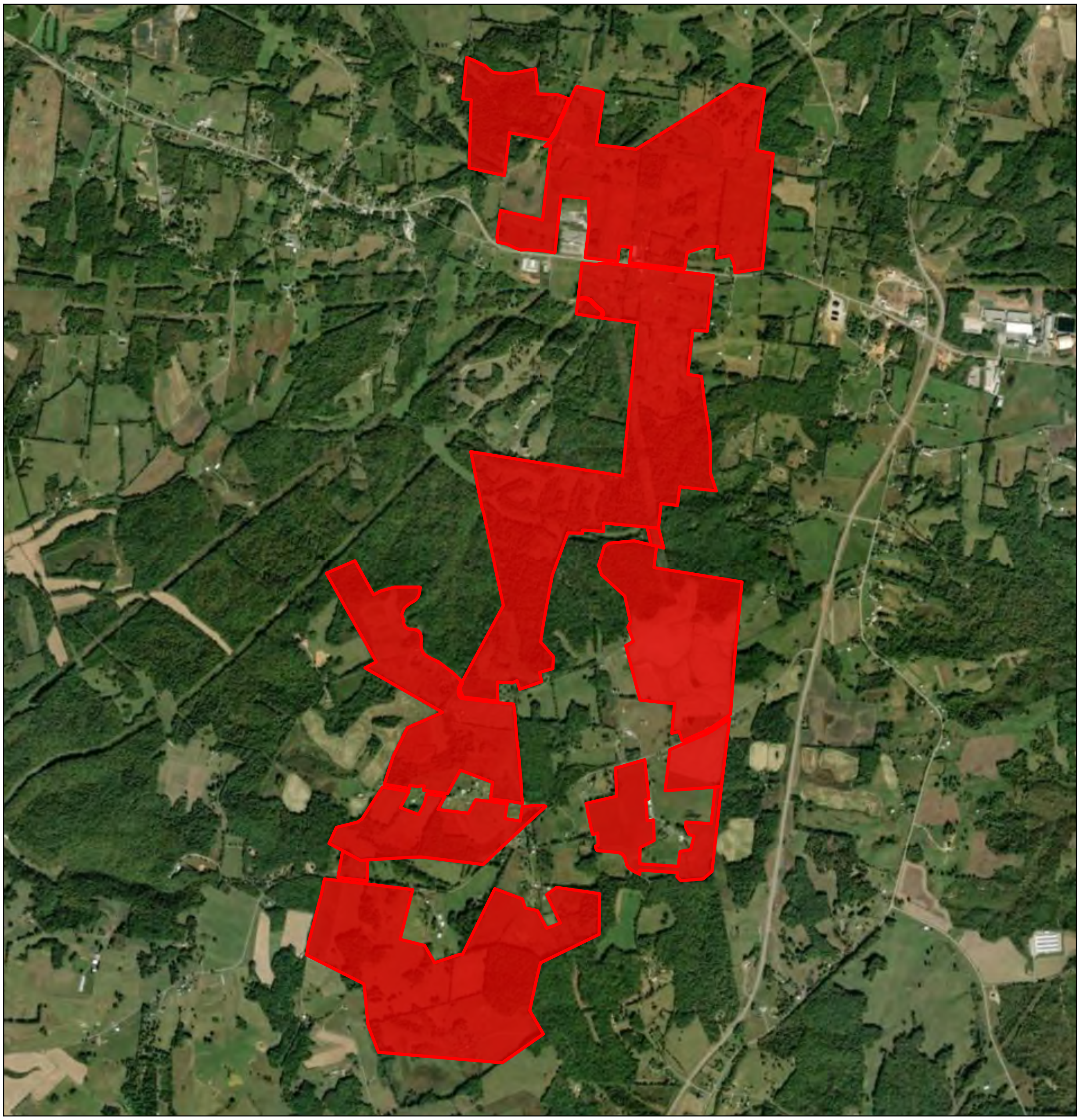
Witness: Alfonso Tovar

SITING BOARD 1-4:

Explain why Summer Shade has chosen a site with so many noncontiguous parcels.

Response: As demonstrated on the map attached below, the parcels under site control are contiguous, or connected via easements that are contained within the leased premises. The site’s topography and constraints contribute to the distributed layout of the PV panels. Summer Shade’s siting is consistent with a preference to develop projects with contiguous parcel ownership located near existing transmission infrastructure.

Witness: Aubree Muse



Legend
🟥 Project Boundary

0 1,500 3,000
Feet
(At original document size of 8.5x11)
1:35,766

N

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: ESRI World Imagery

Stantec

Project Location
Metcalfe County, Kentucky

Prepared by TCN on 2025-05-21

Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
RFI Responses

Figure No.
G

Title
Site Overview

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SITING BOARD 1-5:

Explain how a non-contiguous Project site can be developed and function as a single integrated Project.

Response: The Project site is comprised of contiguous parcels under site control via our option to lease agreements and related easement agreements. The site's topography and constraints have forced a distributed array design of the Project. All arrays are interconnected with medium voltage cables, making the Project function as a single, integrated power generation plant, collecting the power generated by all arrays at the Project's substation. The power collected at the Project's substation is then stepped up to transmission voltage and injected into the grid.

Witness: Aubree Muse

SITING BOARD 1-6:

Explain how power generated within the non-contiguous portions of the Project site will be delivered to the substation.

Response: Power will be delivered via medium voltage cables within easements. Cables will be installed underground or overhead.

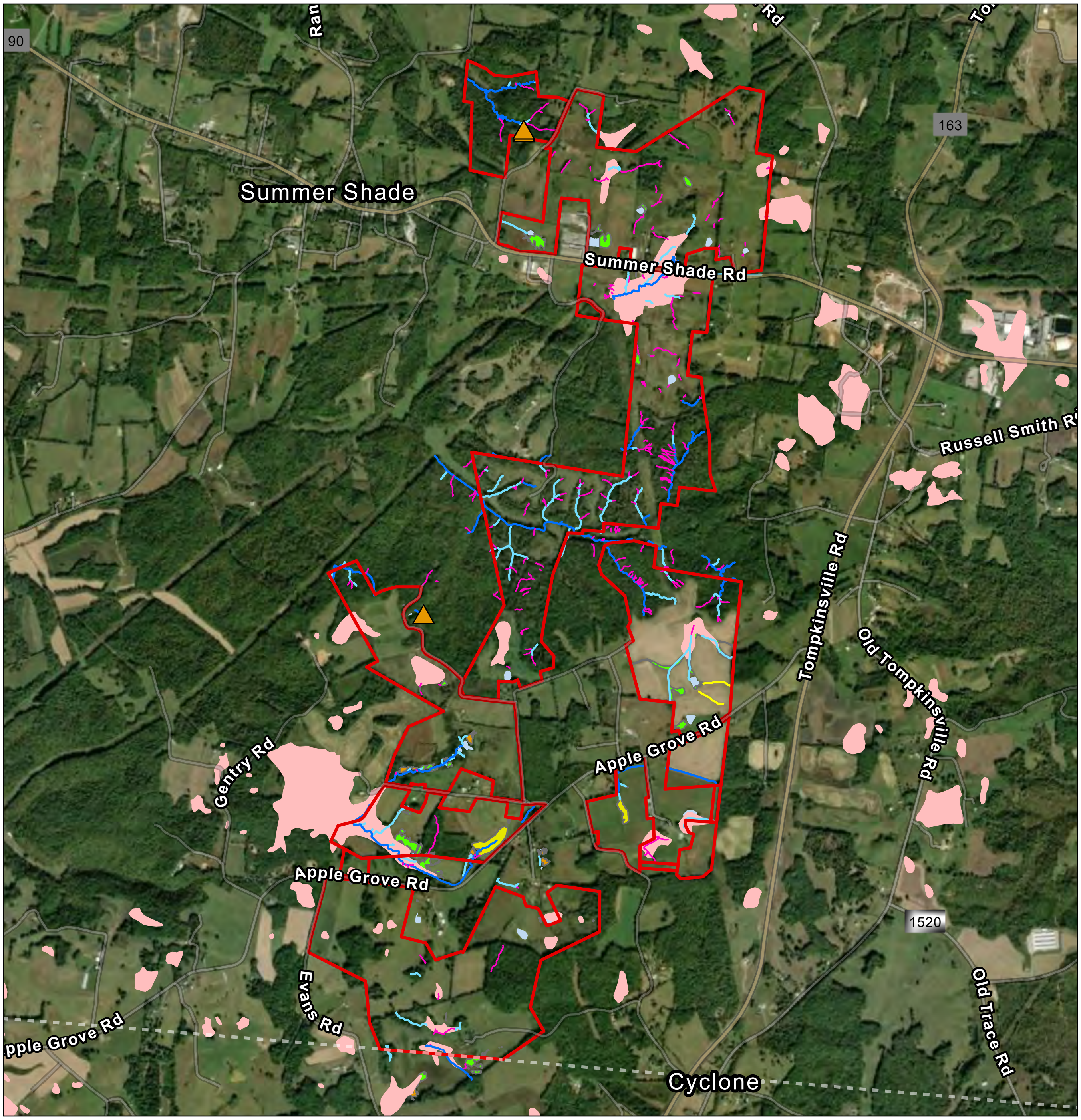
Witness: Alfonso Tovar

SITING BOARD 1-7:

Provide a one-page site map that contains the locations of water features, including rivers, streams, lakes, and ponds. Also include any known or suspected karst features.

Response: Please see attached map below.

Witness: Shane Kelley



Legend

- ▭ Project Boundary
- ∿ Ephemeral Stream
- ∿ Intermittent Stream
- ∿ Perennial Stream
- ∿ Upland Drainage Feature
- 🟩 PEM Wetland
- 🟧 PFO Wetland
- 🟨 PSS Wetland
- 🟦 Open Water
- ▨ Potential Sinkhole
- ▲ Cave

0 1,500 3,000
Feet
(At original document size of 8.5x11)
1:36,000

N

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC, KDOW
3. Background: ESRI World Imagery Hybrid

Stantec

Project Location
Metcalfe County, Kentucky

Prepared by TCN on 2025-05-21

Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
RFI Responses

Figure No.
A

Title
Water Features and Suspected Karst Features

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SITING BOARD 1-8:

List all churches or other religious facilities within a two-mile radius of the project. Provide the corresponding distances from the facility to the closest site boundary.

Response: The following churches were identified within a 2-mile buffer of the project boundary:

- Cyclone Church of Christ (3,326-ft from project boundary)
- Summer Shade Christian Church (2,689-ft from project boundary)
- Beaumont United Methodist Church (7,846-ft from project boundary)
- Summer Shade Missionary Baptist Church (2,015-ft from project boundary)
- Goodson Chapel Methodist Church (262-ft from project boundary)
- Corinth Church (6,201-ft from project boundary)
- Mount Moriah Church (7,578-ft from project boundary)
- Red Hill Church (8,022-ft from project boundary)

Witness: Shane Kelley

SITING BOARD 1-9:

Provide any communication with any churches or other religious facilities regarding the project. Describe any concerns that were raised.

Response: Email outreach was made to the Goodson Chapel Methodist Church located near Goodson Chapel Road and Apple Grove Road, but no response was received. The church was also sent public notice letters for the Project's Public Information Meeting as well as notice of the Project's application filing, but it was returned by the Postal Service as undeliverable and unable to be forwarded. According to the United Methodist Church Online Directory and Statistics website (https://www.umdata.org/church?church=380210) the Goodson Chapel Methodist Church closed in June of 2023.

Witness: Aubree Muse

SITING BOARD 1-10:

Provide any historic or archeologic studies that have been planned or completed for the project site.

Response: A cultural resources critical issues analysis was completed for the project. This included both desktop review and preliminary field surveys to assess the potential for cultural and historic resources on and around the project. It is provided below. A Phase I Cultural Resources/Historic Survey is planned for the project in support of a USACE Nationwide Permit.

Witness: Shane Kelley

Cultural Resources Critical Issues Analysis

for the Summer Shade Solar Facility within Metcalfe and Monroe Counties, Kentucky

172658275

17 April 2024

Prepared for:

Summer Shade Solar, LLC

Prepared by:

Ashley Burnette
Stantec, Inc.
10420 Bluegrass Parkway
Louisville, Kentucky 40299

This document entitled Cultural Resources Critical Issues Analysis for the Summer Shade Solar Facility within Metcalfe and Monroe Counties, Kentucky was prepared by Stantec Consulting Services Inc. ("Stantec") for the account of Summer Shade Solar, LLC (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not consider any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ______________________________
(signature)

Ashley Burnette

Reviewed by ______________________________
(signature)

Duane Simpson

Approved by Shane Kelley
(signature)

Shane Kelley

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INTRODUCTION

The Summer Shade Solar LLC (the “Client”) is proposing to develop the Summer Shade Solar Facility (the “Project”) within Metcalfe County and Monroe County, Kentucky (Figure 1). The Project includes approximately 1,625 acres of primarily upland and riparian forested areas and agricultural fields. Kentucky State Highway 90 (Summer Shade Road) runs west to east through the northern portion of the Project and Kentucky State Highway 163 (Tompkinsville Road) runs north to south to the east of the Project area. The Project is located between the towns of Summer Shade, which lies to the west of the Project, and Beaumont, which lies to the east, and is approximately 13 miles southeast of the city of Glasgow, Kentucky.

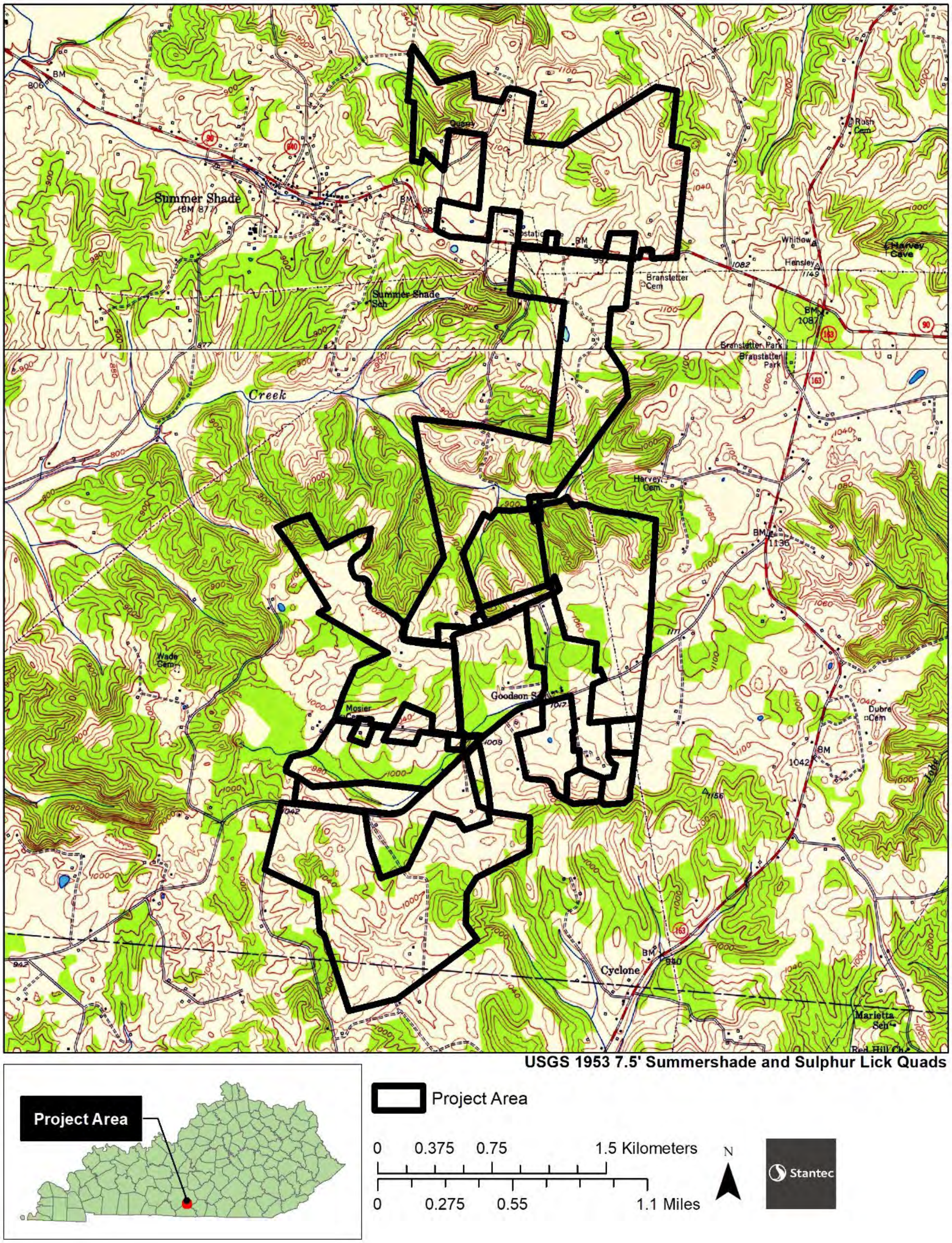
The Project is primarily contained within the Skaggs Creek watershed (HUC-10 0511000203), though a small portion in the northeast corner of the Project overlaps the Little Barren River watershed (HUC-10 0511000106). Additionally, the entire Project area lies within the Green River watershed (HUC-6 051100). The Project is drained by Nobob Creek, which flows east to west through the central portion of the Project. Glover Creek and its tributaries are also located near the Project, with one tributary directly adjacent to the northwesternmost parcel in the Project area.

This overview was conducted as due diligence effort focused on any archaeological or historic resources located within or in proximity to the Project area that might represent critical issues to the Project’s development. A search of records maintained by the National Register of Historic Places (NRHP), the Kentucky Office of State Archaeology (KyOSA), and the Kentucky Heritage Council (KHC) was conducted to identify any previously recorded cultural resources. Additional information was also reviewed to broaden the understanding of the region in which the Project is located, including historic and current topographic maps, historic aerials, cemetery information in databases such as Find-A-Grave.com, and the Kentucky Historical Societies Historical Marker Database.

It is unknown at this time what level of survey will be required for the Project or if this Project will become federally funded or require a federal permit. As such, any recommendations offered within this document are provided to the client as measures Stantec deems as prudent to ensure minimal impact to cultural resources identified within the region and should not be construed as required to be completed within the permitting and licensing process for the solar development. If this Project should become federally funded or require a federal permit, it would be considered an undertaking subject to Section 106 of the NHPA and require compliance with 36 CFR Part 800. The level and scope of survey efforts would then be dictated by the lead Federal Agency.

RESULTS

Stantec’s cultural resource specialists reviewed information regarding known archaeological and historic sites, as well as prior cultural resources studies, from the KHC and KyOSA (Figure 2). The National Historic Landmarks List, National Register of Historic Places (NRHP) and historic USGS topographic maps of the region were also consulted for evidence of historic use of the proposed Project area. No National Historic Landmarks or NRHP listed properties are located in the vicinity of the Project area.



USGS 1953 7.5' Summershade and Sulphur Lick Quads

Figure 1. Project location depicted on the 1953 Summershade and Sulphur Lick, quadrangles.

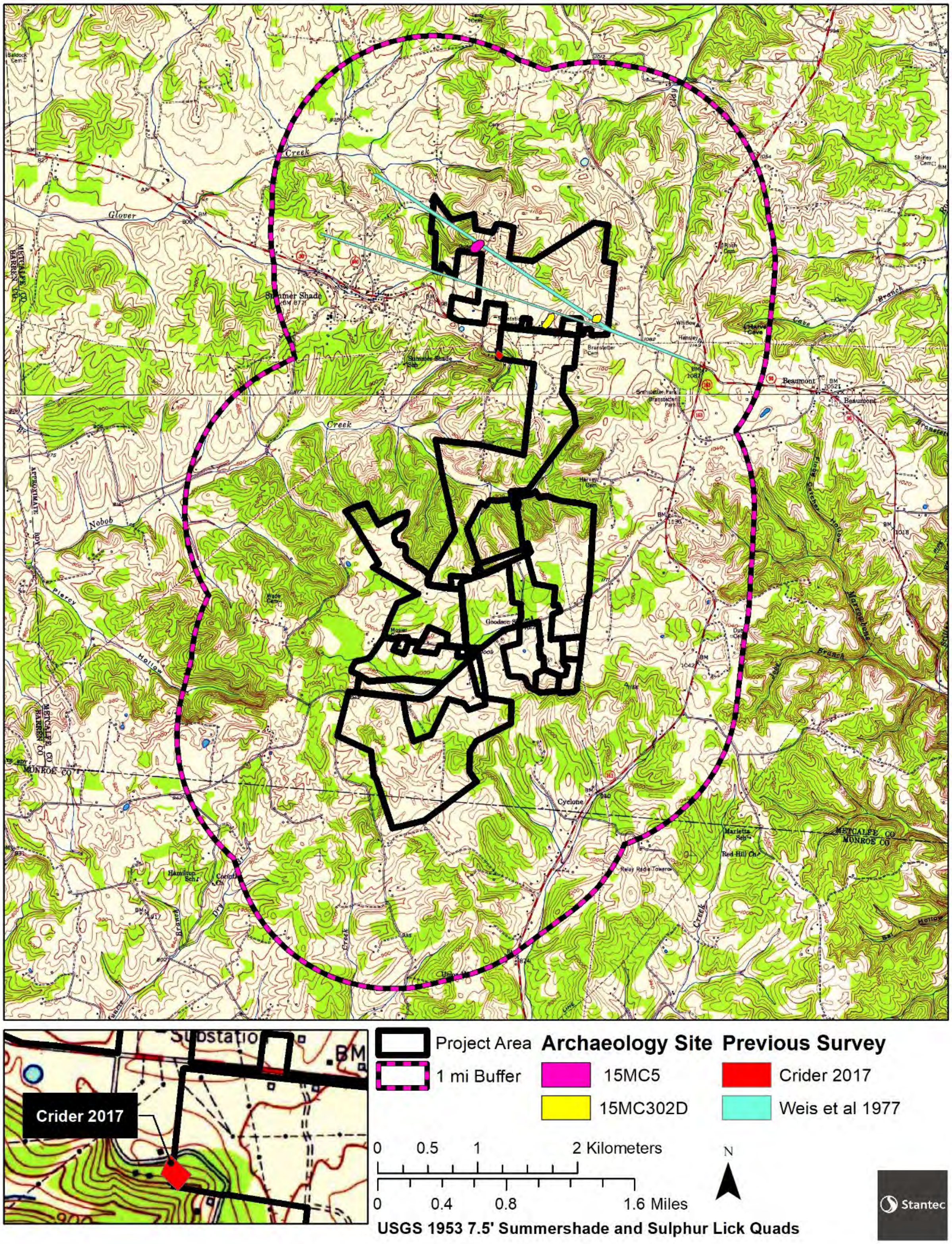


Figure 2. Previous Archaeological Sites and Surveys completed within the Project Area.

Information provided by the KyOSA GIS database indicates eight previous archaeological surveys have been conducted within 2-km of the Project area. Of these eight surveys only two intersect the current Project area: Weis et al. 1977 and Crider 2017 (Figure 2). In 1974 and 1977, Western Kentucky University conducted a series of surveys for five different alternatives of the proposed relocation of KY 90 (Weis et al. 1977). These surveys primarily used pedestrian reconnaissance and interviews with local informants as primary assessment methodologies and would not be consistent with current KHC survey standards. The second survey was completed by Environment & Archaeology for the replacement of pipeline valve on a small parcel of less than a tenth of an acre (Crider 2017). The survey area is extremely small, intersecting only a small portion of the proposed Project to the southeast of Summer Shade (Figure 2). This second survey was completed through shovel testing at intervals consistent with current KHC survey standards.

The KyOSA database indicated that at least two sites have been identified within the Project area. Site 15Mc302D was identified during the Weis et al. (1977) survey, but there is a discrepancy in its exact mapped location (Figure 2). Survey efforts in 1974 and 1977 indicate the potential that multiple sites were identified within fields to the east of Summer Shade, but only 15MC302D was recorded on KyOSA mapping. It is unclear if the site was incorrectly mapped or if the two mapped locations represent two different sites. The site represents a prehistoric lithic scatter of indeterminate age that was identified during pedestrian reconnaissance. The site's eligibility was not assessed at the time of its recordation. The second site is Shirley Cave (15Mc5) that was originally recorded by Webb and Funkhouser in 1932. The site was supposedly revisited in 1977 by Weis et al. but no survey form is available for the site within kyOSA records. Webb and Funkhouser's recordation of the cave would have been based on local informants rather than actual survey investigations, and as such little is known about the cave. It is recorded within KyOSA records as a prehistoric occupation of indeterminate age. Webb and Funkhouser noted an infant burial being reported at the cave by local informants. The identification of human remains within the cave would be consistent with general interment practices by Native Americans through specifics portions of the prehistoric past. Additional sites in proximity to a cave or rockshelter, such as Shirley Cave, are common and it would be possible that these occupations outside of the cave may also be highly sensitive. Given the potential for unmarked graves and the highly sensitive nature of the associated prehistoric deposits, Shirley Cave would be considered an issue to the development of the Project and should be avoided. The current mapped site boundary for 15Mc5 encompasses approximately 3.9 acres, an area that would likely be much larger than the actual cave or rockshelter. The site boundary as currently drawn should provide the necessary buffer from a development perspective to ensure that the site is avoided.

Information obtained from KHC's GIS database indicates that 144 above ground resources over 50 years in age are located within one mile of the proposed Project area (Figures 3 and 4; Table 1). These resources include 100 residential structures, 18 agricultures structures, 12 commercial structures, 2 churches, and 3 schools. The NRHP status of 142 of the resources is undetermined or in one case the structure has been demolished. Based on the lack of assessment it is not possible to determine if any of these resources may prove to be a critical issue to the development of the Project. Of the remaining resources, MC 403 and MC 438 are both considered eligible for the NRHP, but they have not been nominated (Figure 3). While these resources have not been officially nominated and listed on the NRHP, KHC will view these resources as sensitive and treat them in a similar manner as if they have been nominated. Both of these structures lie approximately 0.5 miles east of the Project area within the community of Summer Shade and may not be visible from the Project area.

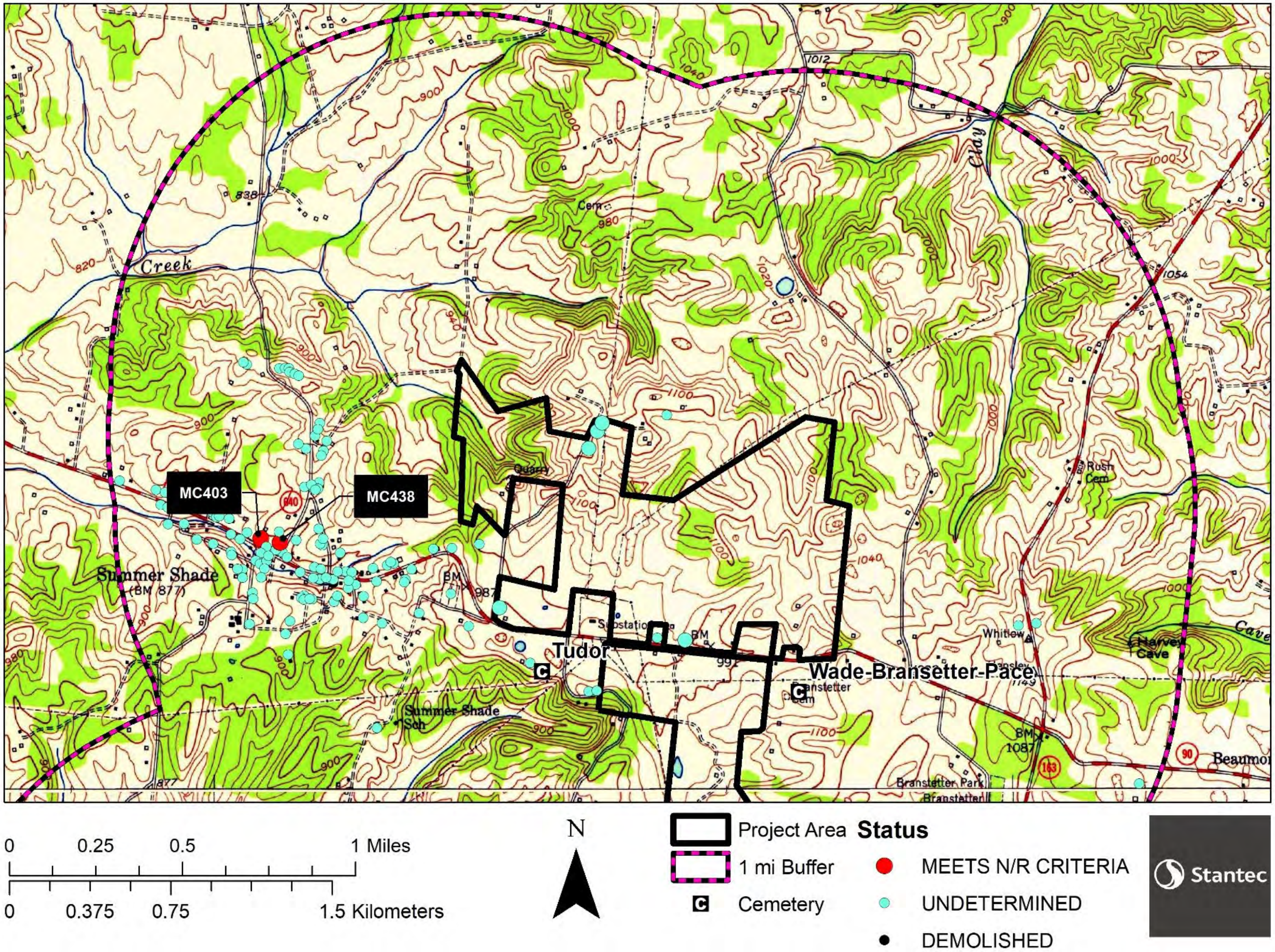


Figure 3. Historic Resources identified within 1 mile of the Project area, northern half.

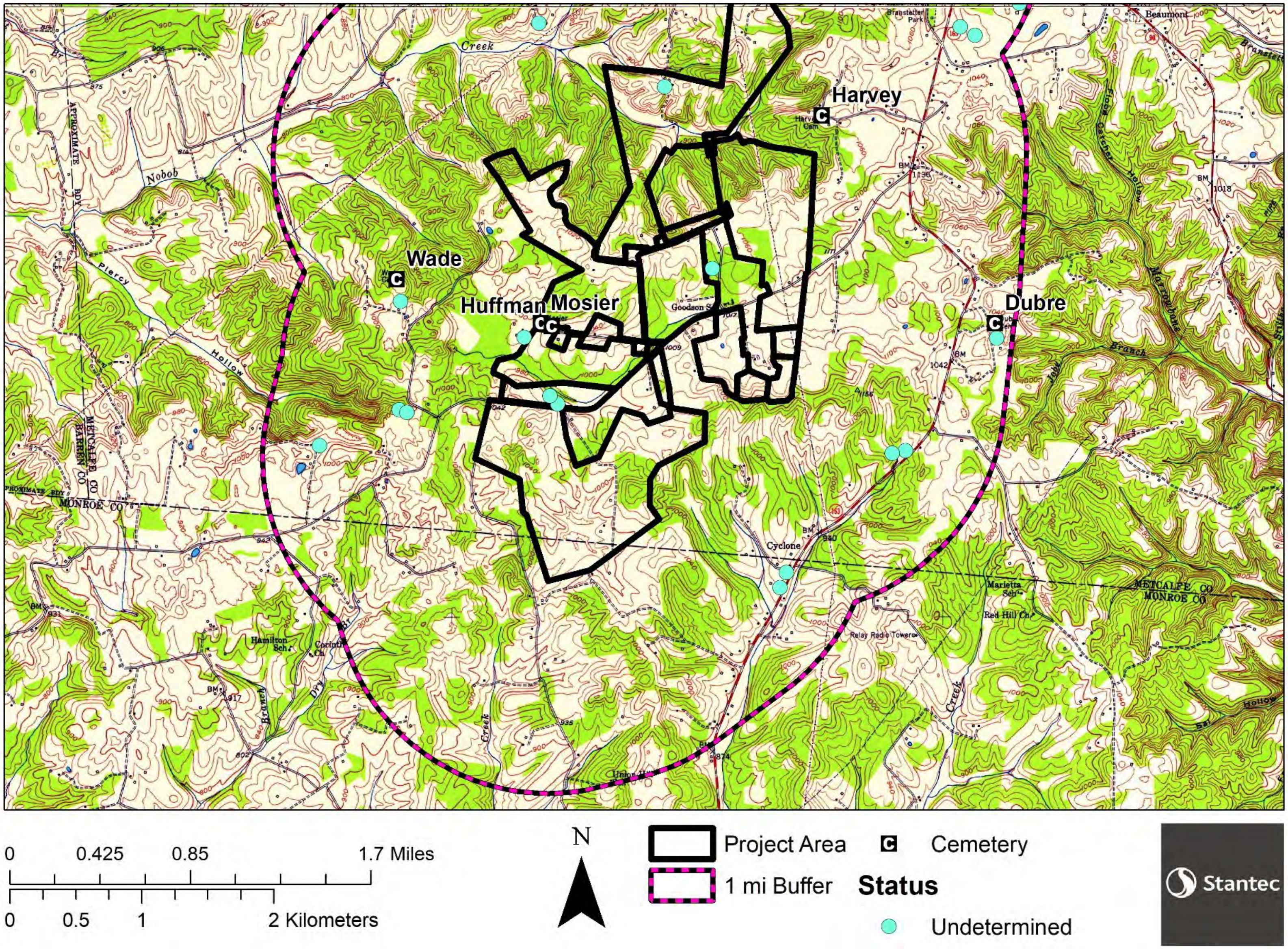


Figure 4. Historic Resources identified within 1 mile of the Project area, southern half.

Table 1. KHC surveyed resources.

Site No	Name	Date	Style	Function	Status	
MC 148	BARN	1850-1874	VERNACULAR-VICTORIAN	AGRICULTURAL BUILDINGS	UNDETERMINED	*
MC 149	HOUSE	1825-1849	VERNACULAR-ANTEBELLUM	SINGLE DWELLING	UNDETERMINED	*
MC 186	SHIRLEY/BUCHANAN HOME	1800-1824	VERNACULAR SETTLEMENT	SINGLE DWELLING	UNDETERMINED	*
MC 187	BARN	1900-1924	VERNACULAR-20TH CENT.	AGRICULTURAL BUILDINGS	UNDETERMINED	*
MC 188	BARN	1825-1849	VERNACULAR-ANTEBELLUM	AGRICULTURAL BUILDINGS	UNDETERMINED	*
MC 191	CRIB	1825-1849	VERNACULAR-ANTEBELLUM	AGRICULTURAL BUILDINGS	UNDETERMINED	*
MC 429	HOUSE	1950-1974	RANCH	SINGLE DWELLING	UNDETERMINED	*
MC 471	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	*
MC 20	MAYFIELD HOUSE (GEORGE R CLARK HOUSE)	1850-1874	VERNACULAR-VICTORIAN	SINGLE DWELLING	UNDETERMINED	*
MC 127	LOG BARN	1825-1849	VERNACULAR-ANTEBELLUM	AGRICULTURAL BUILDINGS	UNDETERMINED	
MC 128	LOG CRIB	1825-1849	VERNACULAR-ANTEBELLUM	AGRICULTURAL BUILDINGS	UNDETERMINED	
MC 139	HOUSE	1825-1849	VERNACULAR-ANTEBELLUM	SINGLE DWELLING	UNDETERMINED	
MC 140	EDDISON POST OFFICE	1900-1924	VERNACULAR-20TH CENT.	GOVERNMENT/PUBLIC - UNKNOWN	UNDETERMINED	
MC 141	HOUSE	1825-1849	VERNACULAR-ANTEBELLUM	SINGLE DWELLING	UNDETERMINED	
MC 142	HOUSE	1850-1874	VERNACULAR-VICTORIAN	SINGLE DWELLING	UNDETERMINED	
MC 143	BARN RUINS	1825-1849	VERNACULAR-ANTEBELLUM	AGRICULTURAL BUILDINGS	UNDETERMINED	
MC 144	HOUSE	1825-1849	VERNACULAR-ANTEBELLUM	SINGLE DWELLING	UNDETERMINED	
MC 145	HUGHES HOUSE	1825-1849	VERNACULAR-ANTEBELLUM	SINGLE DWELLING	UNDETERMINED	
MC 168	COMMERCIAL BLDG/POST OFFICE	1875-1899	COMMERCIAL-VICTORIAN	COMMERCIAL/PROFESSIONAL/OFFICE - UNKNOWN	UNDETERMINED	
MC 169	DR BOWMAN'S OFFICE	1900-1924	VERNACULAR-20TH CENT.	OTHER	UNDETERMINED	
MC 170	DR MEDFORD BOWMAN'S HOUSE	1875-1899	ECLECTIC	SINGLE DWELLING	UNDETERMINED	
MC 171	HERBERT KNOPP HOME	1875-1899	VERNACULAR-TOC	SINGLE DWELLING	UNDETERMINED	
MC 172	EZEKIEL WITTY HOUSE	1850-1874	GREEK REVIVAL	SINGLE DWELLING	UNDETERMINED	
MC 173	COMMERCIAL BLDG	1875-1899	COMMERCIAL-VICTORIAN	COMMERCIAL/PROFESSIONAL/OFFICE - UNKNOWN	UNDETERMINED	
MC 174	COMMERCIAL BLDG	1875-1899	COMMERCIAL-VICTORIAN	COMMERCIAL/PROFESSIONAL/OFFICE - UNKNOWN	UNDETERMINED	
MC 175	HOUSE	1900-1924	VERNACULAR-20TH CENT.	SINGLE DWELLING	UNDETERMINED	

MC 176	BARBER/TOOMEY HOUSE	1850-1874	GREEK REVIVAL	SINGLE DWELLING	UNDETERMINED	
MC 177	TOM RIGGS HOME	1850-1874	GREEK REVIVAL	SINGLE DWELLING	UNDETERMINED	
MC 178	HOUSE	1850-1874	GOTHIC REVIVAL	SINGLE DWELLING	UNDETERMINED	
MC 179	JOHN D SWOPE HOME	1875-1899	GOTHIC-VICTORIAN	SINGLE DWELLING	UNDETERMINED	
MC 180	HERMAN PERKINS HOUSE	1875-1899	ECLECTIC	SINGLE DWELLING	UNDETERMINED	
MC 181	SUMMER SHADE BLACK SCHOOL	1900-1924	VERNACULAR-20TH CENT.	SCHOOL	UNDETERMINED	
MC 182	HOUSE	1825-1849	VERNACULAR-ANTEBELLUM	SINGLE DWELLING	UNDETERMINED	
MC 183	HOUSE	1850-1874	VERNACULAR-VICTORIAN	SINGLE DWELLING	UNDETERMINED	
MC 184	HUFFMAN SCHOOL	1875-1899	VERNACULAR-TOC	SCHOOL	UNDETERMINED	
MC 185	CUL TAYLOR COBBLER SHOP	1875-1899	COMMERCIAL-VICTORIAN	COMMERCIAL/PROFESSIONAL/OFFICE - UNKNOWN	UNDETERMINED	
MC 189	BEN SHIRLEY HOME	1825-1849	GREEK REVIVAL	SINGLE DWELLING	UNDETERMINED	
MC 190	BARN - OLD TUDOR PLACE	1825-1849	VERNACULAR-ANTEBELLUM	AGRICULTURAL BUILDINGS	UNDETERMINED	
MC 403	HOUSE	1900-1924	VERNACULAR-TOC	SINGLE DWELLING	MEETS N/R CRITERIA	
MC 404	BARN	1925-1949		AGRICULTURAL BUILDINGS	UNDETERMINED	
MC 405	HOUSE	1950-1974	RANCH	SINGLE DWELLING	UNDETERMINED	
MC 411	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 412	HOUSE	1950-1974	OTHER	SINGLE DWELLING	UNDETERMINED	
MC 413	HOUSE	1950-1974	VERNACULAR-MODERN	SINGLE DWELLING	UNDETERMINED	
MC 414	HOUSE	1950-1974	CRAFTSMAN	SINGLE DWELLING	UNDETERMINED	
MC 414	GARAGE	1950-1974		GARAGE	UNDETERMINED	
MC 415	HOUSE	1900-1924	VERNACULAR-20TH CENT.	SINGLE DWELLING	UNDETERMINED	
MC 415	BARN	1900-1924		BARN, FUNCTION UNKNOWN	UNDETERMINED	
MC 416	HOUSE	1900-1924		SINGLE DWELLING	UNDETERMINED	
MC 417	HOUSE	1950-1974	RANCH	SINGLE DWELLING	UNDETERMINED	
MC 417	SHED	1950-1974		SHED	UNDETERMINED	
MC 418	HOUSE	1925-1949	CRAFTSMAN	SINGLE DWELLING	UNDETERMINED	
MC 418	BARN	1925-1949		BARN, FUNCTION UNKNOWN	UNDETERMINED	
MC 419	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 419	GARAGE	1925-1949		GARAGE	UNDETERMINED	
MC 419	SHED	1925-1949		SHED	UNDETERMINED	
MC 419	BARN	1925-1949		BARN, FUNCTION UNKNOWN	UNDETERMINED	
MC 419	BARN	1925-1949		BARN, FUNCTION UNKNOWN	UNDETERMINED	
MC 419	SHED	1925-1949		SHED	UNDETERMINED	

MC 420	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 420	SHED	1925-1949		SHED	UNDETERMINED	
MC 421	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 421	SHED	1925-1949		SHED	UNDETERMINED	
MC 421	SHED	1925-1949		SHED	UNDETERMINED	
MC 421	BARN	1950-1974		BARN, FUNCTION UNKNOWN	UNDETERMINED	
MC 422	HOUSE	1900-1924		MULTIPLE FAMILY DWELLING	UNDETERMINED	
MC 423	HOUSE	1925-1949	CRAFTSMAN	SINGLE DWELLING	UNDETERMINED	
MC 424	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 424	GARAGE	1925-1949		GARAGE	UNDETERMINED	
MC 425	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 425	SHED	1925-1949		SHED	UNDETERMINED	
MC 426	HOUSE	1875-1899		SINGLE DWELLING	UNDETERMINED	
MC 427	HOUSE	1950-1974	VERNACULAR-MODERN	SINGLE DWELLING	UNDETERMINED	
MC 427	SHED	1950-1974		SHED	UNDETERMINED	
MC 427	GARAGE	1975-2000		GARAGE	UNDETERMINED	
MC 428	HOUSE	1950-1974	RANCH	SINGLE DWELLING	UNDETERMINED	
MC 430	HOUSE	1950-1974	RANCH	SINGLE DWELLING	UNDETERMINED	
MC 431	HOUSE	1950-1974	VERNACULAR-MODERN	SINGLE DWELLING	UNDETERMINED	
MC 432	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 433	HOUSE	1900-1924		SINGLE DWELLING	UNDETERMINED	
MC 433	SHED	1950-1974		SHED	UNDETERMINED	
MC 433	GARAGE	1975-2000		GARAGE	UNDETERMINED	
MC 434	HOUSE	1900-1924	QUEEN ANNE	SINGLE DWELLING	UNDETERMINED	
MC 434	SHED	1900-1924		SHED	UNDETERMINED	
MC 435	HOUSE	1925-1949	VERNACULAR-20TH CENT.	SINGLE DWELLING	UNDETERMINED	
MC 436	SUMMER SHADE BAPTIST CHURCH (CHRISTIAN CHURCH)	1950-1974		CHURCH/RELIGIOUS BUILDING	UNDETERMINED	
MC 437	COMMERCIAL BUILDING	1950-1974		COMMERCIAL/PROFESSIONAL/OFFICE - UNKNOWN	UNDETERMINED	
MC 438	HOUSE	1950-1974	TUDOR REVIVAL	SINGLE DWELLING	MEETS N/R CRITERIA	
MC 439	HOUSE	1925-1949	CRAFTSMAN	SINGLE DWELLING	UNDETERMINED	
MC 440	HOUSE	1900-1924		SINGLE DWELLING	UNDETERMINED	
MC 440	SHED	1900-1924		SHED	UNDETERMINED	
MC 440	GARAGE	1925-1949		GARAGE	UNDETERMINED	

MC 441	HOUSE	1900-1924		SINGLE DWELLING	UNDETERMINED	
MC 442	HOUSE	1950-1974	TUDOR REVIVAL	SINGLE DWELLING	UNDETERMINED	
MC 443	HOUSE	1950-1974	RANCH	SINGLE DWELLING	UNDETERMINED	
MC 444	HOUSE	1925-1949		COMMERCIAL/PROFESSIONAL/OFFICE - UNKNOWN	UNDETERMINED	
MC 445	HOUSE	1950-1974	RANCH	SINGLE DWELLING	UNDETERMINED	
MC 446	HOUSE	1925-1949	VERNACULAR-TOC	SINGLE DWELLING	UNDETERMINED	
MC 447	COMMERCIAL BUILDING	1950-1974	OTHER VICTORIAN	COMMERCIAL/PROFESSIONAL/OFFICE - UNKNOWN	UNDETERMINED	
MC 448	MCMURTREY FUNERAL HOME	1925-1949	VERNACULAR-MODERN	MULTIPLE FAMILY DWELLING	UNDETERMINED	
MC 449	HOUSE	1900-1924	QUEEN ANNE	SINGLE DWELLING	UNDETERMINED	
MC 450	PITTSBURGH PAINTS	1925-1949	COMMERCIAL-MODERN	SPECIALTY STORE/SHOP	UNDETERMINED	
MC 451	HOUSE		RANCH	SINGLE DWELLING	UNDETERMINED	
MC 451	BARN	1950-1974		BARN, FUNCTION UNKNOWN	UNDETERMINED	
MC 452	BARN	1925-1949	CRAFTSMAN	SINGLE DWELLING	UNDETERMINED	
MC 453	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 454	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 455	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 456	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 457	HOUSE	1950-1974	RANCH	SINGLE DWELLING	UNDETERMINED	
MC 458	HOUSE	1950-1974		SINGLE DWELLING	UNDETERMINED	
MC 459	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 459	SHED	1925-1949		SHED	UNDETERMINED	
MC 460	HOUSE	1950-1974	RANCH	SINGLE DWELLING	UNDETERMINED	
MC 460	SHED	1925-1949		SHED	UNDETERMINED	
MC 461	HOUSE	1950-1974	RANCH	SINGLE DWELLING	UNDETERMINED	
MC 462	HOUSE	1925-1949		SINGLE DWELLING	UNDETERMINED	
MC 463	HOUSE	1925-1949	CRAFTSMAN	SINGLE DWELLING	UNDETERMINED	
MC 464	HOUSE	1925-1949	CRAFTSMAN	SINGLE DWELLING	UNDETERMINED	
MC 464	GARAGE	1975-2000		GARAGE	UNDETERMINED	
MC 464	BARN	1925-1949		BARN, FUNCTION UNKNOWN	UNDETERMINED	
MC 465	HOUSE	1900-1924		SINGLE DWELLING	UNDETERMINED	
MC 466	HOUSE	1950-1974	VERNACULAR-MODERN	SINGLE DWELLING	UNDETERMINED	
MC 466	GARAGE	1950-1974		GARAGE	UNDETERMINED	
MC 467	SUMMER SHADE FLOWER SHOP	1900-1924	COMMERCIAL-MODERN	SINGLE DWELLING	UNDETERMINED	

MC 468	SUMMER SHADE MISSIONARY BAPTIST CHURCH	1925-1949	VERNACULAR-MODERN	CHURCH/RELIGIOUS BUILDING	UNDETERMINED	
MC 469	COMMERCIAL BUILDING	1925-1949	COMMERCIAL-2OTH CENT.	COMMERCIAL/PROFESSIONAL/OFFICE - UNKNOWN	UNDETERMINED	
MC 470	COMMERCIAL BUILDING	1925-1949	VERNACULAR-20TH CENT.	SPECIALTY STORE/SHOP	UNDETERMINED	
MC 472	SUMMER SHADE CEMETERY	1875-1899		GRAVES/BURIALS- UNMARKED	UNDETERMINED	
MC 473	HOUSE	1925-1949	CRAFTSMAN	SINGLE DWELLING	UNDETERMINED	
MC 474	HOUSE	1900-1924		SINGLE DWELLING	UNDETERMINED	
MC 475	HOUSE	1900-1924		SINGLE DWELLING	UNDETERMINED	
MC 475	SHED	1925-1949		SHED	UNDETERMINED	
MC 475	SHED	1925-1949		SHED	UNDETERMINED	
MC 475	SHED	1925-1949		SHED	UNDETERMINED	
MC 475	SHED	1925-1949		SHED	UNDETERMINED	
MC 475	BARN	1925-1949		BARN, FUNCTION UNKNOWN	UNDETERMINED	
MC 493	HOUSE	1925-1949	VERNACULAR-20TH CENT.	SINGLE DWELLING	UNDETERMINED	
MC 493	TOBACCO BARN			TOBACCO BARN, AIR-CURED	UNDETERMINED	
MC 494	HOUSE	1925-1949	CRAFTSMAN	SINGLE DWELLING	UNDETERMINED	
MC 494	TOBACCO BARN			TOBACCO BARN, AIR-CURED	UNDETERMINED	
MC 495	HOUSE	1925-1949	VERNACULAR-20TH CENT.	SINGLE DWELLING	UNDETERMINED	
MR 173	CHURCH OF CHRIST CYCLONE	1925-1949	VERNACULAR-MODERN	RELIGIOUS - UNKNOWN	UNDETERMINED	
MR 174	ZELLA PLACE	1900-1924	VERNACULAR-20TH CENT.	SINGLE DWELLING	UNDETERMINED	

Of the 141 surveyed structures, 8 are located within the Project area, these structures are denoted with an asterisk in the Table 1. These resource, MC 148, MC 149, MC 186, MC 187, MC 188, MC 191, MC 429, MC 471, have not been assessed for eligibility and it is unclear if they would represent an issue for the proposed solar development. Avoidance of these resource is recommended. The remaining 136 resources are located outside of the Project area (Figures 3 and 4). Some are located well away from the Project area boundary and do not pose issues for the proposed solar development. 12 resources, including MC 189, MC 190, MC 461, MC 462, MC 404, MC 472, MC 463, MC 459, MC 428, MC 460, MC 140, MC 141 are all located just outside of the Project area boundary (Figures 3 and 4; Table 1). Additional architectural review of these resources is recommended to assess their NRHP eligibility. Moreover, given the number of unsurveyed structures identified during the review of historic maps, any additional architectural review should include any extant structures within the Project area.

Finally, cemetery records indicate that six historic cemeteries are located within one mile of the Project area (Figures 3 and 4). Dubre, Harvey, Wade-Bransetter-Pace, and Wade Cemetery are located outside of the Project area and should not be affected by the proposed solar development. Mosier and Huffman Cemetery are in the southeastern portion of the Project area (Figure 4). These resources do pose an issue for the proposed solar development. While most counties in the state of Kentucky do not maintain a prescribed buffer for development around cemeteries, Metcalf and Monroe Counties being examples of one of these, Stantec recommends the establishment of at least a 50-foot avoidance buffer around these cemeteries to minimize any affect by the proposed solar development.

To assess the potential for historic archaeological sites in the area historic maps were reviewed to identify structures that may no longer be extant but may retain an archaeological signature. On the 1953 Summer Shade and Sulphur Lick 15’ quadrangles, 48 structures are mapped within the Project area. By 2013, 4 of these structures are no longer mapped and could have archaeological signatures. A review of the Historical Society marker database did not find any placed within or adjacent to the Project area.

SUMMARY

A review of data from the KyOSA indicates that two archaeological surveys have been undertaken in the area identifying 2 or 3 archaeological sites within the Project area. Two of the sites have not been assessed and the spatial accuracy remains in question, but Shirley Cave, site 15Mc5 represents a sensitive resource that should be avoided during the development of the Project. The mapped boundary of this site would appear much larger than the actual cave location and should be sufficient to provide a buffer for the protection of the site. If the client desires a more refined boundary to encapsulate the site, a field visit would be required to update current mapping for the site. The structural database maintained by the KHC indicates that 144 surveyed above ground resources of 50 years of age or older are located within one mile of the Project area. Twenty of these structures are located within or directly adjacent to the Project area and should be avoided or assessed to determine their historical significance. Two of the 144 structures (MC 403 and MC 438) have been determined to be eligible for the NRHP but have not been nominated or listed. Both structures lie approximately 0.5 mile east of the Project area within the community of Summer Shade and may not be visible from the Project area. Finally, six historic cemeteries are mapped within one mile of the Project area. Mosier and Huffman Cemetery, both located on Clifton Smith Rd, are located within the Project area. Stantec recommends the establishment of at least a 50-foot avoidance buffer around these cemeteries to minimize any affect by the proposed solar development.

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REFERENCES

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1953 *Summer Shade, KY topographic quadrangle map*. 7.5’ 1:24000. United States geological Survey, Washington, D.C.

1953 *Sulphur Lick KY, topographic quadrangle map.* 7.5’ 1:24000. United States geological Survey, Washington, D.C.

2013 *Summer Shade, KY topographic quadrangle map.* 7.5’ 1:24000. United States geological Survey, Washington, D.C., USA Topo version.

2013 *Sulphur Lick, KY topographic quadrangle map.* 7.5’ 1:24000. United States geological Survey, Washington, D.C., USA Topo version.

Webb, William S., and William D. Funkhouser
1932 Archaeological Survey of Kentucky. Reports in Archaeology and Anthropology Vol. II. Department of Anthropology and Archaeology, University of Kentucky, Lexington. pp. 290-292.

Weis, Terry L, Gary Cole, and Jack M. Schock
1977 An Archaeological Survey of the Proposed Relocation of Kentucky 90, Barren and Metcalfe Counties, Kentucky. Western Kentucky University, Bowling Green, Kentucky. Manuscript on file, Office of State Archaeology, University of Kentucky, Lexington.

SITING BOARD 1-11:

Provide any communication that has occurred with any schools within a two-mile radius of the project. Describe any concerns that were raised.

Response: No schools were identified within a 2-mile radius of the project.

Witness: Aubree Muse

SITING BOARD 1-12:

Provide a narrative description of the location of each of the following site features:

a. Each construction entrance.

b. Each entrance to be used in operations.

c. Operating & Maintenance area.

d. Meteorological station.

Response:

A. Please refer to Updated Preliminary Site Layout in response to Item #39 for the location of each construction entrance.

B. The entrances listed above are expected to be used to access the site during operations as necessary.

C. The O&M area is anticipated to be near the Project substation and BESS area, with entrance to this area from Highway 90.

D. There will be approximately 4 to 6 meteorological stations distributed across the site. Meteorological stations will be attached at power conversion stations, with sensors on the roof or at the tracker level.

Witness: Alfonso Tovar

SITING BOARD 1-13:

Provide what time of day construction, operation and maintenance activities will begin and end each day.

Response: Generally, construction activities will take place during daylight hours. Summer Shade Solar will limit construction activity, process, and deliveries, including field visits, arrival, departure, planning, meetings, surveying, etc to the hours between 6 a.m. and 10 p.m. local time, Monday through Saturday. Select non-noise causing activity and non-construction work may be required during night hours when equipment is not energized. Construction activities that create a higher level of noise, such as pile-driving, will be limited to 7 a.m. to 9 p.m. local time, Monday through Saturday. Expected routine operation and maintenance activities will be 9:00 to 5:00 pm, Monday through Friday.

Witness: Alfonso Tovar

SITING BOARD 1-14:

Provide a narrative description of the location of each laydown area to be used during construction.

Response: The laydown areas will be temporary areas set apart to store equipment and material. These areas will be chosen close to the site-access locations and naturally flat to avoid or minimize grading. Please refer to map submitted as part of Response #39 below for anticipated laydown area locations.

Witness: Alfonso Tovar

SITING BOARD 1-15:

Provide the security measures for the operations and maintenance (O&M) area and substation.

Response: The O&M area and substation will have security camera monitoring. The substation will be surrounded by fencing built to the applicable required standards. All project gates will be closed and locked when not in use; emergency services and project employees will have access to all entrances.

Witness: Alfonso Tovar

SITING BOARD 1-16:

Explain how Summer Shade will coordinate with local enforcement and fire services regarding security and emergency protocols during construction and operations.

Response: Summer Shade and its contractors will coordinate with local law enforcement and fire services prior to and during construction and operations to ensure all stakeholders are well-informed and aligned regarding security and emergency management protocols. Coordination via pre-construction meetings and open communication channels should ensure protocols are well-understood and complied with. Additionally, per proposed Mitigation Measure #5 in the Site Assessment Report, prior to construction, Summer Shade Solar shall provide a finalized Emergency Response Plan to the local fire district, first responders, and any County Emergency Management Agency. Summer Shade Solar shall provide site-specific training for local emergency responders at their request. Access for fire and emergency units shall be set up after consultation with local authorities.

Witness: Aubree Muse

SITING BOARD 1-17:

Provide any communication with local emergency services on security and emergency protocols during construction and operations. If contact has not been made, explain when that contact will occur.

Response: Summer Shade has held a preliminary meeting with the Metcalfe County Emergency Management Director to introduce the Project and gather feedback that may better inform how to coordinate security and emergency protocols during construction and operations. Summer Shade has also hosted a training session with the Metcalfe County volunteer fire department on solar and BESS fire safety, utilizing the expertise of professional fire safety and emergency response consultants. Summer Shade will continue to coordinate with emergency services prior to construction and operations.

Witness: Aubree Muse

SITING BOARD 1-18:

Provide a detailed table listing all residential structures located within 2,000 square feet of the Project boundary line. The table must state the distance measurement in feet (not meters) for each structure, listed below:

a. The distance to the boundary line.

b. The distance to the closest solar panel.

c. The distance to the nearest inverter.

d. The distance to the substation

Response: The requested distances to each residential structure within 2,000 feet of the project boundary line are provided in the table below.

Witness: Shane Kelley

Name	Closest Distance to Array (ft)	Closest Distance to Boundary (ft)	Clostest Distance to Inverter (ft)	Closest Distance to Substation (ft)
1	1486	1422	2673	17989
2	474	405	3061	15902
3	1054	973	2658	14408
4	1155	1075	2666	14021
5	1415	1334	2097	14118
6	277	182	1364	13402
7	193	100	1218	11537
8	185	30	791	11427
9	327	79	572	11506
10	333	198	548	11366
11	320	119	338	11519
12	362	195	584	11264
13	328	88	860	11286
14	229	119	1103	11542
15	521	165	1040	12107
16	475	153	996	12179
17	460	152	2138	12265
18	1769	1650	2290	17182
19	1644	1379	2484	15670
20	1709	1572	2561	15611
21	1442	1053	626	14590
22	285	129	1035	12134
23	424	315	2689	11094
24	964	904	1209	11849
25	358	97	1221	10376
26	390	268	1863	10329
27	1334	1249	1856	9841
28	1252	1192	2908	9592
29	1990	1871	1916	9198
30	798	587	3242	8424
31	2079	1502	3518	7478
32	2421	1637	2275	7346
33	1845	772	2645	6605
34	1729	1098	2875	6423
35	1949	1305	2311	6613
36	1357	989	1907	5964
37	946	655	1356	5553
38	329	216	3786	3821
39	2095	2005	3713	6038
40	2038	1951	3648	6007
41	1995	1911	3126	5989
42	1401	1307	720	5326
43	1407	1326	3031	5423
44	1566	1513	2944	5610
45	1465	1411	2663	5509
46	1125	1069	1814	5173
47	411	171	1678	3588
48	182	66	1192	3323
49	246	71	1913	2956
50	827	635	2261	4834
51	1188	922	1318	5168
52	1596	1284	1989	5547
53	797	611	2839	4808
54	1554	1359	3314	5677
55	1848	1692	3244	6122
56	1964	1904	2929	5865
57	1849	1779	3829	5366
58	2824	2146	2522	5101
59	1874	1665	2310	3818
60	1784	1732	2626	3431
61	2236	1868	1395	3083

62	2294	1902	2247	2985
63	1854	1493	2036	2801
64	1649	1278	1959	2598
65	1602	1197	1689	2316
66	1311	930	1066	2300
67	759	388	2865	1525
68	2540	1745	2107	2767
69	1802	452	2283	1501
70	1981	460	2449	1508
71	2150	581	1649	1592
72	1802	212	1640	1260
73	1445	131	1557	1650
74	942	101	1425	1507
75	1104	971	1228	10341
76	935	761	1680	9969
77	1133	1068	1486	9560
78	306	117	1657	10607
79	222	135	1512	10471
80	227	75	662	10442
81	483	427	1254	9978
82	603	529	909	9673
83	447	393	1516	9304
84	927	65	1451	8977
85	310	204	1964	13469
86	1661	1540	844	13617
87	454	324	3357	13468
88	2612	2011	3114	7999
89	2187	2043	3257	9231
90	2362	2237	3565	9399
91	2613	2414	3601	9278
92	2596	2336	3970	9034
93	2949	2655	4147	9040
94	3094	2754	4503	8874
95	3442	3083	4547	8902
96	3451	3045	4764	8607
97	3727	3391	4420	9164
98	2745	2656	4289	6682
99	2626	2539	4190	6585
100	2520	2430	4086	6444
101	2414	2327	4059	6371
102	2415	2323	3940	6323
103	2267	2175	3878	6180
104	2186	2094	3910	6103
105	2257	2173	3797	6242
106	2140	2056	4193	6126
107	2558	2475	16335	6548
108	831	637	1587	4145
109	201	67	998	9450
110	415	75	925	9232
111	413	124	945	12384
112	445	150	919	12544
113	264	81	603	11576
114	225	70	2718	3522
115	1306	1202	3249	4968
116	1844	1742	1476	5582
117	900	845	1691	10097
118	188	95	1040	10692
119	605	504	709	12040

SITING BOARD 1-19:

Provide a detailed table listing all non-residential structures located within 2,000 feet of the Project boundary line. For each structure, provide:

a. The distance to the boundary line.

b. The distance to the closest solar panel.

c. The distance to the nearest inverter.

d. The distance to the substation.

Response: The requested distances to each residential structure within 2,000 feet of the project boundary line are provided in the table below.

Witness: Shane Kelley

ID	Closest Distance to Boundary (ft)	Closest Distance to Array (ft)	Clostest Distance to Inverter (ft)	Closest Distance to Substation (ft)
1	1196	1207	1517	16453
2	1085	1093	1535	16268
3	1019	1046	1366	13867
4	1481	1508	1795	14219
5	992	1018	1318	13963
6	701	728	1061	13810
7	131	174	1020	11664
8	24	64	735	11390
9	284	348	1628	11838
10	523	564	1569	11573
11	174	222	1449	11728
12	85	173	1147	11465
13	495	508	1236	11007
14	931	1003	1382	10322
15	795	914	1263	10037
16	968	980	1613	9466
17	1074	1087	1629	9611
18	933	949	1298	14475
19	816	824	1321	15984
20	525	533	1038	15719
21	788	800	1443	17131
22	1720	1735	2559	18298
23	1671	1686	2510	18249
24	1750	1761	2587	18336
25	1800	1812	2637	18384
26	1800	1814	2638	18382
27	1382	1421	2276	17929
28	1576	1651	2096	17083
29	1286	1321	1732	16985
30	1218	1243	1644	16961
31	1193	1216	1617	16946
32	1383	1621	2284	15794
33	1641	1682	2552	15606
34	1389	1665	2948	14968
35	1850	2012	3560	14983
36	157	290	1189	12293
37	304	381	959	12137
38	39	78	639	11848
39	69	77	701	11697
40	62	71	782	11540
41	131	140	1083	11247
42	97	105	1082	11215
43	209	266	1599	10707
44	164	318	1528	10559
45	79	229	1418	10653
46	569	718	1632	10169
47	602	747	1644	10149
48	262	270	1202	9822
49	579	590	1322	9731
50	413	421	1355	9975
51	465	475	963	9311
52	481	492	945	9262
53	561	571	852	8784
54	32	42	323	8641
55	146	909	1591	8970
56	153	184	800	9374
57	65	97	714	9462
58	74	106	732	9453
59	116	192	516	11611
60	227	304	578	11307
61	260	335	562	11312
62	240	338	575	11279
63	118	168	717	11131

64	465	736	1350	12355
65	420	708	1338	12270
66	230	491	1089	12274
67	630	701	1349	12652
68	583	642	1287	12690
69	554	613	1259	12718
70	329	392	1079	13011
71	290	422	1122	13013
72	235	462	1167	13017
73	71	326	1275	13074
74	58	301	1107	13252
75	1110	1475	2544	14564
76	790	801	2645	11819
77	763	771	2427	11588
78	471	480	1127	9962
79	1165	1173	1821	9601
80	459	510	1681	8513
81	1917	1999	3002	9153
82	2153	2246	3241	9257
83	1250	1787	3019	7294
84	1539	2015	3266	7552
85	1684	2480	3502	7289
86	834	1839	2715	6632
87	760	1853	2697	6641
88	943	1643	2594	6433
89	605	1768	2681	6691
90	597	1669	2700	6726
91	544	1713	2639	6662
92	529	1655	2637	6670
93	1309	1830	2849	6577
94	1710	2014	3087	6659
95	1853	2075	3166	6640
96	1908	2126	3219	6680
97	989	1246	2311	5963
98	987	1178	2263	5861
99	1002	1167	2259	5828
100	1039	1192	2288	5836
101	1065	1215	2312	5850
102	654	785	1877	5490
103	431	700	1730	5486
104	490	592	1430	4138
105	969	1023	2005	4642
106	1977	2013	3716	6050
107	1403	1439	3155	5488
108	1601	1635	3333	5690
109	1369	1406	3126	5453
110	1531	1540	3036	5625
111	1420	1428	2912	5509
112	1106	1114	2539	5179
113	1201	1209	2616	5272
114	977	985	2456	5055
115	1030	1040	2615	5130
116	993	1002	2535	5083
117	1040	1051	2289	5218
118	909	930	2210	5128
119	556	575	1868	4777
120	1317	1374	2681	5578
121	1428	1503	2816	5691
122	1476	1576	2915	5733
123	804	840	2175	4965
124	779	798	2133	4927
125	1412	1431	2618	5159
126	1738	1757	2894	5342
127	1679	1698	2850	5322
128	1789	1809	2856	5209
129	1783	1804	2779	5069

130	328	1235	1865	2584
131	564	1451	1830	2806
132	159	700	1970	2402
133	275	749	1997	2511
134	1801	2408	3455	4719
135	1784	2447	3477	4766
136	1784	2112	3054	4460
137	1917	2084	2743	4008
138	1453	1465	2034	3199
139	1655	1667	2234	3376
140	1985	2167	2674	3471
141	2022	2184	2699	3525
142	1798	2100	2545	3111
143	1879	2169	2620	3209
144	1190	1514	1950	2507
145	1081	1401	1838	2443
146	1120	1412	1858	2566
147	1015	1356	1778	2224
148	1604	1931	2366	2807
149	1641	1983	2403	2652
150	1939	2278	2703	2952
151	1884	2211	2646	3047
152	1960	2279	2717	3169
153	1794	2120	2555	2976
154	1711	2038	2473	2892
155	1938	2274	2703	2989
156	1927	2401	2813	2909
157	1743	2279	2682	2727
158	1734	2437	2829	2751
159	1662	2720	3076	2719
160	1987	3054	3416	3045
161	1821	1911	3778	4552
162	349	316	722	14149
163	555	549	928	13919
164	634	670	1003	13789
165	336	827	1156	13553
166	1024	1036	1662	9828
167	976	1162	1768	10036
168	941	1118	1664	10214
169	881	1050	1687	10306
170	903	1063	1644	10356
171	31	185	1455	10398
172	45	132	510	12214
173	74	141	1233	3658
174	381	469	1590	3840
175	71	110	1609	3357
176	297	960	1776	595
177	170	648	1374	463
178	130	764	1593	633
179	51	626	1449	638
180	320	1578	2372	1030
181	283	1559	2437	1004
182	288	1595	2406	1053
183	400	1675	2550	1118
184	443	1781	2528	1249
185	669	2016	2368	1726
186	499	1802	2154	1551
187	493	1942	2323	1535
188	210	1653	2119	1239
189	567	888	1247	1584
190	386	727	1111	1643
191	324	636	994	1490
192	244	501	851	1241
193	811	1417	1767	1719
194	826	1442	1791	1738
195	1145	1858	2223	2123

196	1688	2273	2671	2678
197	1653	2309	2701	2656
198	1786	2521	2911	2810
199	993	1116	1549	3795
200	1165	1270	1592	3629
201	1345	1382	1742	3221

SITING BOARD 1-20:

Clarify whether any existing structures on the Project site will be demolished or removed in order to accommodate the Project.

Response: There are some old barns that will likely be demolished as permitted or consented to in the lease(s). They are in disrepair and sparsely used.

Witness: Matt Kiehlmeier

SITING BOARD 1-21:

Explain whether there are any residential neighborhoods as defined under KRS 278.700(6) without any of "the parameters" that were described in the Motion for Deviation. If so, provide the following for each neighborhood:

a. Distance to the panel.

b. Distance to the Inverter.

c. Distance to the Substation.

d. Distance to the BESS.

Response: Summer Shade interprets the definition of "residential neighborhoods" in KRS 278.700(6) in a way that is consistent with the articulated parameters. Therefore, it does not believe that there are any residential neighborhoods within 2,000 feet of generating facilities that would require a deviation from the statute.

Notably, the two parameters articulated in the Motion were (1) that the collection of parcels that have an adjoining boundary with at least one of the other parcels in the neighborhood and (2) that public roads are not considered in determining whether parcels are adjoining. These parameters are reasonable as there would be absurd results if they were not implemented. For example, if parcels in a "residential neighborhood" did not need to share parcel boundaries, a "residential neighborhood" could consist of six one-acre parcels that are spread out hundreds of feet from each other around the perimeter of the project. Or, if a public road severed parcels from consideration of a "residential neighborhood," a residential development with 1,000 quarter-acre parcels would not be a "residential neighborhood" if only 19 parcels were collectively within the same block and separated by a road from other parcels.

Despite the fact that elimination of these parameters would lead to absurd results, of the six areas identified in the Motion, Areas 1 and 5 may have five or more non-contiguous residential parcels that has five or more acres containing at least one residential structure per acre, and Area 3 may have five or more contiguous residential parcels that has five or more acres containing at least one residential structure per acre but the Area 3 is severed by roads. None of these three Areas are completely within 2,000 feet from the proposed location of generating facilities.

Although these Areas should not qualify as "residential neighborhoods," the respective distances to the closest parcel in each of these Areas is listed below:

a. Distance to the panel.

   Area 1: 1,247 feet

   Area 3: 1,955 feet

   Area 5: 1,917 feet

b. Distance to the Inverter.

   Area 1: 1,625 feet

   Area 3: 3,610 feet

   Area 5: 2,836 feet

c. Distance to the Substation.

   Area 1: 2,249 feet

   Area 3: 5,949 feet

   Area 5: 8,538 feet

d. Distance to the BESS.

   Area 1: 2,291 feet

Area 3: 6,033 feet

Area 5: 8,711 feet

Witness: Legal / Shane Kelley

SITING BOARD 1-22:

Provide a table with the distances from the nearest nonparticipating residence (dwelling not property line) to the following:

a. Fencing.

b. Closest solar panel.

c. Closest inverter.

d. Substation.

e. Battery storage.

Response:

a. Fencing.	93 feet
b. Closest solar panel.	185 feet
c. Closest inverter.	721 feet
d. Substation.	1,260 feet
e. Battery storage.	1,536 feet

Witness: Shane Kelley

SITING BOARD 1-23:

Refer to the Motion for Deviation from the Setback Requirements. For the closest residence (dwelling not property line) in each neighborhood provide a table with the distance to the following:

a. Fencing.

b. Closest solar panel.

c. Closest inverter.

d. Substation.

e. Battery Storage.

Response: As discussed in the Motion for Deviation, Summer Shade does not believe that there are any residential neighborhoods as defined by KRS 278.700 within 2,000 feet of the project. In response to Item 1-21 above, Summer Shade identified distances to the nearest property boundaries of certain areas identified in the Motion for Deviation. The table below identifies the distances to the nearest residences in those areas:

Fencing	Area 1	1,255 feet
	Area 3	1,948 feet
	Area 5	1,929 feet
Closest solar panel	Area 1	1,311 feet
	Area 3	1,995 feet
	Area 5	1,990 feet
Closest inverter	Area 1	1,689 feet
	Area 3	3,648 feet

	Area 5	2,908 feet
Substation	Area 1	2,300 feet
	Area 3	5,989 feet
	Area 5	9,198 feet
Battery Storage	Area 1	2,304 feet
	Area 3	6,023 feet
	Area 5	9,531 feet

Witness: Shane Kelley

SITING BOARD 1-24:

Explain whether participating landowners will continue to use property not leased to the Applicant for residential or agricultural purchases. Are there any restrictions within the lease agreements for property not leased to the Applicant?

Response: Landowners may use the property that is not part of the solar project and are free to do so without restrictions in the lease or other agreements. Land may be used for continued residential or agricultural purposes.

Witness: Matt Kiehlmeier

SITING BOARD 1-25:

State when the peak construction activity period will occur (which month(s) or quarter of the full construction period).

Response: Construction will take approximately 14 months, with peak activities close to the middle of the construction period. Please refer to Exhibit submitted in response to Item #27 for identification of peak construction activity period.

Witness: Alfonso Tovar

SITING BOARD 1-26:

Provide a detailed description of different construction activities, including a construction timeline and schedule by activity, including development of the transmission line.

Response: The main construction activities consist of the following:

1- Vegetation removal and civil works: civil works includes grading, retention ponds, internal roads, perimeter fencing and, in general, overall site preparation. Civil works is the first construction activity after vegetation removal, but several civil works continue simultaneously while other activities start.

2- Installation of steel piles

3- Assembly of mounting structures

4- Trenching or boring for medium voltage cables

5- Installation of modules on mounting structures

6- Installation of power conversion stations and electrical connections

7- Testing and commissioning.

8- The project's substation and interconnection line are built independently. Construction of the project substation is not tied to construction activity of the solar plant however, the project's substation and interconnection line must be finished before or at the same time as the solar plant, so the solar plant can be energized for testing and commissioning.

A projected timeline for construction activities is attached to the response to Item 27 below.

Witness: Alfonso Tovar

SITING BOARD 1-27:

Provide a schedule for the project, starting from the receipt of the proposed certificate of construction to the completion of the project, including the length of each construction phase. Include when the peak construction would occur within the timeline.

Response: See attached document below.

Witness: Alfonso Tovar

Candela
RENEWABLES

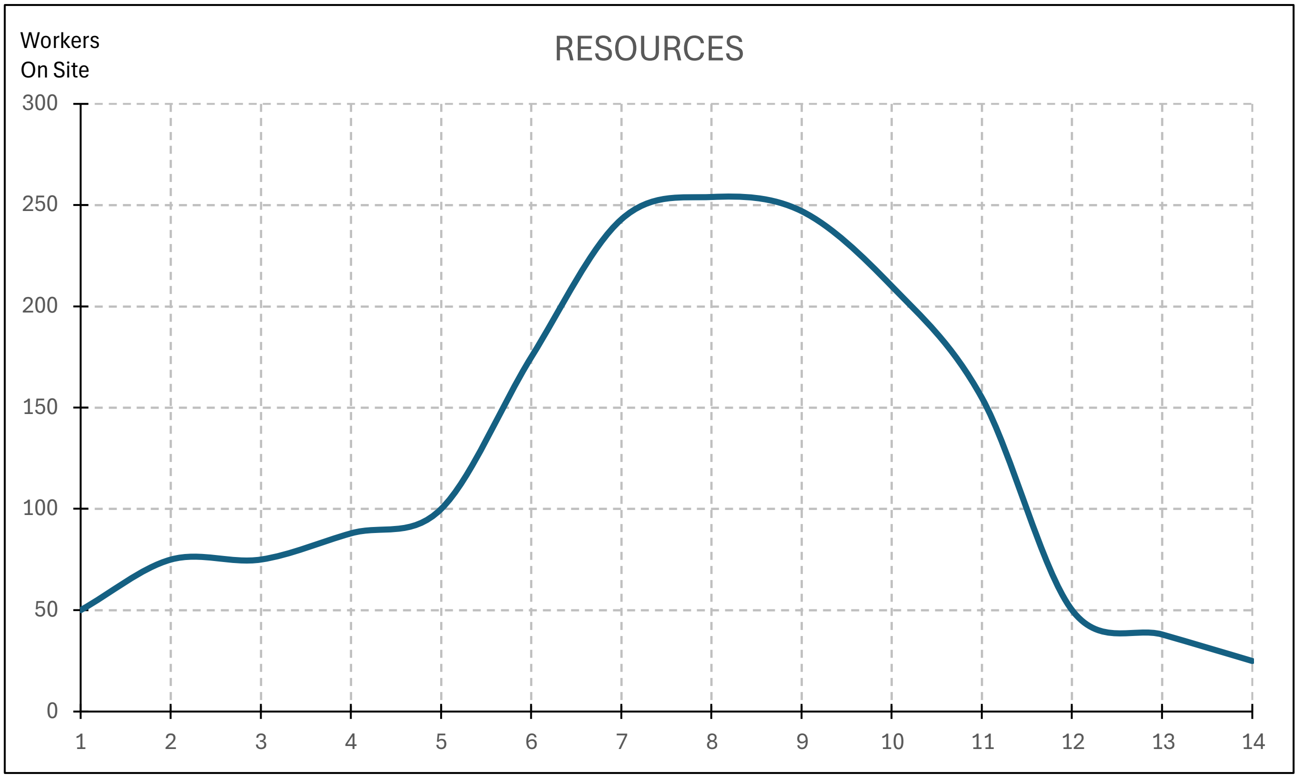
SUMMER SHADE SOLAR PROJECT

106 MW-AC

Chart for Main Construction Activities - Representative

Active Construction Period (expected): 14 months

TASK	MONTH													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mobilization	🟩													
Vegetation removal	🟩	🟩	🟩											
Civil works		🟩	🟩	🟩	🟩	🟩								
Pile installation					🟩	🟩	🟩	🟩						
Tracker installation						🟩	🟩	🟩	🟩					
Module installation							🟩	🟩	🟩	🟩				
Installation of MV cables						🟩	🟩	🟩	🟩	🟩	🟩			
Electrical connections and inverters								🟩	🟩	🟩	🟩			
Testing and commissioning									🟩	🟩	🟩	🟩	🟩	🟩
Project substation	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		



SITING BOARD 1-28:

Provide a narrative description of the proposed transmission line and alternate route, including the number of poles to be installed, the height of the poles and the length and width of the transmission line corridor.

Response: The proposed substation location will be located on parcel ID 030-00-00-15.03. The proposed transmission line is estimated to be less than 300-feet in length and will cross from this parcel directly to the parcel owned by East Kentucky Power Cooperative (EKPC), where the existing 161 kV Summer Shade substation is located. Due to the adjacency of the proposed project substation to the existing EKPC substation, as well as the existing congestion of transmission lines in this area, there is no alternate route identified at this time. The Project is awaiting a Facilities Study from PJM/EKPC to identify the exact point to interconnect and hence, the most optimal route the proposed transmission line will need to take to connect into the EKPC Substation. The Facilities Study results will determine if any poles are needed, as well as the length and width of the transmission corridor.

Witness: Alfonso Tovar

SITING BOARD 1-29:

Explain how the proposed transmission route was determined.

Response: The proposed transmission route is the most optimal route to interconnect our Project substation to the 161kV EKPC Substation, considering the infrastructure that already exists around EKPC's substation, the EKPC Facilities Study will need to define the actual interconnection location.

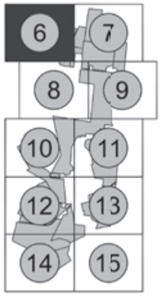
Witness: Alfonso Tovar

SITING BOARD 1-30:

Provide a map showing the existing property lines that the proposed transmission line is proposed to cross.

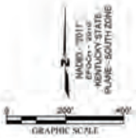
Response: Please refer to ALTA figure attached for property lines, and to the Updated Preliminary Site Layout in response to Item #39 for the location of the proposed substation and proposed transmission line route. The proposed substation location will be located on parcel ID 030-00-00-15.03. The proposed transmission line will cross from this parcel directly to the parcel owned by East Kentucky Power Cooperative where the existing 161 kV EKPC substation is located. The transmission line is approximately 300 feet and will cross one property line.

Witness: Aubree Muse



SHEET INDEX
NOT TO SCALE

PRELIMINARY
FOR REVIEW ONLY



Know what's below.
811 before you dig.

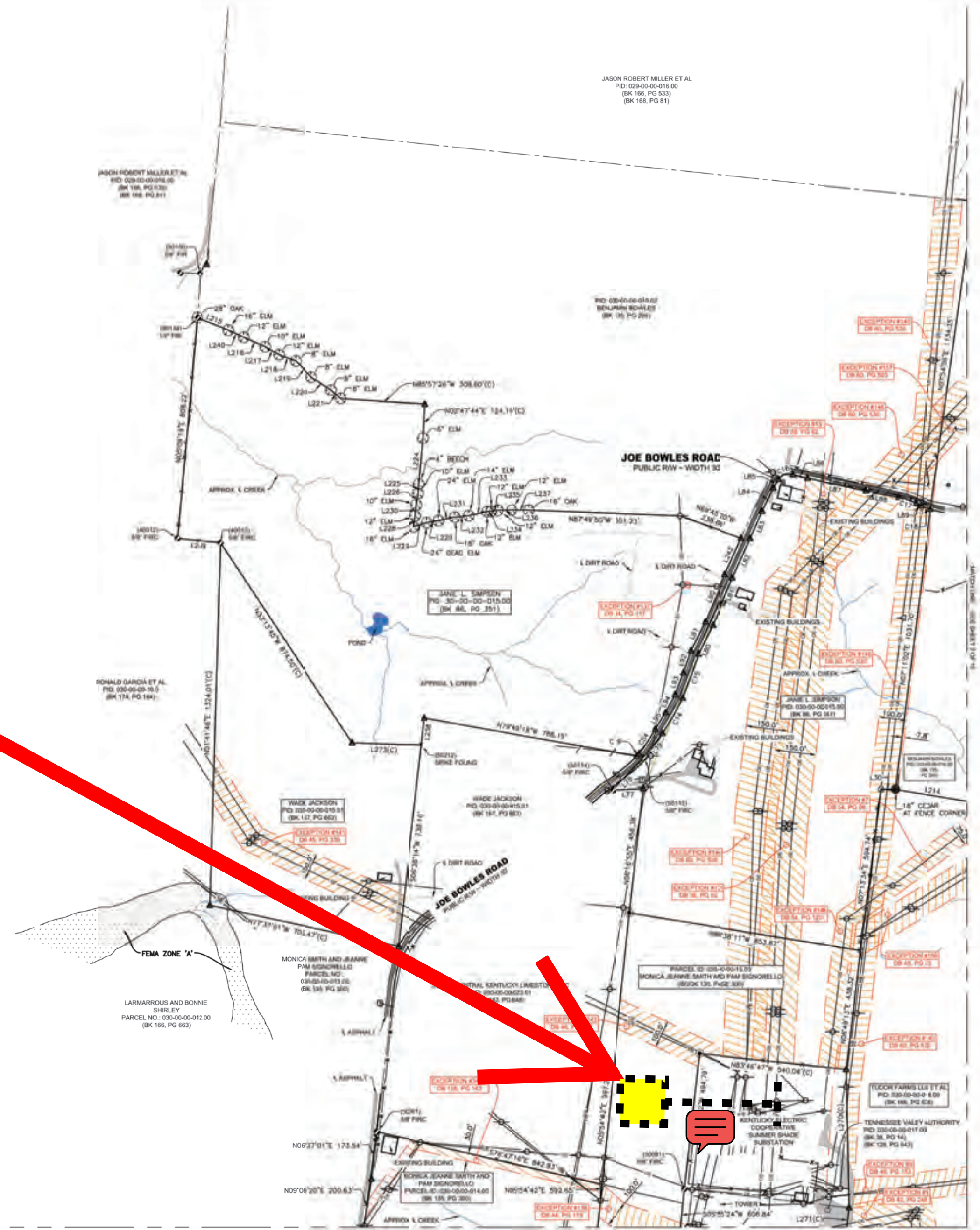
LEGEND

- = UTILITY POLE
- = BOLLARD
- = CORNER POST
- = SIGN
- = TELEPHONE MARKER
- = FIBER MARKER
- = GAS MARKER
- = GAS VENT
- = TELEPHONE MARKER
- = WATER VALVE
- = WATER METER
- = TELEPHONE PEDESTAL
- = CABLE PEDESTAL
- = WATER FAUCET
- (XXXXX) = SAM POINT NUMBER
- = CALCULATED POINT
- (C) = CALCULATED BEARING
- FIR = FOUND IRON ROD
- FIRC = FOUND IRON ROD W/ CAP
- FCM = FOUND CONCRETE MONUMENT
- FIP = FOUND IRON PIPE
- = ADJOINER LINE, LINE NOT SURVEYED-LINE MAPPED FROM DEEDS OR PLATS (UNLESS NOTED)
- R/W = RIGHT-OF-WAY LINE, LINE NOT SURVEYED-LINE MAPPED FROM DEEDS OR PLATS (UNLESS NOTED)
- = BOUNDARY/PROPERTY LINE
- OE = OVERHEAD UTILITY LINE
- W = UNDERGROUND WATER LINE
- UT = UNDERGROUND COMMUNICATION LINE
- G = UNDERGROUND GAS LINE
- = ABOVE GROUND GAS LINE
- X = BARBED WIRE FENCE
- O = CHAIN LINK FENCE
- / = FARM FENCE
- = FEMA ZONE "A" LINE
- ▭ = PAVED ASPHALT SURFACE
- ▨ = FEMA ZONE "A"
- ▨ = TITLE EXCEPTION
- ▭ = DIRT SURFACE

LINE TABLE		
NUMBER	DIRECTION	LENGTH
L77	S87°12'15"W	111.30'
L78	N44°42'18"E	164.32'
L80	N26°17'18"E	116.93'
L81	N22°55'54"E	189.08'
L82	N24°05'54"E	157.21'
L83	N23°29'29"E	109.06'
L84	N25°45'01"E	94.41'
L85	N30°58'48"E	36.04'
L86	S76°19'30"E	54.33'
L87	S77°58'06"E	219.98'
L88	S78°39'53"E	120.70'
L89	S65°26'07"E	22.76'
L90	S22°55'54"W	188.50'
L91	S26°17'18"W	117.99'
L92	S18°55'00"W	84.55'
L93	S20°16'18"W	86.01'
L94	S27°44'29"W	74.05'
L95	S31°44'57"W	71.35'
L214	N80°42'41"W	2,546.49'
L215	N67°48'07"W	123.50'

LINE TABLE		
NUMBER	DIRECTION	LENGTH
L216	N65°28'51"W	85.35'
L217	N60°29'25"W	58.57'
L218	N69°23'32"W	64.87'
L219	N44°23'41"W	82.65'
L220	N56°32'09"W	86.38'
L221	N49°32'45"W	45.77'
L224	N05°25'55"E	165.91'
L225	N03°43'36"E	34.39'
L226	N08°59'59"E	42.59'
L227	S71°45'27"W	50.28'
L228	N08°18'55"E	41.25'
L229	S80°38'16"W	43.71'
L230	N06°14'53"E	39.75'
L231	S77°23'11"W	60.34'
L232	S84°11'18"W	51.15'
L233	S77°14'37"W	68.13'
L234	S85°33'13"W	14.94'
L235	S80°42'13"W	24.41'
L236	S89°23'01"W	51.69'
L237	N89°34'01"W	63.24'

LINE TABLE		
NUMBER	DIRECTION	LENGTH
L238	S06°16'15"W	99.00'
L239	N84°00'47"W	159.76'
L240	N65°37'54"W	61.16'
L242	S24°05'54"W	144.99'
L270(C)	N01°13'11"W	502.79'
L271(C)	N06°33'51"E	648.38'
L273(C)	N88°04'30"W	253.85'



MATCH LINE - SEE SHEET 8 OF 15

PROJECT: CANDELA RENEWABLES
SUMMER SHADE SOLAR
JOB NUMBER 102307604
DATE: 04/2024
SCALE: 1"=200'
SURVEYOR: —
TECHNICIAN: E. SKORETZ/ M. LOSEY
DRAWING: 102307604 - SUMMER SHADE - ALTA.DWG
TRACT ID: SEE FACE OF SURVEY
PARTYCHIEF: C. MARSTILLER/ K. GARDNER/ R. HOWELL
FIELDBOOKS: 42052, 42055, 42159, 43254, 43255, 43321

REVISION NO. DATE

9047 Executive Park Dr., Ste. 120
Knoxville, TN 37923
Ofc: 865.200.4366
Email: info@sam.biz

PRELIMINARY ALTA/NSPS Land Title Survey
for: Candela Renewables
Summer Shade Solar - Being a Portion of the Property Described in Deed Book ###,
Page ###
Lying Near the City of Summer Shade
And Within the Counties of Metcalfe and Monroe, Kentucky

SHEET 6
OF 15

PATH: \\SAMINC\KNX\PROJECTS\102307604\100\SURVEY\02BASE\102307604 - SUMMER SHADE - ALTA - SHEET LAYOUT.DWG

CURVE TABLE				
CURVE NO.	RADIUS	LENGTH	CHORD BEARING	CHORD LENGTH
C18	354.59'	36.49'	S69°22'28"E	36.48'
C17	290.96'	66.14'	S71°29'49"E	66.00'
C16	40.63'	59.26'	N71°10'19"E	54.14'
C15	3738.72'	171.29'	N19°36'55"E	171.28'
C14	1104.61'	148.59'	N29°40'13"E	148.48'
C19	466.95'	12.96'	S42°03'57"W	12.96'
C54	637.47'	106.62'	S33°05'28"W	106.49'

SITING BOARD 1-31:

Provide information on all electric transmission lines that intersect the project. Include in the response the owner, voltage, status, and right-of-way (ROW) setbacks.

Response: Please see below table identifying ROW owners, estimated widths, and voltages. These values will be verified prior to construction.

ROW Owner	Width	Est Voltage
Tennessee Valley Authority	75 Feet	161
Eastern Kentucky Power Corp	150 Feet	238
Eastern Kentucky Power Corp	100 Feet	161
Tennessee Valley Authority	225 feet	345
Tennessee Valley Authority	75 feet	69
Tennessee Valley Authority	75 Feet	69
Tri-County Electric Membership	75 feet	69
Tennessee Valley Authority	100 feet	161
Eastern Kentucky Power Corp	75 Feet	69
Eastern Kentucky Power Corp	75 feet	69
Kentucky Utilities	100 Feet	161
Eastern Kentucky Power Corp	20 feet	34.5

Witness: Matt Kiehlmeier

SITING BOARD 1-32:

Detail any communication with the residences closest to the proposed substation location.

Response: The proposed substation location is adjacent to the location of the existing 161kV EKPC Substation, and 1000 feet or more from residences. Residences closest to the proposed substation are participating landowners, or across HWY 90 (Summer Shade Road). Adjacent property owners to the Project received certified mail notices of the Application filing, as well as notices of our public information meeting. There were no concerns raised about the location of the proposed substation.

Witness: Aubree Muse

SITING BOARD 1-33:

Explain whether vegetative clearing will be required to accommodate the proposed 300-foot long transmission line. If yes, provide the anticipated acreage of vegetative clearing and any permits that will be required.

Response: Vegetative clearing will be required to accommodate the proposed approximately 300-foot transmission line. The clearing area is anticipated to be 0.25 acres or less. A Section 7 consultation and coordination with the USACE may be required for this activity.

Witness: Aubree Muse / Mark Carney

SITING BOARD 1-34:

Explain how the proposed route of the electric transmission line will minimize significant adverse impact to the scenic assets of Kentucky.

Response: The proposed route of the electric transmission line will only be a few hundred feet in length, and will be in the same vicinity as the existing electric infrastructure and transmission lines entering and exiting the existing 161 kV Summer Shade substation. By locating our facility where existing infrastructure is already in place and by pursuing the shortest proposed route available, we believe we have minimized any adverse impacts on the scenic assets of Kentucky.

Witness: Aubree Muse

SITING BOARD 1-35:

Provide a detailed map of the proposed transmission line route and the alternate route, including proposed pole locations, access roads and nearby residences.

Response: The proposed transmission line is estimated to be less than 300 feet in length and will cross from this parcel directly to the parcel owned by East Kentucky Power Cooperative where the existing 161 kV Summer Shade substation is located. Due to the adjacency of the project substation to the existing EKPC substation, there is no alternate route identified. Because the exact interconnection location to the EKPC Substation is still being determined, no additional transmission line poles are expected to be required for interconnection, and interconnection will occur within participating landowner parcels. Therefore, no residences would have a view of additional transmission line poles associated with the project. Please refer to the Updated Preliminary Site Layout in response to Item #39 for the proposed transmission line route which will need to be confirmed by EKPC.

Witness: Alfonso Tovar

SITING BOARD 1-36:

Provide any sketches of the proposed transmission line support structure.

Response: The EKPC Facilities Study will determine if any poles are needed for this proposed route, but none are anticipated at this time. A conceptual sketch of a monopole structure is provided, should they be needed as determined by EKPC.

Witness: Alfonso Tovar

36. Provide any sketches of the proposed transmission line support structure.

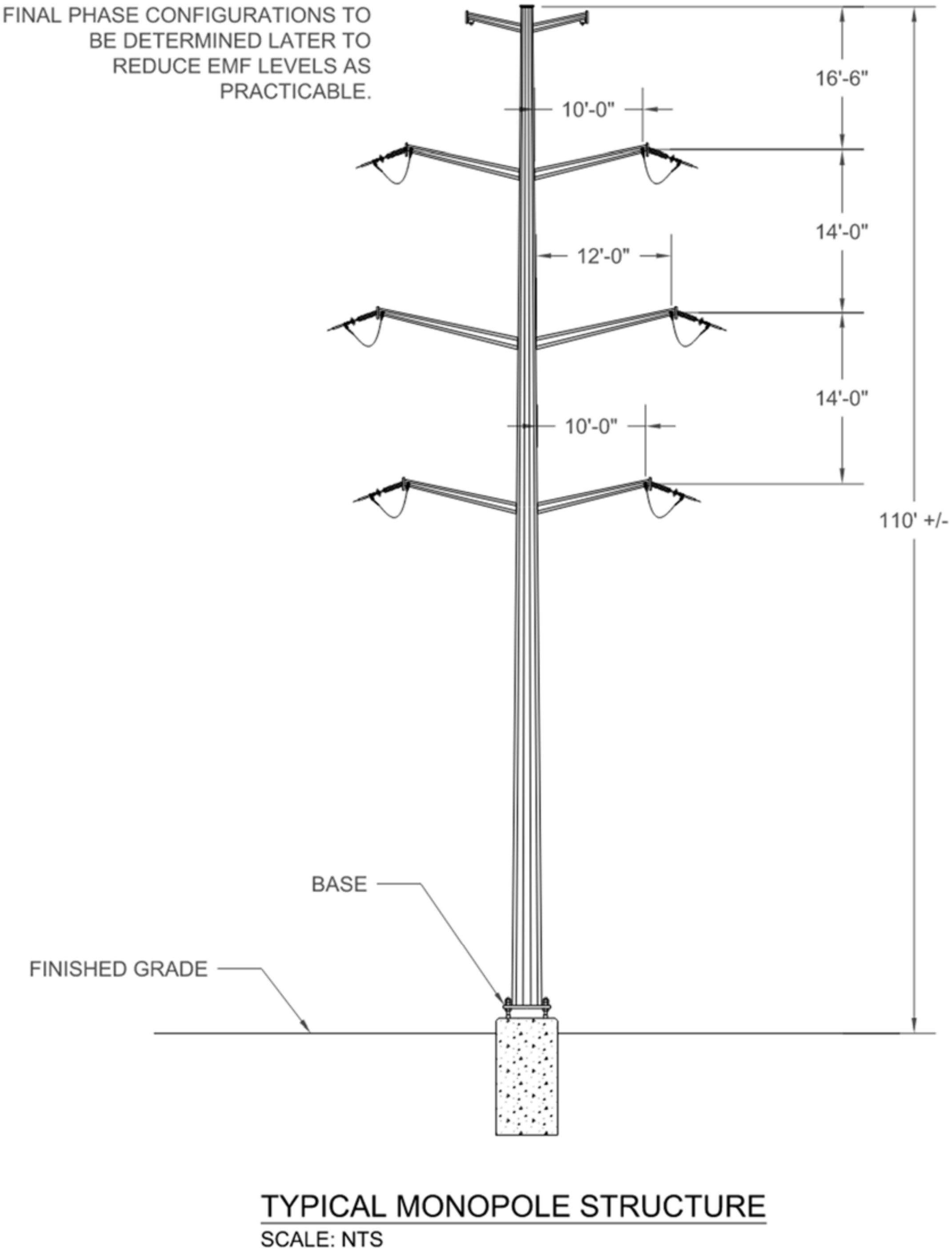


Figure 1. Interconnection – Typical transmission line support structure

SITING BOARD 1-37:

Provide a table showing the distance between transmission line structures (poles) and nearby residences, for the proposed route and the alternate route.

Response: As stated in response #35, the exact interconnection location and whether any poles will be needed has not been determined at this time. The Updated Preliminary Site Layout in response to Item #39 shows the proposed location of the point of interconnection and a distance longer than 1,000 ft to the nearest residence. The Project is awaiting a Facilities Study from PJM/EKPC to identify the exact point to interconnect and hence, the most optimal route the proposed transmission line will need to take to connect into the EKPC Substation, if other than the proposed interconnection location is not deemed feasible by EKPC. The Facilities Study results will determine if any poles are needed.

Witness: Alfonso Tovar

SITING BOARD 1-38:

State the number of individual parcels and landowners participating in the Project, including the transmission line.

Response: Including the transmission line, the Project is comprised of 17 parcels and has 24 landowners with 12 total agreements.

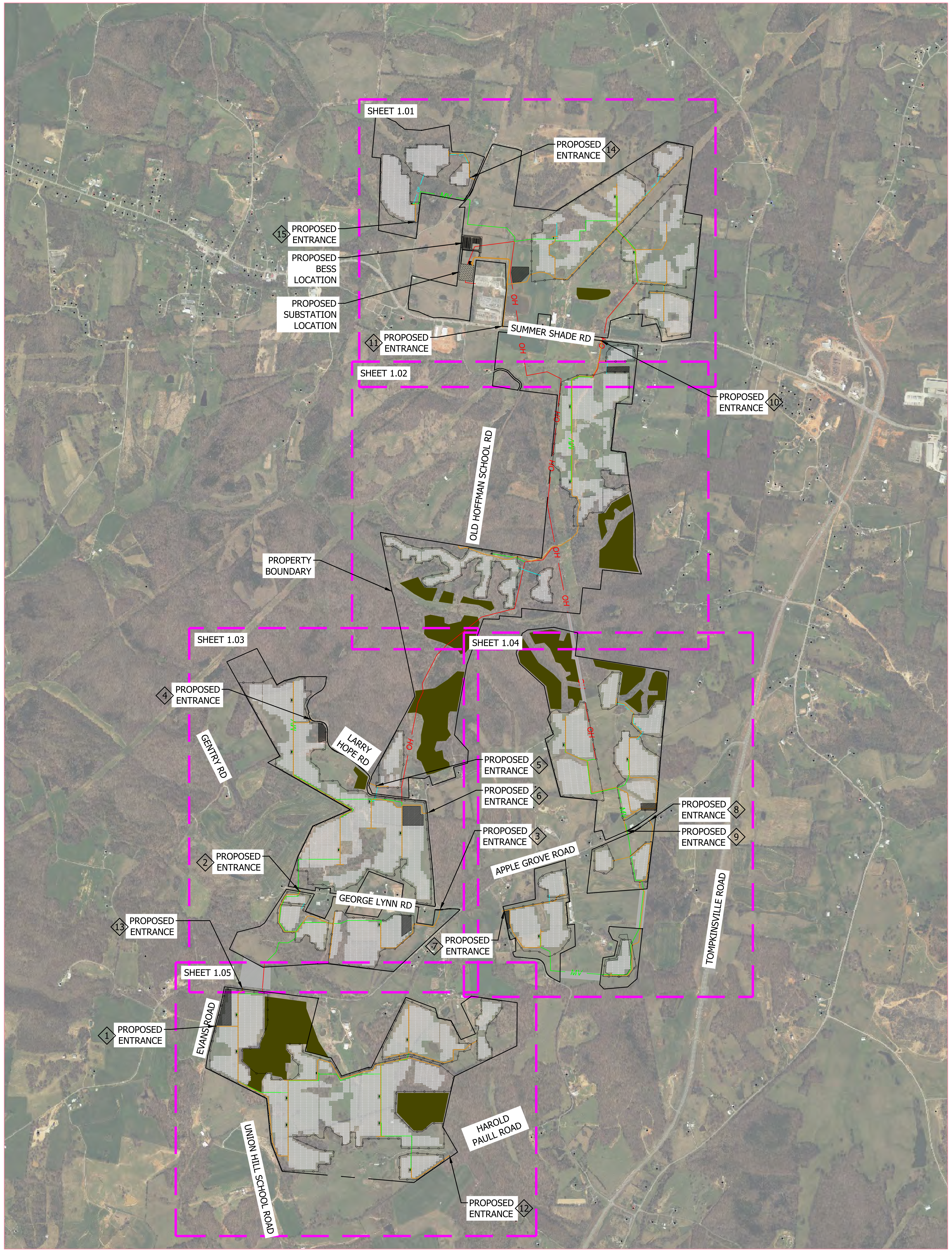
Witness: Matt Kiehlmeier

SITING BOARD 1-39:

Update the Revised Site Plan filed on May 16, 2025. Include an icon labeling every residential structure in each map. Update the map legend accordingly.

Response: The Updated Preliminary Site Layout has been updated to include residential structures and is included below.

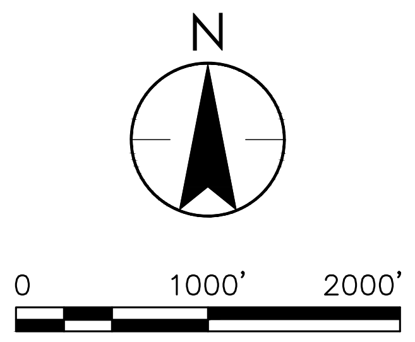
Witness: Shane Kelley



System Size and Equipment Summary Assumptions	
PV PROJECT	
Developer	Candela Renewables
Project	Summer Shade Solar
Location	Metcalfe County, Kentucky
Coordinates	36.868, -85.688
Total Site Area (Acres)	1535
Total PV Plant Area (Acres)	737
PV PLANT CAPACITY	
AC Capacity @ POI	106.00
AC Capacity (Nameplate)	110.00
DC Capacity (Nameplate)	139.18
DC/AC Ratio @ POI	-
DC/AC Ratio (Nameplate)	1.27
INTERCONNECTION	
Point of Interconnection	Existing EKPC Substation
POI Coordinates	36.88, -85.68
Interconnection Voltage	161kV
Gen-Tie Length	300' FT
MODULE	
Type	JA Solar
Make/Model	JAM72D40
Nominal Power	520Wp
Modules per String	27
Total Modules	267,651
POWER CONVERTER SYSTEM (PCS)	
Type	Central @1500Vdc
Make/Model	Sungrow/SD4400UD-MV-US
Nominal Power	4.4
Total Inverters	25
FIXED TILT	
Type	Fixed Tilt, 2P Landscape
Modules per Row (2 Strings)	54
Modules per Row (1 Strings)	27
Pitch	30.5' FT
Ground Coverage Ratio (GCR)	51%
Total Rows (2 Strings)	4,305
Total Rows (2 Strings)	1,303
TYPICAL ARRAY CONFIGURATION	
Number of Strings per Array (Average)	397
Number of Modules per Array (Average)	10,706
BESS INFORMATION	
Number of Inverters	24
Nominal Power	4.4
Number of BESS Units	96
Design Duration (Hr)	4
MWh	424
MWac	106

LEGEND

— — —	PROPERTY BOUNDARY LINE
—□—	PERIMETER FENCE/BUILDABLE AREA
— OH —	OVERHEAD ELECTRIC
—	ACCESS ROAD
▭	FIXED TILT TRACKER
▮	INVERTERS
— MV —	MV CABLES (UNDERGROUND)
— DF —	DC CABLES (UNDERGROUND)
┄┄	DIRECTIONAL BORE
▨	SUBSTATION
▨	LAYDOWN AREA
■	AVOIDANCE AREAS
◇9	PROPOSED ENTRANCE NUMBER
+	RESIDENTIAL STRUCTURE



Stantec
5209 Center Street
Williamsburg, Virginia 23188
www.stantec.com

SUMMER SHADE SOLAR PROJECT
CANDELA RENEWABLES
SUMMER SHADE, METCALFE COUNTY, KY

ISSUED: 06/20/2025
PRELIMINARY PV LAYOUT

NO.	REVISION	DATE
1	ISSUE FOR REVIEW	04.28.25
2	UPDATED PV LAYOUT	05.13.25
3	CLIENT COMMENTS	06.20.25

DRAWN	RMA
DESIGNED	RMA
CHECKED	CMA
APPROVED	DDF
PROJ. NO.	172658275

SHEET NUMBER
E-100

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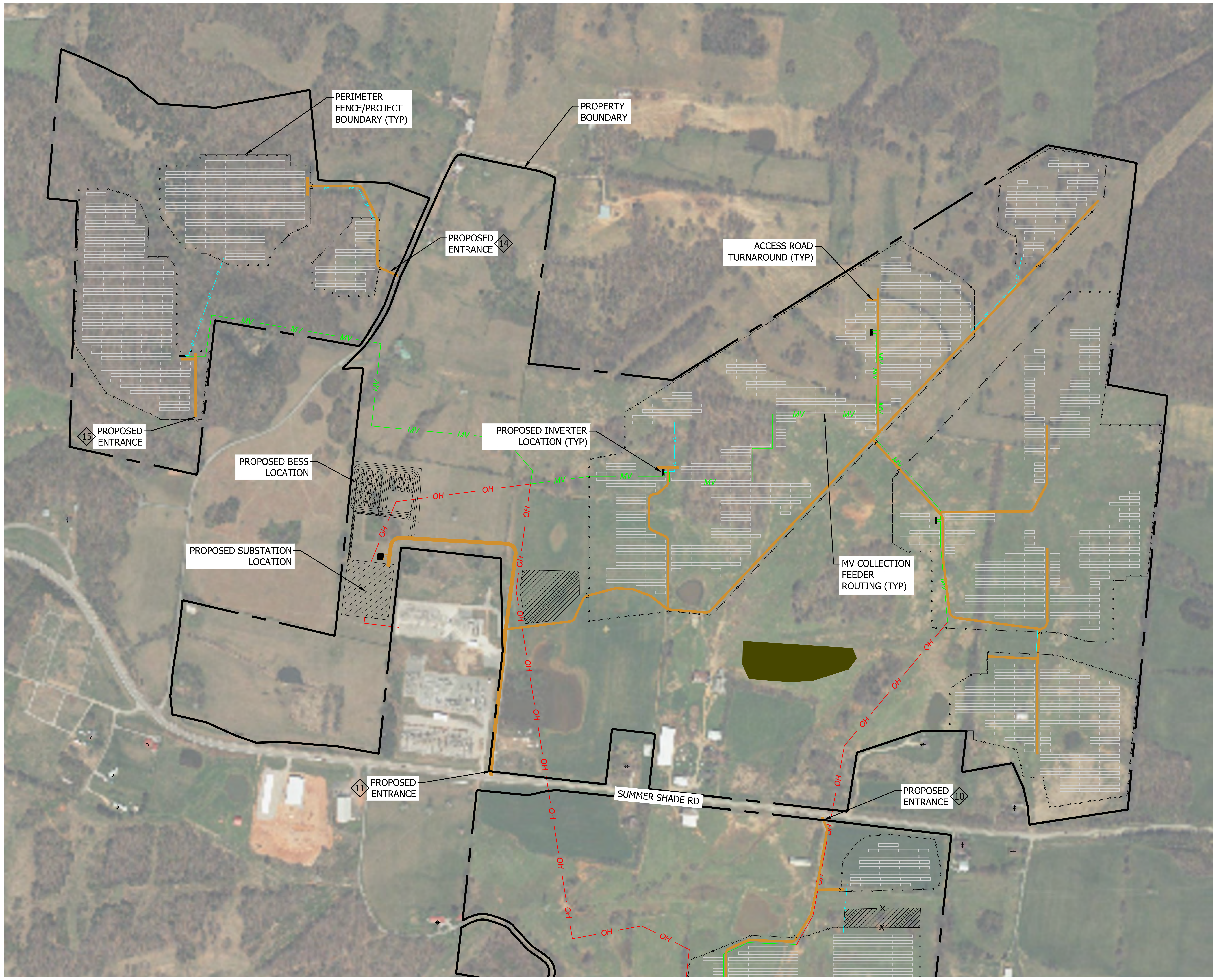
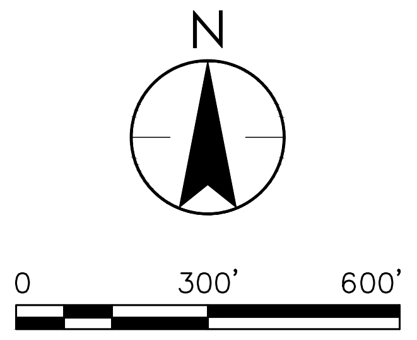
2025/06/20 2:03 PM By: Andrews, Robert

ORIGINAL SHEET - ARCH D



LEGEND

— — —	PROPERTY BOUNDARY LINE
—□—	PERIMETER FENCE/BUILDABLE AREA
— OH —	OVERHEAD ELECTRIC
—	ACCESS ROAD
▭	FIXED TILT TRACKER
▮	INVERTERS
— MV —	MV CABLES (UNDERGROUND)
— DF —	DC CABLES (UNDERGROUND)
········	DIRECTIONAL BORE
▨	SUBSTATION
▨	LAYDOWN AREA
■	AVOIDANCE AREAS
◇9	PROPOSED ENTRANCE NUMBER
+	RESIDENTIAL STRUCTURE



Stantec

5209 Center Street
Williamsburg, Virginia 23188
www.stantec.com

SUMMER SHADE SOLAR PROJECT

CANDELA RENEWABLES
SUMMER SHADE, METCALFE COUNTY, KY

ISSUED: 06/20/2025
PRELIMINARY PV LAYOUT

NO.	REVISION	DATE
1	ISSUE FOR REVIEW	04.28.25
2	UPDATED PV LAYOUT	05.13.25
3	CLIENT COMMENTS	06.20.25

DRAWN	RMA
DESIGNED	RMA
CHECKED	CMA
APPROVED	DDF
PROJ. NO.	172658275

SHEET NUMBER
E-101

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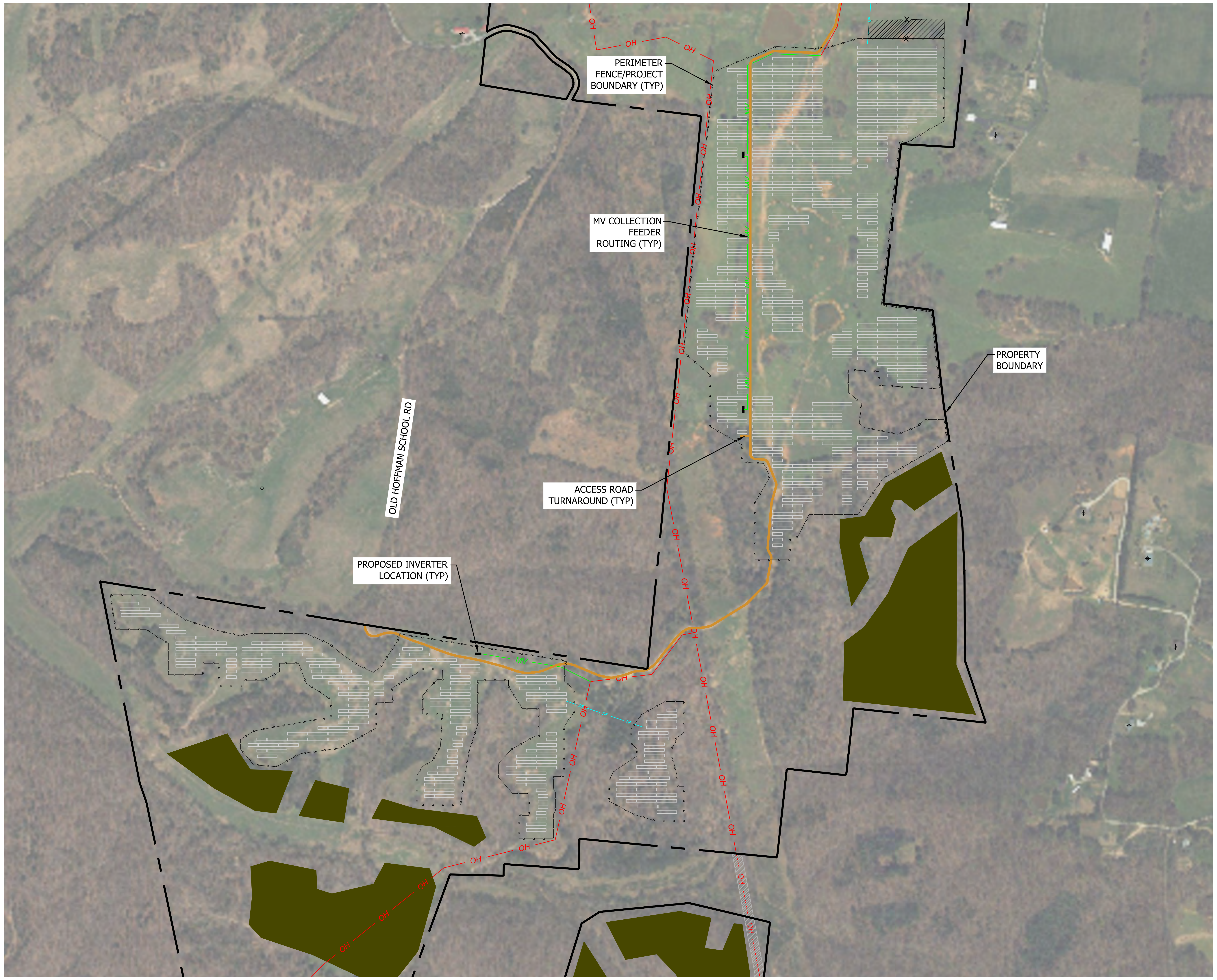
2025/06/20 2:03 PM By: Andrews, Robert

ORIGINAL SHEET - ARCH D



LEGEND

- ▬ ▬ PROPERTY BOUNDARY LINE
- ─□─ PERIMETER FENCE/BUILDABLE AREA
- ── OH ── OVERHEAD ELECTRIC
- ▬ ACCESS ROAD
- ▭ FIXED TILT TRACKER
- ▮ INVERTERS
- ── MV ── MV CABLES (UNDERGROUND)
- ── DF ── DC CABLES (UNDERGROUND)
- ┄┄ DIRECTIONAL BORE
- ▨ SUBSTATION
- ▨ LAYDOWN AREA
- ■ AVOIDANCE AREAS
- ◇9 PROPOSED ENTRANCE NUMBER
- ⌖ RESIDENTIAL STRUCTURE

N

0 300' 600'

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SUMMER SHADE SOLAR PROJECT
CANDELA RENEWABLES
SUMMER SHADE, METCALFE COUNTY, KY

ISSUED: 06/20/2025
PRELIMINARY PV LAYOUT

NO.	REVISION	DATE
1	ISSUE FOR REVIEW	04.28.25
2	UPDATED PV LAYOUT	05.13.25
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APPROVED	DDF
PROJ. NO.	172658275

SHEET NUMBER
E-102

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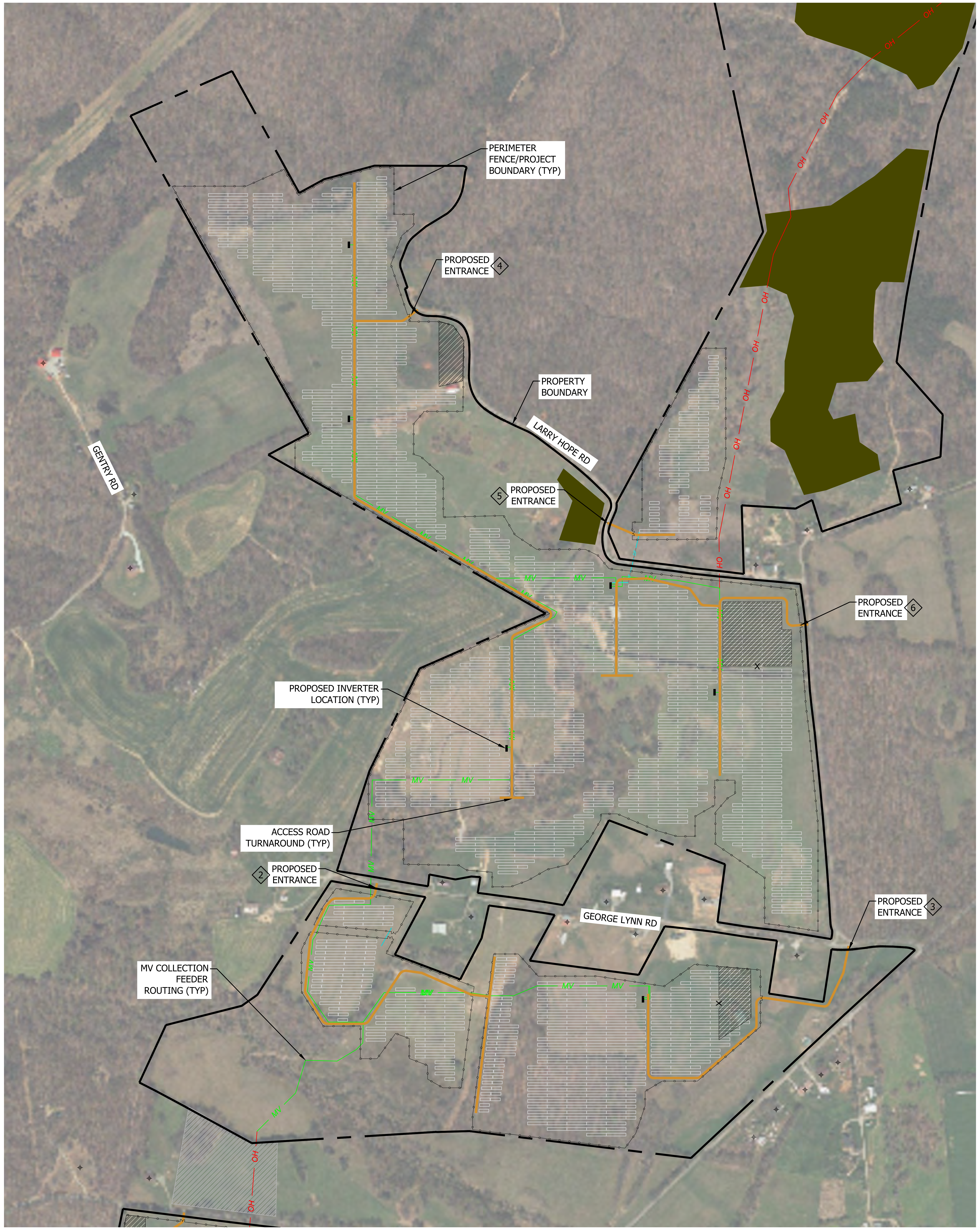

LEGEND

— — —	PROPERTY BOUNDARY LINE
—□—	PERIMETER FENCE/BUILDABLE AREA
— OH —	OVERHEAD ELECTRIC
—	ACCESS ROAD
▭	FIXED TILT TRACKER
▮	INVERTERS
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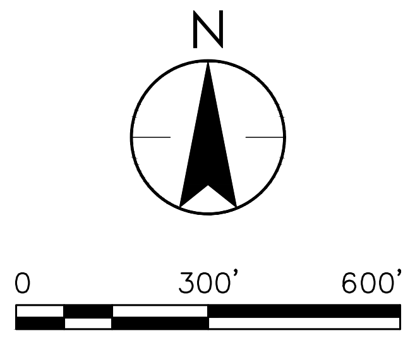
⌖	RESIDENTIAL STRUCTURE



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SUMMER SHADE SOLAR PROJECT
CANDELA RENEWABLES
SUMMER SHADE, METCALFE COUNTY, KY

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DRAWN	RMA
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APPROVED	DDF
PROJ. NO.	172658275

SHEET NUMBER
E-103

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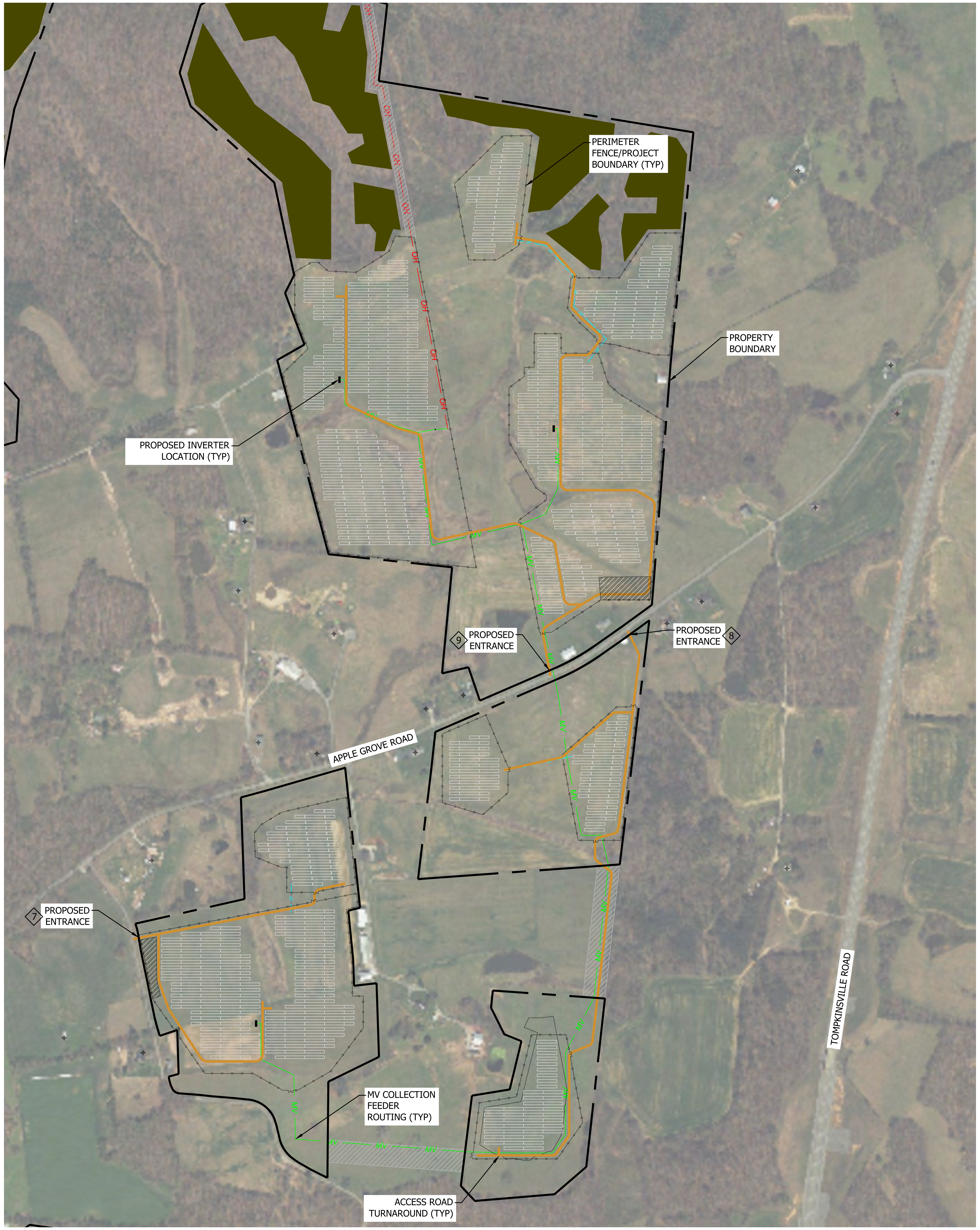
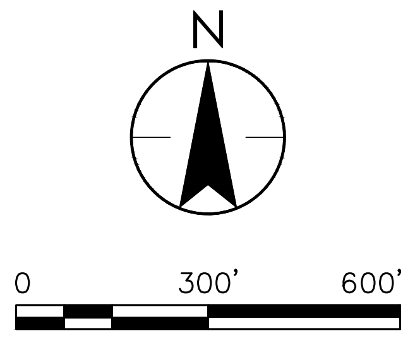


LEGEND

— – —	PROPERTY BOUNDARY LINE
—□—	PERIMETER FENCE/BUILDABLE AREA
— OH —	OVERHEAD ELECTRIC
—	ACCESS ROAD
▭	FIXED TILT TRACKER
▮	INVERTERS
— MV —	MV CABLES (UNDERGROUND)
— DF —	DC CABLES (UNDERGROUND)
-------	DIRECTIONAL BORE
▨	SUBSTATION
▨	LAYDOWN AREA
■	AVOIDANCE AREAS
◇9	PROPOSED ENTRANCE NUMBER
⌖	RESIDENTIAL STRUCTURE



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SUMMER SHADE SOLAR PROJECT
CANDELA RENEWABLES
SUMMER SHADE, METCALFE COUNTY, KY

ISSUED: 06/20/2025
PRELIMINARY PV LAYOUT

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DRAWN	RMA
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PROJ. NO.	172658275

SHEET NUMBER
E-104

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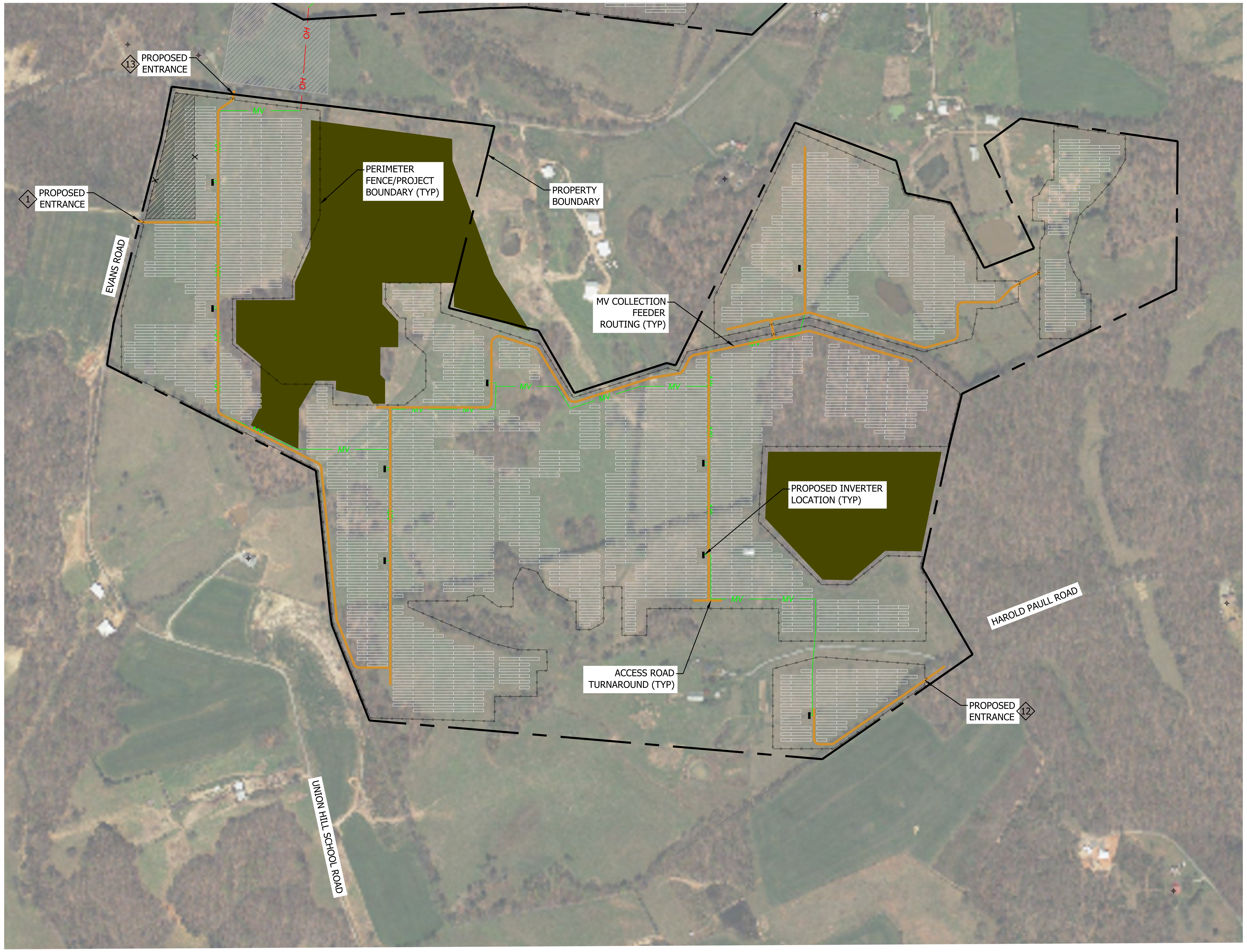
ORIGINAL SHEET - ARCH D



LEGEND

— — —	PROPERTY BOUNDARY LINE
—□—	PERIMETER FENCE/BUILDABLE AREA
— OH —	OVERHEAD ELECTRIC
—	ACCESS ROAD
▭	FIXED TILT TRACKER
▮	INVERTERS
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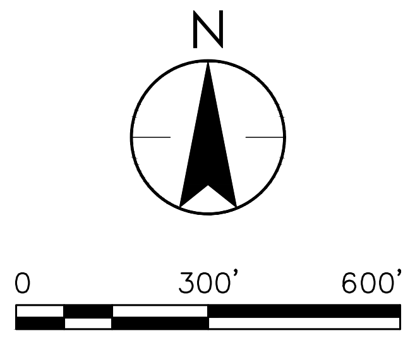
········	DIRECTIONAL BORE
▨	SUBSTATION
▨	LAYDOWN AREA
■	AVOIDANCE AREAS
◇9	PROPOSED ENTRANCE NUMBER
+	RESIDENTIAL STRUCTURE



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SUMMER SHADE SOLAR PROJECT

CANDELA RENEWABLES
SUMMER SHADE, METCALFE COUNTY, KY

ISSUED: 06/20/2025
PRELIMINARY PV LAYOUT

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2025/06/20 2:03 PM By: Andrews, Robert

ORIGINAL SHEET - ARCH D

SITING BOARD 1-40:

Refer to Application, Appendix B, Solar PV Layout. Highlight all construction entrances to the Project site and all operational entrances to the Project site on the map.

Response: The Updated Preliminary Site Layout has been updated to include proposed entrances and is included in response to Item 39 above. All proposed entrances are expected to be used for both construction and operation.

Witness: Shane Kelley

SITING BOARD 1-41:

Explain why such a substantial amount of proposed access points were proposed.

Response: The access points proposed ensure there is adequate, quick access to each part of the project site. Additional access points are beneficial to disperse construction deliveries to various areas, as well as ensure maintenance vehicles and/or emergency response (if needed) can access each area of the Project in an efficient manner.

Witness: Alfonso Tovar

SITING BOARD 1-42:

Refer to Application, Appendix B, Solar PV Layout. Identify on the map all above ground and underground infrastructure required to connect the areas of solar panels to the proposed Substation. Provide the total length of cabling used in this infrastructure.

Response: See Attachment G - Decommissioning Plan of the application. The decommissioning plan estimates that approximately 140,215 feet of cabling would be required for the solar infrastructure and 15,000 feet of cabling would be required for the BESS. Aboveground and underground collection lines have been labeled on the Preliminary Site Layout submitted in response to Item 39 above.

Witness: Shane Kelley

SITING BOARD 1-43:

Provide a detailed description of different construction activities, including a construction timeline and schedule by activity, including development of the transmission line.

Response: See responses to Items 27 and 28 above.

Witness: Alfonso Tovar

SITING BOARD 1-44:

Provide the assumption of how many monthly trips for each type of delivery truck will be needed on average over the Project construction period and during the peak construction period.

Response: "Refer to Exhibit ""SSHKYSB_CAND27_BasicConstructionChart"" submitted in response to Item #27 for guidance:

During the first 4 months, heavy construction equipment for site conditioning will be used.

During months 5-10, an average of 225 trucks per month (11/day) will be delivering steel posts, tracker components and modules. Rolls of medium cable voltage and the 31 (expected) inverter containers will also be delivered during this timeframe. This will be the period with the heaviest traffic across the site.

Witness: Alfonso Tovar

SITING BOARD 1-45:

Provide the maximum expected load weights for each type of delivery truck, including cement and water trucks, heavy equipment, gravel for access roads, panels, inverters, and the transformer.

Response: Nearly all trucks will be limited to the US highway limit (typically 80,000 pounds), or the limit set by state and/or county roads. This limit includes the weight of the truck itself and its cargo. If special requirements are necessary, the construction company will be responsible for obtaining the necessary permits for overweight loads.

Witness: Alfonso Tovar

SITING BOARD 1-46:

Identify the specific roadways used by heavy trucks, including for delivery of the transformer.

Response: Heavy trucks will utilize Highway 90 (Summer Shade Road), including the delivery of the transformer, as well as Tompskinville Rd. (KY 163) as main roads. Additional roadways that may be utilized by heavy trucks include but are not limited to Apple Grove Road and Clifton Smith Road. Planned routes for deliveries will be finalized prior to construction.

Witness: Alfonso Tovar

SITING BOARD 1-47:

Provide the estimated weight of the project's required substation transformer and the truck class necessary for its delivery.

<u>Response</u>: The estimated weight of the Project's required substation transformer is 230,000 pounds. The truck class will be determined by the transportation provider for this delivery.

<u>Witness</u>: Alfonso Tovar

SITING BOARD 1-48:

Explain whether any oversize or overweight deliveries will require special permits from the Metcalfe County Road Department of the Kentucky Department of Transportation. Explain the plan for repairing Project-related damage to any roadways or bridges.

Response: No oversize or overweight deliveries are expected, except the main power transformer. We will confirm whether any oversize or overweight deliveries will require special permits from the Metcalfe County Road Department and/or the Kentucky Department of Transportation prior to construction. Summer Shade will plan to have a conditions survey performed to document the pre-construction condition of roadways and bridges. Pre-construction, or any project-related damage to the roadways and bridges will be repaired as required in a timely manner.

Witness: Mark Carney

SITING BOARD 1-49:

Explain whether any traffic stoppages will be necessary to accommodate large truck deliveries for the Project and/or for constructing the Project transmission line. If yes, provide the expected locations, frequency and length of those stoppages.

Response: The construction company will be responsible for managing traffic and flagging for traffic as necessary. The construction company will communicate and coordinate with the County before deliveries are expected.

Witness: Alfonso Tovar

SITING BOARD 1-50:

State the local roads that will be utilized for construction of the transmission line. For these roads, provide:

a. A description of current traffic and road conditions, including number of lanes, presence of shoulders and/or bridges, speed and weight limits.

b. Anticipated traffic impacts from transmission line construction activities, i.e., number of construction vehicle trips by type (passenger or delivery) per day, load weights, stoppages, delays, etc.

c. Any road or traffic mitigation measures that will be implemented before or after transmission line construction.

Response: Highway 90, also known as Summer Shade Road, will be the main roadway utilized for construction of the transmission line.

a. See the Traffic Analysis in Appendix F of the SAR. Page 4 of the Traffic Analysis Report contains the description of all roadways (including Apple Grove Road and KY 90) in the vicinity of the project area. The description includes Annual Average Daily Traffic (AADT), number of lanes, posted speed limits, and functional class. Page 13-14 of the Traffic Analysis Report identifies the truck weight limits on each roadway (including Apple Grove Road and KY 90) based on KYTC roadway classification. The shoulder width for KY 90 is 6' (2' paved & 4' unpaved). The shoulder width for Apple Grove Road is unknown but it is unlikely that a shoulder exists for the local roadway. One bridge (KY 90 @ milepoint 1.13) was identified with truck weight limit less than the weight limit classification.

b. Due to the short length of the transmission line, no additional traffic impacts are expected beyond impacts already anticipated as part of constructing the overall Project.

c. Please refer to the proposed mitigation measures 21-25 of the Site Assessment Report, which are the following:

21. Summer Shade Solar shall consult with the Kentucky Transportation Cabinet (KYTC) regarding truck and other construction traffic and obtain necessary permits from the KYTC.

22. Summer Shade Solar shall consult with the Metcalfe County Road Supervisor regarding truck and other construction traffic and obtain any necessary permits from the County.

23. Summer Shade Solar shall develop special plans and obtain necessary permits before transporting heavy loads, especially the substation transformer, onto state or county roads.

24. Summer Shade Solar shall comply with any road use agreement executed with the County. Such an agreement might include special considerations for overweight loads, routes utilized by heavy trucks, road weight limits, and bridge weight limits.

25. Summer Shade Solar shall develop and implement a traffic management plan to minimize the impact on traffic flow and keep traffic safe. Any such traffic management plan shall also identify any traffic-related noise concerns during the construction phase and develop measures that would address those noise concerns.

Witness: Shane Kelley

SITING BOARD 1-51:

Provide the width and weight limit ratings of all bridges and culverts within a two-mile radius of the project.

Response: The following bridges are located within 2 miles of the project:

- There is a bridge identified on KY 90 at milepoint 1.13 over Glover Creek. The width of the bridge is 37 feet (34 feet curb to curb) and length is 64 feet, and it was rated in “Fair” condition in 2024. It has a posted weight limit of 44,000 lbs.
- There is a bridge on Hilltop View Road approximately 0.04 miles south of the intersection with KY 90 over a tributary for Glover Creek. The width of the bridge is 24 feet (22.5 feet curb to curb) and the length is 28 feet, and it was rated in “Good” condition in 2024. There is no posted weight limit but the weight limit on a local roadway is up to 36,000 lbs.
- There is a bridge identified on KY 640 at milepoint 0.92 which is 0.92 miles north of the intersection with KY 90 over Glover Creek. The width of the bridge is 21 feet and the length is 23 feet, and it was rated in “Fair” condition in 2024. There is no posted weight limit but the weight limit on KY 640 (Class AA) is 62,000 lbs.
- There is a bridge identified on KY 163 at milepoint 0.96 which is 0.7 mile south of the intersection with Apple Grove Road. The width of the bridge is 51 feet (47.5 feet curb to curb) and the length is 102.3 feet, and it was rated in “Good” condition in 2022. There is no posted weight limit but the weight limit on KY 163 (Class AAA) is 80,000 lbs.

Witness: Shane Kelley

SITING BOARD 1-52:

Describe any repairs or upgrades that will need to be made to any bridges or culverts prior to the delivery and construction phase of the project.

Response: Repairs and upgrades to bridges and culverts will be evaluated on a case by case basis, based on the expected bearing load. Upgrades will be performed as necessary in accordance with any road agreement executed with the County.

Witness: Alfonso Tovar

SITING BOARD 1-53:

Provide any communication with the Federal Aviation Administration (FAA) or the Kentucky Airport Zoning Commission regarding the project.

Response: The FAA notice criteria tool was utilized to determine if the project exceeded notice criteria requiring coordination with the FAA. The notice criteria tool indicated that the project did not exceed notice criteria, therefore, Summer Shade Solar is not required to coordinate with the FAA. Summer Shade Solar has not communicated with the Kentucky Airport Zoning Commission; however, the Kentucky Airport Zoning Commission Permit Map was used to determine that the project was not located within an "Airport Permit Required Area."

Witness: Shane Kelley

SITING BOARD 1-54:

Refer to the Kentucky Geological Survey Oil and Gas Wells Search (KY Geode: KGS Oil and Gas Wells Search (uky.edu)).

a. Provide a map with all active and inactive oil or gas wells on the proposed site. Also include any gas- gathering pipelines associated with the wells.

b. Determine and provide an explanation of whether any of these wells are currently permitted and active.

c. Confirm whether the existence of oil and gas wells and pipelines will require adjustments to the proposed location of solar panels for each oil and gas wells and pipelines.

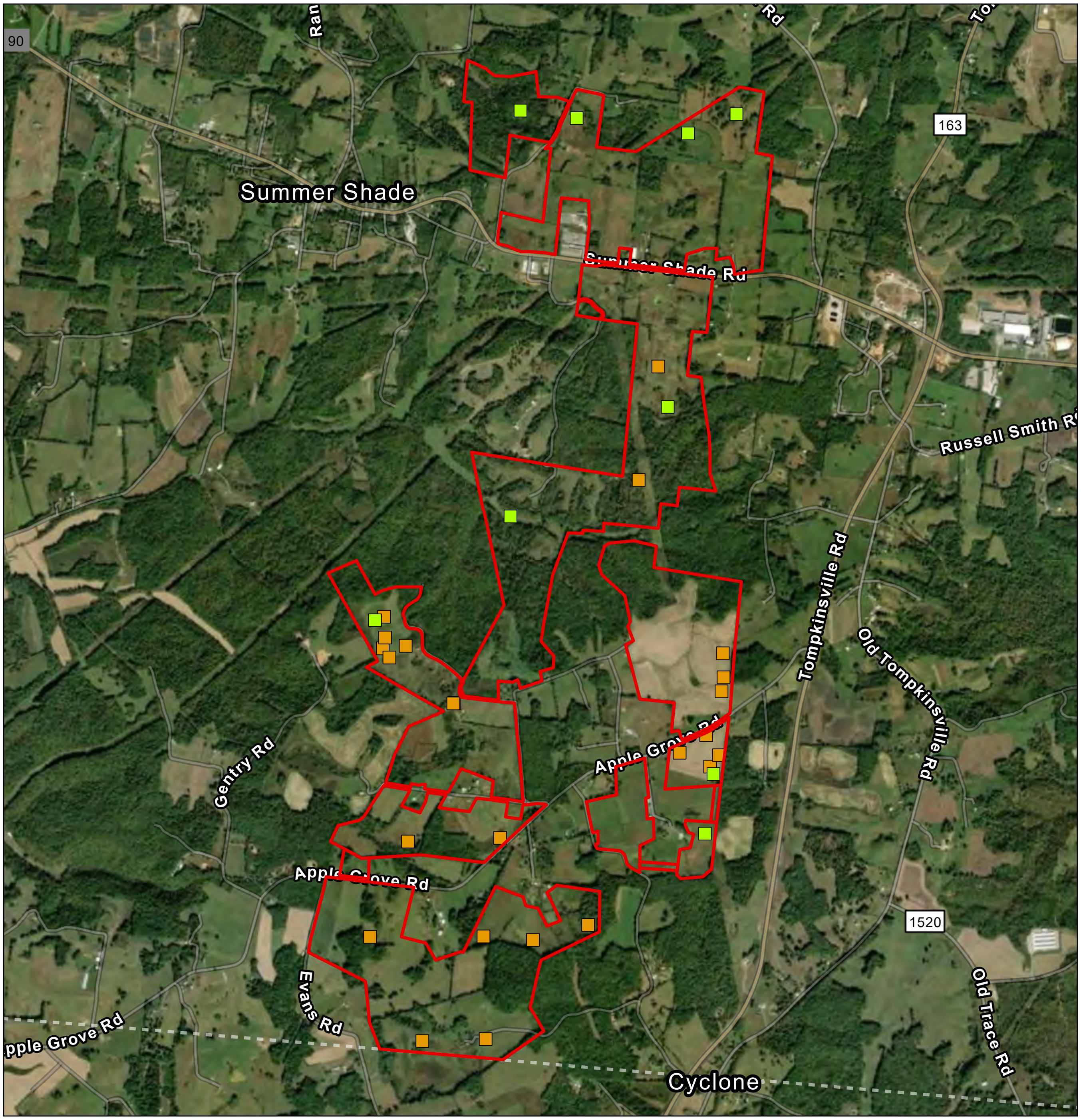
Response:

a. Please see the map provided below for oil/gas wells identified by the KGS Oil and Gas wells database.

b. Thirty-two oil/gas wells were identified within the Project according to the KGS Oil and Gas Wells database. Twenty-three of the identified wells have a status of capped or abandoned. The status of the nine remaining wells is unknown according to the database. See answer to Item 54c below for further information.

c. Landowners with prior existing oil/gas leases on the properties have all signed affidavits of non-production and have not indicated that there are any oil and gas wells to their knowledge.

Witness: Shane Kelley / Matt Kiehlmeier

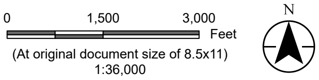


Legend

🟥 Project Boundary

KGS Oil or Gas Well

- 🟩 Well (Status Unknown)
- 🟧 Capped and Abandoned Well



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Project Location
Metcalfe County, Kentucky

Prepared by TCN on 2025-05-21

Client/Project
Summer Shade Solar, LLC
Summer Shade Solar Project
RFI Responses

172658275

Figure No.
B

Title
Oil or Gas Wells Located Within the Project

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC, KGS
3. Background: ESRI World Imagery Hybrid

*No Gathering Lines mapped within Project in KGS Database

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SITING BOARD 1-55:

Provide any geotechnical reports for the project.

Response: See the reports attached. Due to file sizes, the reports are being submitted in separate files.

Witness: Alfonso Tovar

SITING BOARD 1-56:

Explain any specific restrictions to be placed on the time of day or days of the week during which other loud construction activities, other than pile driving, may take place.

Response: As shared in proposed Mitigation Measure 14 of the Site Assessment Report, Summer Shade will limit construction activity, process and deliveries, including field visits, arrival, departure, planning, meetings, surveying, etc to the hours between 6 a.m. and 10 p.m. local time, Monday through Saturday. Select non-noise causing activity and non-construction work may be required during night hours when equipment is not energized. Higher-noise level activities such as pile-driving are proposed between 7 a.m. to 9 p.m. local time, Monday through Saturday.

Witness: Alfonso Tovar

SITING BOARD 1-57:

Provide the types of equipment used for construction of the transmission line and sound levels generated by this equipment at a distance of 50 feet.

Response: Due to the short length of the proposed transmission line, the equipment expected to be used is anticipated to generate less or equal noise levels compared to the construction of the generation facilities. There are no receptors within 50 feet of the proposed transmission line.

Witness: Alfonso Tovar

SITING BOARD 1-58:

State the number of residential structures that may have a view of any portion of the Project, including fencing, solar arrays, substation or other infrastructure.

Response: Stantec conducted a viewshed analysis that is included in Appendix G of the SAR. The viewshed analysis indicated that approximately 74 residential structures may have a view of any portion of the project. This estimate is conservative and many of the residential structures likely only have a very limited view of portions of the project. Mature vegetation will remain where possible and a vegetative screening plan has been developed to reduce impacts to the viewshed of adjacent residential structures.

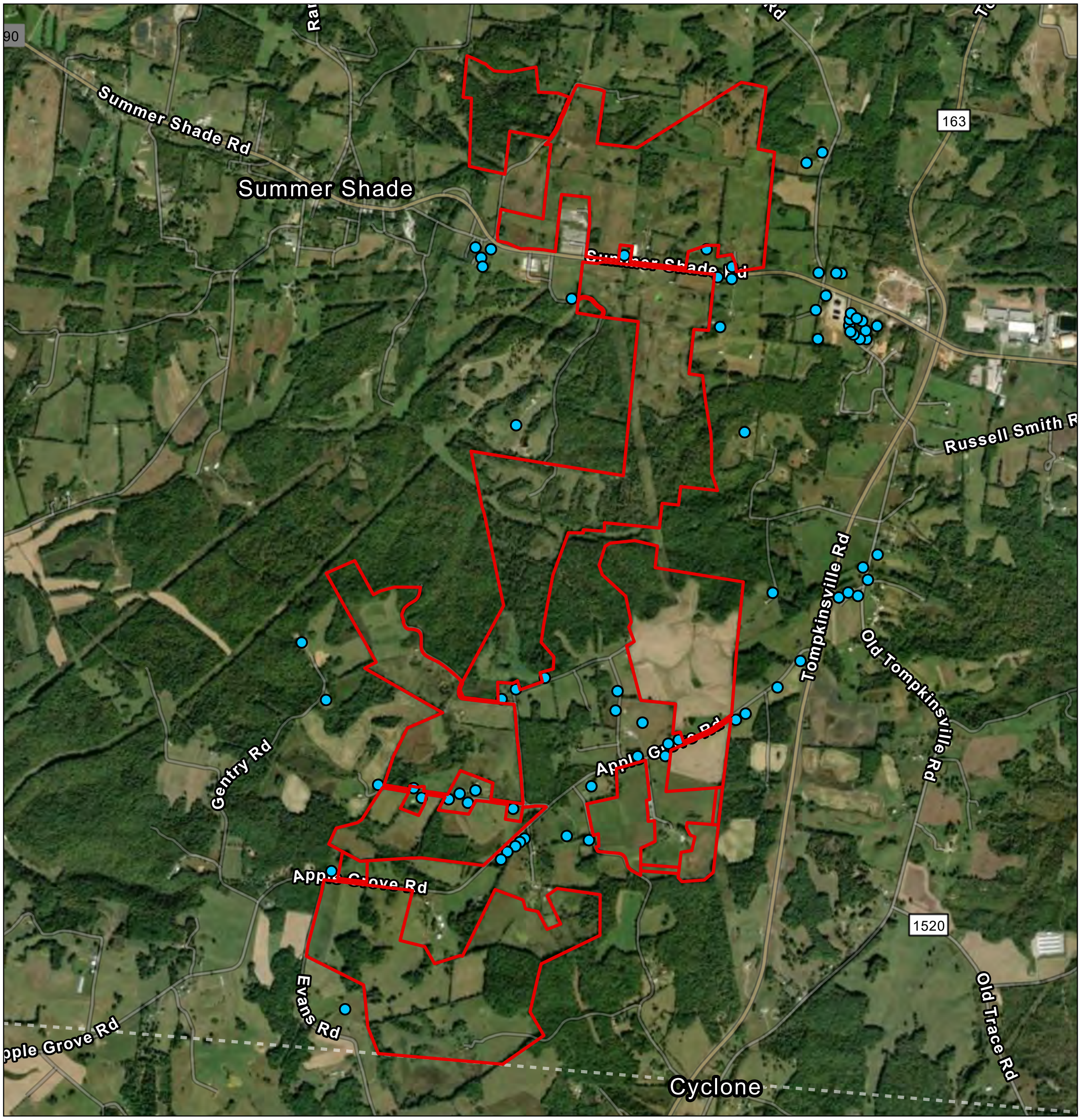
Witness: Shane Kelley

SITING BOARD 1-59:

Provide a map of the residential structures that may have a view of any portion of the Project.

Response: A map of the residential structures that may have a view of any part of the project is provided below.

Witness: Shane Kelley



Legend

🟥 Project Boundary

● Residential Structure Potentially In-view of the Project

0 1,500 3,000 Feet

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1:35,660

N

Stantec

Project Location
Metcalfe County, Kentucky

Prepared by TCN on 2025-05-21

Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
RFI Responses

Figure No.
C

Title
Residential Structures Potentially In-View of Project

Page 1 of 1

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC, USGS
3. Background: ESRI World Imagery Hybrid

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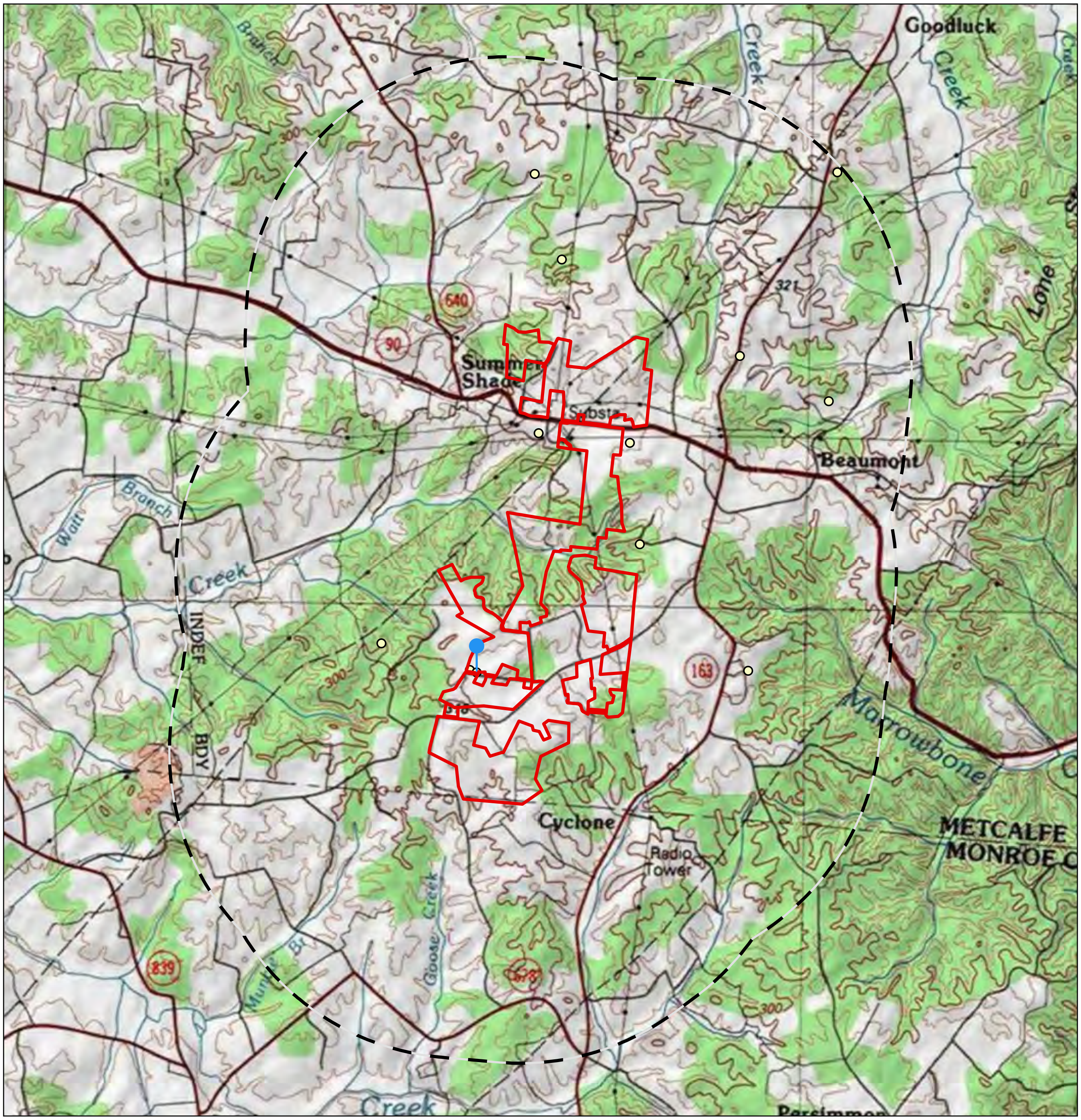
SITING BOARD 1-60:

State the total number of residential structures that may have a view of one or more transmission line poles. State the number of those residential structures with which the Applicant has entered into a ROW agreement.

Response: The transmission line is located within participating parcels of the project and no additional ROW agreements are required. The interconnection location to the EKPC Substation is still being determined; however, at this time no additional transmission line poles will be required for interconnection and interconnection will occur within participating landowner parcels. Therefore, no residential structures would have a view of additional transmission line poles associated with the project.

Witness: Shane Kelley



Legend
🟥 Project Boundary
2-mile Buffer
○ Cemetery

0 1,500 3,000
Feet
(At original document size of 8.5x11)
1:75,000

N

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC, KHC
3. Background: USGS Topographic Map

Stantec

Project Location
Metcalfe County, Kentucky

Prepared by TCN on 2025-05-21

Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
RFI Responses

Figure No.
E

Title
Cemeteries within 2 Miles

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SITING BOARD 1-61:

Confirm all cemeteries located within a two-mile radius of the project and provide if the project will restrict access to them in any way. If not, confirmed explain.

Response: Eleven cemeteries were identified within a 2-mile radius of the project boundary including two within the project itself. Summer Shade has a minimum setback of 50 feet from the cemeteries within the project and will not restrict access to any cemeteries. A map of the identified cemeteries is provided below.

Witness: Shane Kelley

SITING BOARD 1-62:

Provide a one-page directional map showing highlighted anticipated delivery routes for the project. Include on the map: access roads, access points, existing roads, bridges, electric generation components, and all structures within two miles of the project. Differentiate between roads and bridges that will and will not be used for deliveries.

Response: Delivery routes have not yet been determined. As the start date of construction approaches, the hauling contractor and/or EPC contractor will determine the most appropriate route(s). The deliveries will comply with all laws and regulations related to roadways.

Witness: Alfonso Tovar

SITING BOARD 1-63:

State the number of years it will take for planted trees and scrub to reach mature height.

Response: Refer to Mitigation Measure 10, included in the Site Assessment Report. Planted vegetative screening will, at minimum, reach a height of 6 feet and width of 10 feet within four years after planting.

Witness: Shane Kelley

SITING BOARD 1-64:

Provide how many acres of vegetation are expected by cleared during construction.

Response: Summer Shade Solar estimates approximately 138 acres of tree clearing would be required to develop the project that will be cleared during construction. Those areas are provided in the map in response to Item 67.

Witness: Shane Kelley

SITING BOARD 1-65:

Provide a narrative description of any vegetative clearing that will occur across the project. Include any permits that will be required.

Response: Vegetative clearing across the Project site will be limited to areas that need to be cleared to avoid impeding construction or operations. Permits that may be required include any permits triggered by USACE Section 7 review, the Project Stormwater Pollution Prevention Plan (SWPPP), and the construction general permit.

Witness: Mark Carney / Aubree Muse

SITING BOARD 1-66:

Explain how the project has been designed to minimize the amount of tree clearing required.

Response: The Project land is primarily cleared grazing land. The Project has been designed to minimize tree clearing to only necessary foliage that may impede the construction and/or operations of the plant.

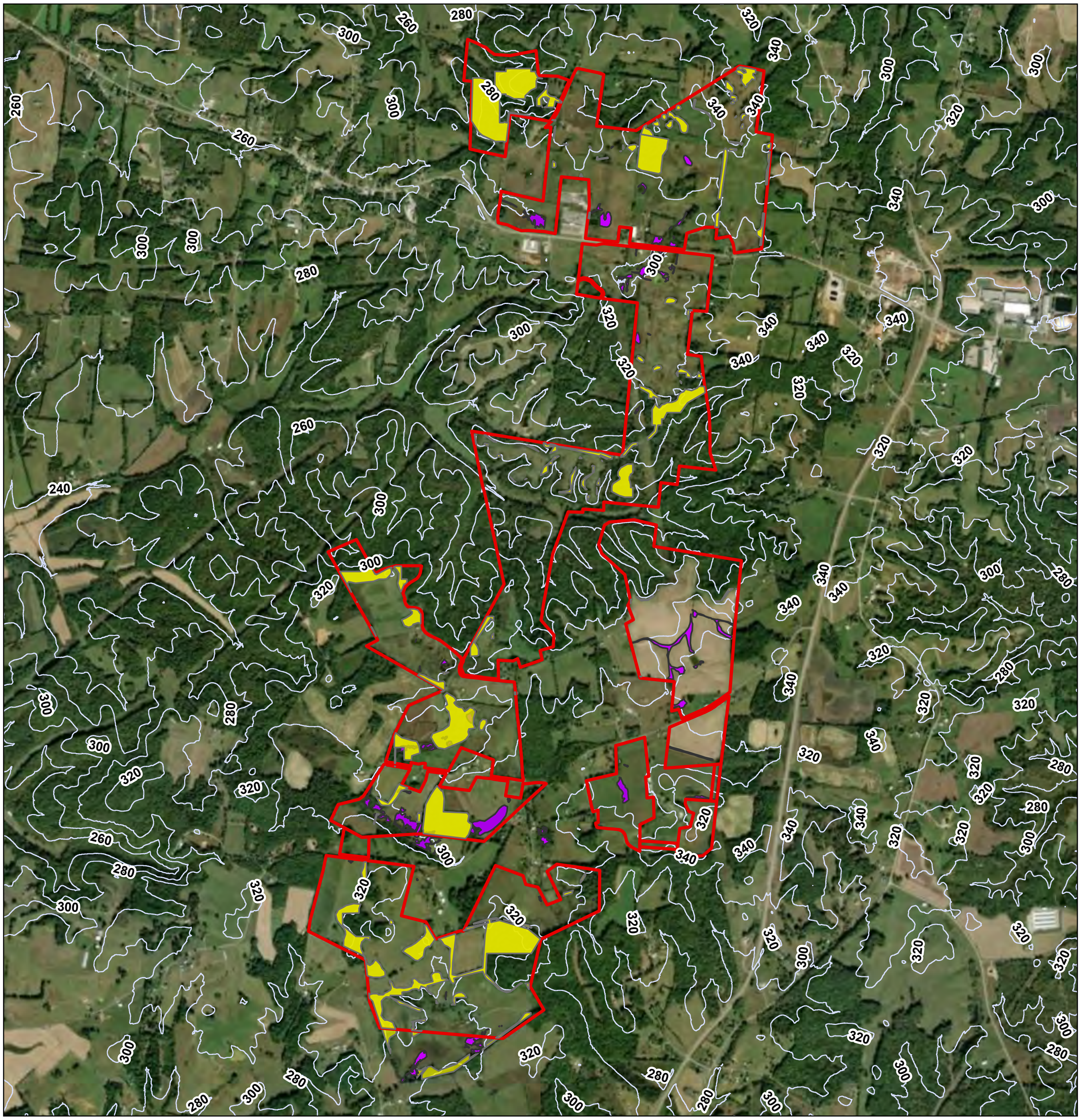
Witness: Aubree Muse

SITING BOARD 1-67:

Provide a map showing all planned areas of vegetative clearing. Include on the map satellite imagery, wetland features, and elevation contours.

Response: Summer Shade Solar estimates approximately 138 acres of tree clearing would be required to develop the project. Those areas are provided in the map below.

Witness: Shane Kelley



Legend

🟥 Project Boundary

🟨 Tree Clearing Area

🟪 Delineated Wetland

(At original document size of 8.5x11)
1:36,000

Stantec

Project Location
Metcalfe County, Kentucky

Prepared by TCN on 2025-05-21

Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
RFI Responses

Figure No.
D

Title
Site Tree Clearing

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: ESRI World Imagery Hybrid

C:\Users\tnewman\OneDrive - Stantec\GIS\Projects\Candela\Summer Shade\SummerShade_172658275.aprx   Revised: 2025-06-20 By: tnewman

SITING BOARD 1-68:

Explain how Summer Shade plans to mitigate flood risks within the site after vegetative clearing.

Response: Summer Shade plans to mitigate flood risks within the site after vegetative clearing by implementing mitigation measures that will be outlined in the SWPPP such as silt fencing, erosion control mats, staging of construction activities to reduce the amount of disturbance occurring at any one time, and temporary seeding to stabilize soil.

Witness: Shane Kelley

SITING BOARD 1-69:

Provide a wetland delineation report for the project. If one does not exist, provide when one will be produced.

Response: A wetland delineation was completed in 2024 and is provided in separate files.

Witness: Shane Kelley

SITING BOARD 1-70:

Explain whether the Site Layout Plan will be modified after the Wetland Delineations are completed.

Response: The site layout takes into account the wetland delineation to reduce impacts to wetlands, streams, and waterbodies. Summer Shade Solar will seek a USACE Nationwide Permit for impacts to waters due to road crossings and trenching for collection lines. The impacts will be well below the Nationwide Permit threshold of 0.5 acres.

Witness: Shane Kelley

SITING BOARD 1-71:

State whether the Project panels will be coated with an anti-reflective coating. If not, explain why not.

Response: Solar modules will have an anti-reflective coating.

Witness: Alfonso Tovar

SITING BOARD 1-72:

Refer to the Application, Attachment D Public Meeting Documentation. Provide any documents that were presented to the community that were not included in Attachment D.

Response: Please see take-home flyer that was available for attendees at the Public Meeting, which is attached below. The flyer includes Project information as well as contact information. Additionally, Summer Shade also projected a Google Earth image of the site layout (as contained in Appendix B to the Site Assessment Report) so that we could provide attendees with points of reference in a live-map format. This depiction is also attached below.

Witness: Aubree Muse

Candela
RENEWABLES

Summer Shade Solar

Proposed
106 MW
photovoltaic solar-plus storage facility

Interconnect:
161 kV
Summer Shade Substation

Summer Shade projected construction start:
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Project life:
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Local Benefits for Metcalfe County, KY

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1 –2 year construction timeline

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summershadesolar.com
info@summershadesolar.com • (270) 681-5058

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and 2025 Milestones

The Summer Shade Project is in mid-stage development and preparing to apply for its construction permit.

- Completed current environmental surveys
- Conducted engineering analysis of site hydrology and subsurface conditions
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The project will encourage vegetation under arrays and explore the possibility of sheep grazing as part of our vegetation management planning.

Multiple tracker technologies to minimize grading needed across the site.

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01.25.25


Feedback welcome!
Please place comments in the basket

SITING BOARD 1-73:

Refer to Application, Section 6, Public Notice Report. Provide a summary of all communication to date with that correspondent (e.g., adjoining neighbor #1, adjoining neighbor #2, community member #1, fire department board member #1, etc.). Each correspondence summary must include questions and concerns voiced, information provided, and feedback received.

Response: As evidenced by the Public Notice Report, the Project team recorded many outreach conversations with Project stakeholders. Given that these conversations and touchpoints occurred over a span of several years, the Summer Shade team cannot recall all specific details to provide a summary of each event. Generally, questions asked were commonly about Project schedule, overall project location, lifespan of the Project, why this location was chosen for the Project, where the point of interconnection is located, and to whom the power will be sold. General concerns voiced included the presence of karst in the area, the material safety of solar panels, whether the Project area would experience a "heat island" effect, and whether the Project would have any impact of property values of surrounding homes. In addition to sharing verbal information on each concern, we provide written reports on our project website, which have been uploaded in response to this question. Feedback received was primarily appreciative that we were listening to concerns and sharing relevant information.

Witness: Aubree Muse

Analysis of the Potential for a Heat Island Effect in Large Solar Farms

Vasilis Fthenakis[1,2] and Yuanhao Yu[1]

[1] Center for Life Cycle Analysis, Department of Earth and Environmental Engineering, Columbia University, New York, NY

[2] PV Environmental Research Center, Brookhaven National Laboratory, Upton, NY

***Abstract* — Large-scale solar power plants are being built at a rapid rate, and are setting up to use hundreds of thousands of acres of land surface. The thermal energy flows to the environment related to the operation of such facilities have not, so far, been addressed comprehensively. We are developing rigorous computational fluid dynamics (CFD) simulation capabilities for modeling the air velocity, turbulence, and energy flow fields induced by large solar PV farms to answer questions pertaining to potential impacts of solar farms on local microclimate. Using the CFD codes Ansys CFX and Fluent, we conducted detailed 3-D simulations of a 1 MW section of a solar farm in North America and compared the results with recorded wind and temperature field data from the whole solar farm. Both the field data and the simulations show that the annual average of air temperatures in the center of PV field can reach up to 1.9℃ above the ambient temperature, and that this thermal energy completely dissipates to the environment at heights of 5 to 18 m. The data also show a prompt dissipation of thermal energy with distance from the solar farm, with the air temperatures approaching (within 0.3℃) the ambient at about 300 m away of the perimeter of the solar farm. Analysis of 18 months of detailed data showed that in most days, the solar array was completely cooled at night, and, thus, it is unlikely that a heat island effect could occur. Work is in progress to approximate the flow fields in the solar farm with 2-D simulations and detail the temperature and wind profiles of the whole utility scale PV plant and the surrounding region. The results from these simulations can be extrapolated to assess potential local impacts from a number of solar farms reflecting various scenarios of large PV penetration into regional and global grids.**

***Index Terms* – PV, climate change, heat island, fluid dynamics**

I. INTRODUCTION

Solar farms in the capacity range of 50MW to 500 MW are being proliferating in North America and other parts of the world and those occupy land in the range from 275 to 4000 acres. The environmental impacts from the installation and operation phases of large solar farms deserve comprehensive research and understanding. Turney and Fthenakis [1] investigated 32 categories of impacts from the life-stages of solar farms and were able to categorize such impacts as either beneficial or neutral, with the exception of the "local climate" effects for which they concluded that research and observation are needed. PV panels convert most of the incident solar radiation into heat and can alter the air-flow and temperature profiles near the panels. Such changes, may subsequently affect the thermal environment of near-by populations of humans and other species. Nemet [2] investigated the effect on global climate due to albedo change from widespread installation of solar panels and found this to be small compared to benefits from the reduction in greenhouse gas emissions. However, Nemet did not consider local micro-climates and his analytical results have not been verified with any field data. Donovan [3] assumed that the albedo of ground-mounted PV panels is similar to that of underlying grassland and, using simple calculations, postulated that the heat island effect from installing PV on grassy land would be negligible. Yutaka [4] investigated the potential for large scale of roof-top PV installations in Tokyo to alter the heat island effect of the city and found this to be negligible if PV systems are installed on black roofs.

In our study we aim in comprehensively addressing the issue by modeling the air and energy flows around a solar farm and comparing those with measured wind and temperature data.

II. FIELD DATA DESCRIPTION AND ANALYSIS

Detailed measurements of temperature, wind speed, wind direction, solar irradiance, relative humidity, and rain fall were recorded at a large solar farm in North America. Fig. 1 shows an aerial photograph of the solar farm and the locations where the field measurements are taken.

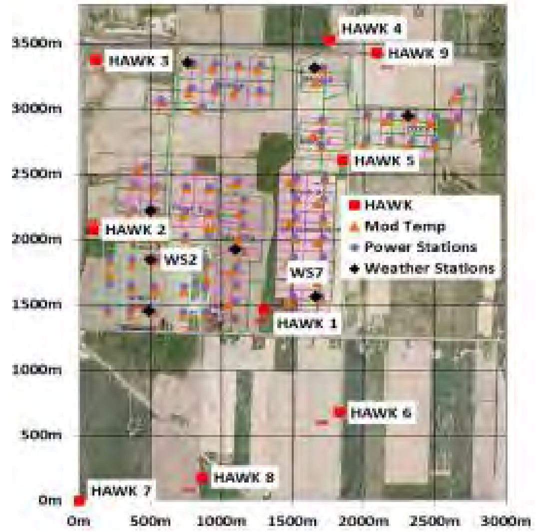


Fig. 1. A picture of the solar farm indicating the locations of the monitoring stations

The field data are obtained from 17 monitoring stations within and around the solar farm, including 8 weather stations (WS) and 9 Hawk stations (HK), all at 2.5 m heights off the ground. There also 80 module temperature (MT) sensors at the back-side of the modules close to each of the corresponding power stations. The WS and MT provide data at 1-min intervals, while the Hawk provides data every 30 minutes. The WS and MT data cover a period of one year from October 2010 to September 2011, while the Hawk data cover a period of 18 months from March 2010 through August 2011.

Hawk stations 3, 6, 7, 8 and 9 are outside the solar farm and were used as reference points indicating ambient conditions. The measurements from Hawk 3, 6, 8 and 9 agree very well confirming that their distances from the perimeter of the solar farm are sufficient for them to be unaffected by the thermal mass of the PV system; Hawk 7 shows higher temperatures likely due to a calibration inaccuracy. In our comparative data analysis we use Hawk 6 as a reference point and, since the prevailing winds are from the south, we selected the section around WS7 as the field for our CFD simulations. Figures 2 to 7 show the difference between the temperatures in Hawk 6 and those in the weather stations WS2 and WS7 within the field, and Hawks 1, 2, 4 and 5 around the solar field.

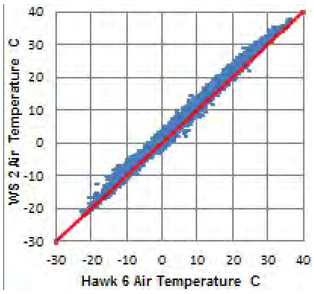


Fig. 2. Air temp WS2 vs. Hawk 6

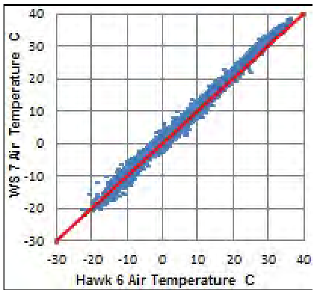


Fig.3. Air temp WS7 vs. Hawk6

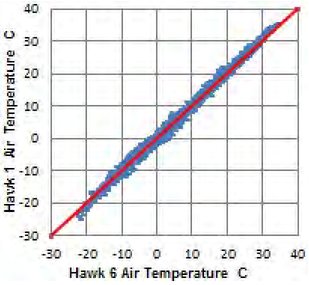


Fig. 4. Air temp Hawk 1 vs. 6

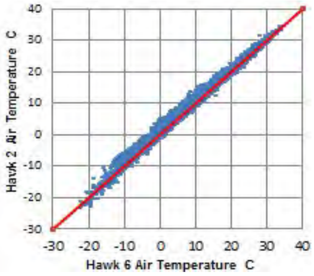


Fig. 5. Air temp Hawk 2 vs. 6

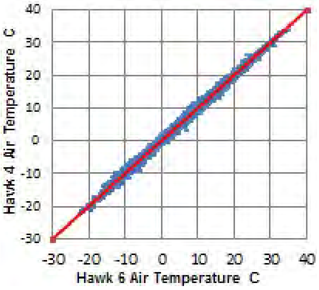


Fig. 6. Air temp Hawk 1 vs. 6

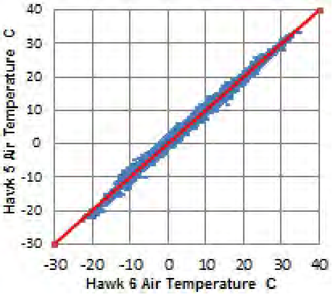


Fig. 7. Air temp Hawk 2 vs. 6

These figures and Table 1 show that with the exception of Hawk 4, the closer the proximity to solar farm the higher the temperature difference from the ambient (indicated by Hawk 6). The relative high temperatures recorded at Hawk 4, and also the relative low temperatures at Hawks 1 and 5 are explained by the prevailing wind direction, which for the time period used in our analysis (8/14/2010-3/14/2011) was Southerly (158°-202°). Hawk 4 is downwind of the solar farm, whereas Hawks 1 and 5 are upwind; the downwind station "feels" more the effect of the heat generated at the solar farm than the ones upwind.

Fig. 8 shows the decline in air temperature as a function of distance to solar farm perimeter. Distances for WS2 and WS7 are negative since they are located inside the solar farm site. WS2 is further into the solar farm and this is reflected in its higher temperature difference than WS7.

TABLE I

DIFFERENCE OF AIR TEMPERATURE (@2.5 M HEIGHTS) BETWEEN THE LISTED WEATHER AND HAWK STATIONS AND THE AMBIENT

Met Station	**WS2**	**WS7**	**HK1**	**HK2**	**HK3**	**HK4**	**HK5**	**HK9**
Temp Difference from H6 (^oC)	1.878	1.468	0.488	1.292	0.292	0.609	0.664	0.289
Distance to solar farm perimeter (m)	-440	-100	100	10	450	210	20	300

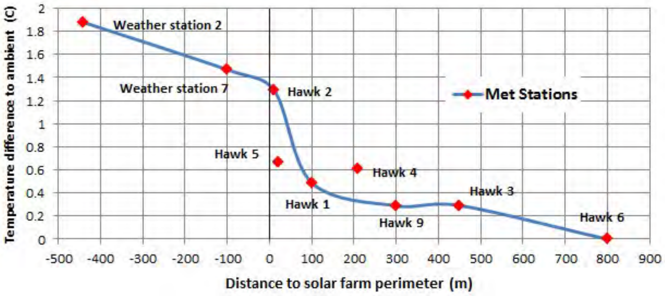


Fig. 8. Air temperature difference as a function of distance from the perimeter of the solar farm. Negative distances indicate locations within the solar farm.

We also examined in detail the temperature differences between the modules and the surrounding air. These vary throughout the year but the module temperatures are consistently higher than those of the surrounding air during the day, whereas at night the modules cool to temperatures below ambient; an example is shown in Fig. 9. Thus, this PV solar farm did not induce a day-after-day increase in ambient temperature, and therefore, adverse micro-climate changes from a potential PV plant are not a concern.

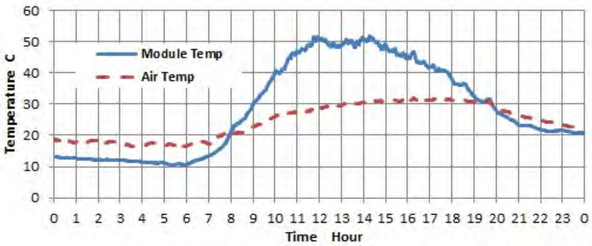


Fig. 9. Comparison of module temperature and air temperature 2.5 m off the ground on a sunny day (July 1, 2011)

III. CFD MODEL DEVELOPMENT

In preliminary simulations we tested the Ansys CFX and FLUENT computational fluid dynamics codes (CFD) and decided to use FLUENT in detailed simulations. FLUENT offers several turbulence schemes including multiple variations of the k-ε models, as well as k-ω models, and Reynolds stress turbulence models. We used the standard, renormalized-group (RNG), and realizable k-ε turbulence closure scheme as it is the most commonly used model in street canyon flow and thermal stratification studies [5]. FLUENT incorporates the P-1 radiation model which affords detailed radiation transfer between the solar arrays, the ground and the ambient air; it also incorporates standard free convection and wind-forced convection models. Our choice of solver was the pressure-based algorithm SIMPLE which uses a relationship between velocity and pressure corrections to enforce mass conservation and obtain the pressure field. We conducted both three-dimensional (3-D) and 2-D simulations.

A 3-D model was built of four fields each covering an area of 93-meters by 73-meters (Fig. 10). Each field contains 23 linear arrays of 73-meter length and 1.8-meter width. Each array has 180 modules of 10.5% rated efficiency, placed facing south at a 25-degree angle from horizontal, with their bottom raised 0.5 m from the ground and their top reaching a height of 1.3 m . Each array was modeled as a single 73 m ×1.8 m × 1 cm rectangular. The arrays are spaced 4 meters apart and the roads between the fields are 8 m. Fig. 10 shows the simulated temperatures on the arrays at 14:00 pm on 7/1/2011, when the irradiance was 966 W/m^2. As shown, the highest average temperatures occur on the last array (array 46). Temperature on the front edge (array 1) is lower than in the center (array 23). Also, temperature on array 24 is lower than array 23, which is apparently caused by the cooling induced by the road space between two fields, and the magnitude of the temperature difference between arrays 24 and 46 is lower than that between arrays 1 and 23, as higher temperature differences from the ambient, result in more efficient cooling.

TABLE II
MODULES TEMPERATURE

Arrays	**1**	**23**	**24**	**46**
Temperature ℃	46.1	56.4	53.1	57.8

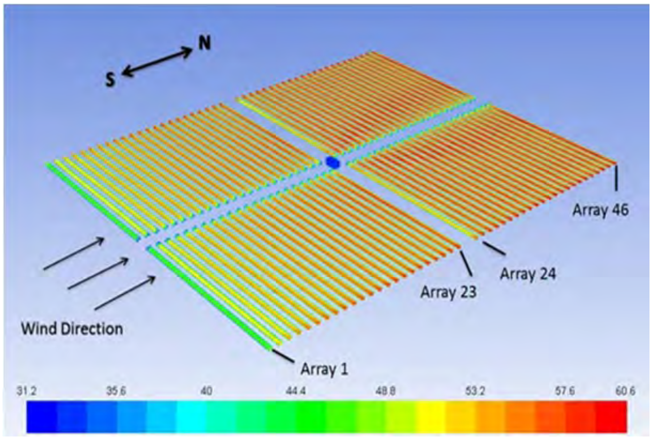
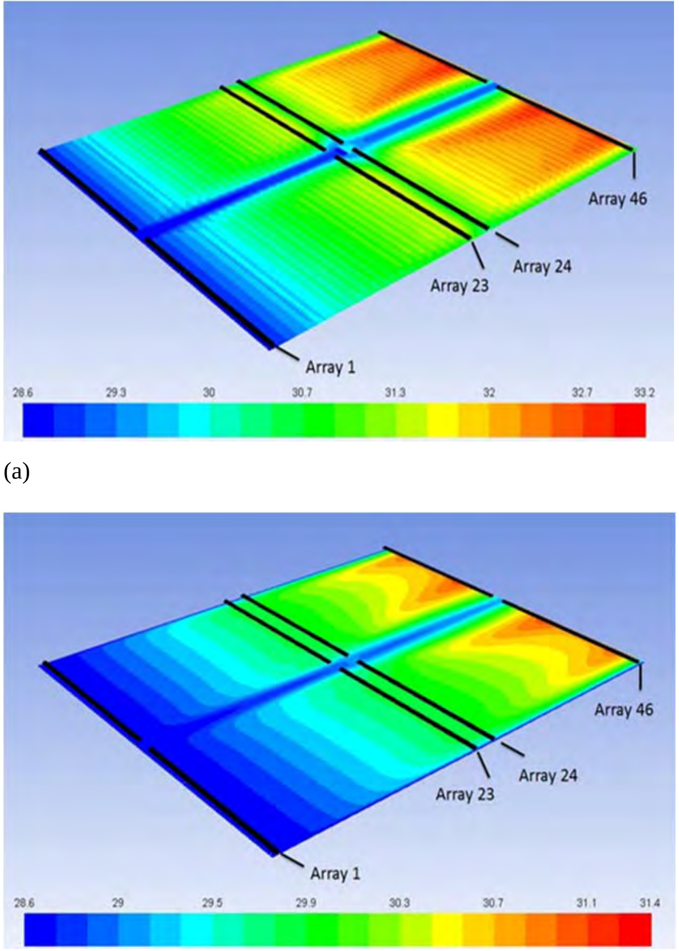


Fig. 10. Module temperatures from 3-D simulations of air flows and thermal exchange during a sunny day

Our simulations also showed that the air temperatures above the arrays at a height of 2.5 m ranged from 28.6 ℃ to 31.1℃; the ambient temperature was 28.6 ℃ (Fig. 11).



(a)

(b)

Fig. 11 Air temperatures from 3-D simulations during a sunny day. a) Air temperatures at a height of 1.5 m; b) air temperatures at a height of 2.5 m.

TABLE III
AIR TEMPERATURE

Temperature	Ambient (℃)	Low (℃)	High (℃)	Average (℃)
2.5m height	28.6	28.6	31.1	30.1
1.5m height	28.6	28.6	33.2	30.8

These simulations show a profound cooling effect with increasing height from the ground. It is shown that the temperatures on the back surface of solar panels is up to 30° C warmer than the ambient temperature, but the air above the arrays is only up to 2.5°C higher than the ambient (i.e., 31.1℃). Also the road between the fields allows for cooling, which is more evident at the temperatures 1.5 m off the ground (Fig. 11a). The simulations show that heat build-up at the power station in the middle of the fields has a negligible effect on the temperature flow fields; it was estimated that a power station adds only about 0.4% to the heat generated by the corresponding modules.

The 3-D model showed that the temperature and air velocity fields within each field of the solar farm were symmetrical along the cross-wind axis; therefore a 2-D model of the downwind and the vertical dimensions was deemed to be sufficiently accurate. A 2-D model reduced the computational requirements and allowed for running simulations for several subsequent days using actual 30-min solar irradiance and wind input data. We tested the numerical results for three layers of different mesh sizes and determined that the following mesh sizes retain sufficient detail for an accurate representation of the field data: a) Top layer: 2m by 1m, b) Middle layer: 1.5m by 0.6m, c) Bottom layer: 1m by 0.4m. According to these mesh specifications, a simulation of 92 arrays (length of 388m, height 9m), required a total of 13600 cells. Figures 12-15 show comparisons of the modeled and measured module and air temperatures.

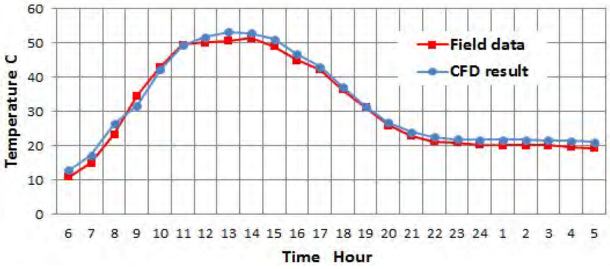


Fig. 12. Comparisons of field and modeled module temperatures; a sunny summer day (7/1/2011); 2-D simulations.

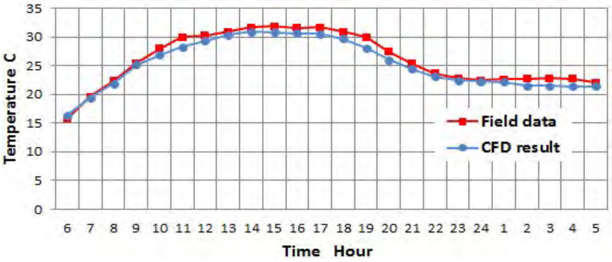


Fig. 13. Comparisons of field and modeled air temperatures at a height of 2.5 m; a sunny summer day (7/1/2011); 2-D simulations.

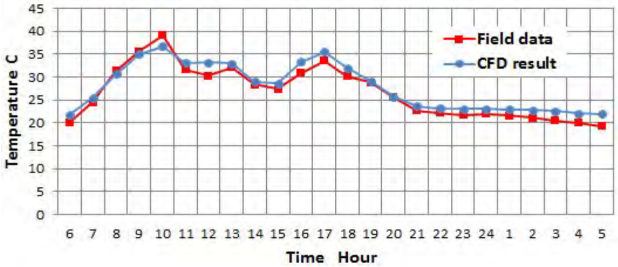


Fig. 14. Comparisons of field and modeled module temperatures; a cloudy summer day (7/11/2011); 2-D simulations.

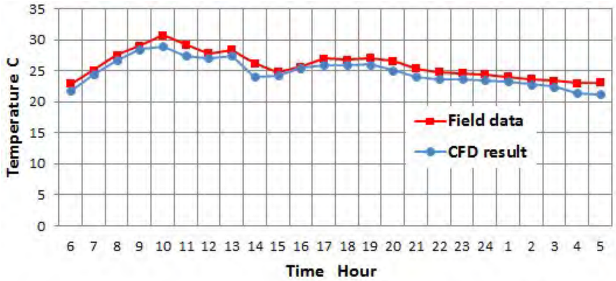
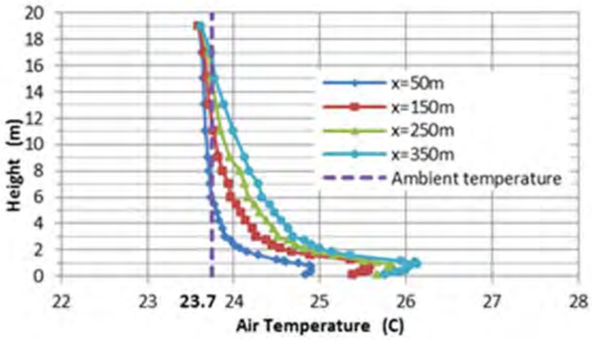
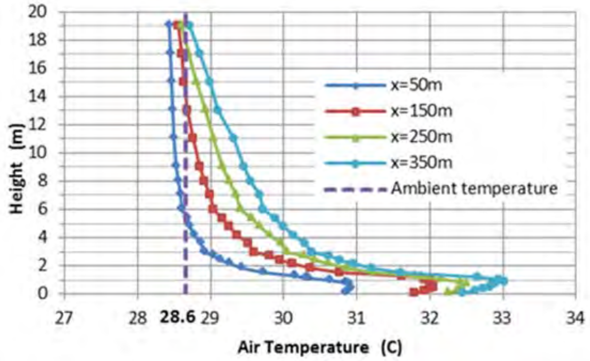


Fig. 15. Comparisons of field and modeled air temperatures at a height of 2.5 m; a cloudy summer day (7/11/2011); 2-D simulations.

Figures 16a and 16b show the air temperature as a function of height at different downwind distances in the morning and afternoon during a sunny summer day. At 9 am (irradiance 500 W/m2, wind speed 1.6 m/s, inlet ambient temperature 23.7℃), the heat from the solar array is dissipated at heights of 5-15m, whereas at 2 pm (irradiance 966 W/m^2, wind speed 2.8m/s, inlet ambient temperature 28.6℃ , the temperature of the panels has reached the daily peak, and the thermal energy takes up to 18 m to dissipate.



(a) 9:00 am



(b) 2:00 pm

Fig. 16 Air temperatures within the solar farm, as a function of height at different downwind distances. From 2-D simulations during a sunny summer day (7/1/2011) at 9 am and 2 pm.

IV. CONCLUSION

The field data and our simulations show that the annual average of air temperatures at 2.5 m of the ground in the center of simulated solar farm section is 1.9℃ higher than the ambient and that it declines to the ambient temperature at 5 to 18 m heights. The field data also show a clear decline of air temperatures as a function of distance from the perimeter of the solar farm, with the temperatures approaching the ambient temperature (within 0.3℃), at about 300 m away. Analysis of 18 months of detailed data showed that in most days, the solar array was completely cooled at night, and, thus, it is unlikely that a heat island effect could occur.

Our simulations also show that the access roads between solar fields allow for substantial cooling, and therefore, increase of the size of the solar farm may not affect the temperature of the surroundings. Simulations of large (e.g., 1 million m^2) solar fields are needed to test this hypothesis.

ACKNOWLEDGEMENT

We are grateful to First Solar for providing data for this study.

REFERENCES

[1] D. Turney and V. Fthenakis Environmental, "Impacts from the installation and operation of large-scale solar power slants," *Renewable and Sustainable Energy Reviews*, vol. 15, pp. 3261-3270, 2011.

[2] F.G. Nemet. "Net radiative forcing from widespread deployment of photovoltaics," *Environ. Sci. Technol.*, vol. 43, pp. 2173-2178, 2009.

[3] M. Donovan, "Memorandum: impact of PV systems on local temperature, " *SunPower*, July 6, 2010. http://www.rurdev.usda.gov/SupportDocuments/EA_5_17_13_RUS_ PartA.pdf

[4] Y. Genchi, M. Ishisaki, Y. Ohashi, H. Takahashi, & A. Inaba, "Impacts of large-scale photovoltaic panel installation on the heat island effect in Tokyo, " *in Fifth Conference on the Urban Climate*, 2003.

[5] Theory Guide, *ANSYS Fluent HELP 13.*

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summershadesolar.com
info@summershadesolar.com • (270) 681-5058

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01.25.25

NC CLEAN ENERGY
TECHNOLOGY CENTER

Health and Safety Impacts of Solar Photovoltaics

MAY 2017

NC STATE UNIVERSITY

NC CLEAN ENERGY TECHNOLOGY CENTER

NC STATE UNIVERSITY

Health and Safety Impacts of Solar Photovoltaics

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

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

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

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

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

1. Hazardous Materials

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

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

1.1 Project Installation/Construction

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

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

1.2 System Components

1.2.1 Solar Panels: Construction and Durability

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

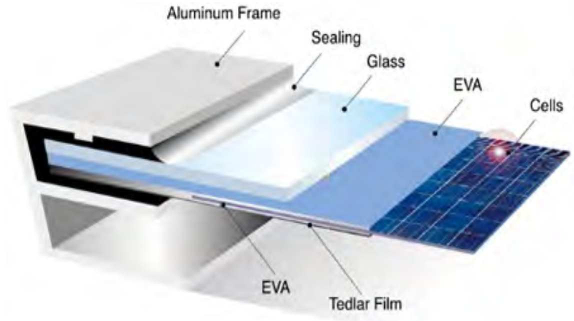

Figure 2: Components of crystalline silicon panels. The vast majority of silicon panels consist of a glass sheet on the topside with an aluminum frame providing structural support. Image Source: www.riteksolar.com.tw

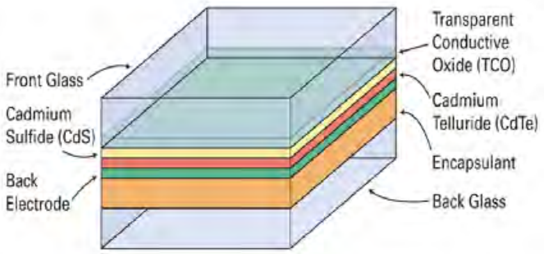

Figure 3: Layers of a common frameless thin-film panel (CdTe). Many thin film panels are frameless, including the most common thin-film panels, First Solar's CdTe. Frameless panels have protective glass on both the front and back of the panel. Layer thicknesses not to scale. Image Source: www.homepower.com

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

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

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

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

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

1.2.2 Photovoltaic (PV) Technologies

a. Crystalline Silicon

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

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

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

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

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

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

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

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

b. Cadmium Telluride (CdTe) PV Panels

This subsection examines the components of a cadmium telluride (CdTe) PV panel. Research demonstrates that they pose negligible toxicity risk to public health and safety while significantly reducing the public's exposure to cadmium by reducing coal emissions. As of mid-2016, a few hundred MWs of cadmium telluride (CdTe) panels, all manufactured by the U.S. company First Solar, have been installed in North Carolina.

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

Cadmium is toxic, but all the approximately 7 grams of cadmium in one CdTe panel is in the form of a chemical compound cadmium telluride, [24] which has 1/100th 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, 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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NC CLEAN ENERGY
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Property Values and Utility-Scale Solar Facilities

Research shows that there is no evidence that solar projects have adversely impacted neighboring properties.

Background

The utility-scale solar industry has seen significant growth over the past decade and demand for clean energy continues to grow as utility companies increase their investment in solar energy to meet customer demand, keep electricity prices affordable, and diversify their energy portfolio. The solar industry drives economic development, especially in rural communities, and can benefit all property owners through tax payments for roads, schools, and community services. In 2020, utility-scale solar projects contributed **$750 million in state and local taxes and land-lease payments** to property owners and have invested **nearly $116 billion total in projects nationwide.**[1] The industry also supports **120,000 jobs** across all 50 states.

Utility-scale solar is the fastest growing source of renewable energy in the United States with 12 gigawatts (GW) of capacity added to the grid in 2020 and 15.5 GW of capacity added in 2021.[2] According to the U.S. Energy Information Administration (EIA), solar power will account for nearly half of new U.S. electric generating capacity in 2022 with an expected growth by 21.5 GW in 2022.[3] There is generally broad support across the United States to increase solar capacity. However, as utility-scale solar installations require large tracts of land, some communities have raised concerns a nearby solar facility may impact local property values. Real world experience has demonstrated this to not be true.

HOME VALUE ASSESSMENT: In 2018, graduate students at the University of Texas at Austin explored the impacts of property values near 956 utility-scale solar installations completed in 2016 or earlier across the United States. The researchers, in partnership with Lawrence Berkeley National Laboratory[4], surveyed approximately 400 property value assessors nationwide, asking if the assessor believed there was an impact on home prices near these sites, the scale and direction of those impacts, and the source of those impacts.

The results indicate that most assessors who responded to the survey believe that **"proximity to a solar installation has either no impact or a positive impact on home values."** The study found that the respondents believe that some features of solar facilities may be associated with positive impacts, such as a location on land that previously had an unappealing use, or the presence of trees or other visual barriers around the array.[5] Furthermore, as the expected lifetime of a solar facility is at least thirty years, residents have assurance the nearby land will not be redeveloped for an unfavorable use.

---

[1] American Clean Power Association. 2021. Utility-scale Solar Power Facts. Accessed at https://cleanpower.org/facts/solar-power/

[2] U.S. Energy Information Administration (EIA). 2022. Accessed at https://www.eia.gov/todayinenergy/detail.php?id=50818

[3] Ibid.

[4] Al-Hamoodah, Leila; Koppa, Kavita; Schieve, Eugenie; Reeves, D. Cale; Hoen, Ben; Seel, Joachim; and Rai, Varun. 2018. An Exploration of Property-Value Impacts Near Utility-Scale Solar Installations. Policy Research Project (PRP), LBJ School of Public Affairs, The University of Texas at Austin, May 2018. of Texas at Austin, May 2018. Accessed at https://emp.lbl.gov/sites/default/files/property-value_impacts_near_utility-scale_solar_installations.pdf.

[5] Al-Hamoodah et al. 2018.

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AGRICULTURAL LAND: Similar results were found in a 2020 study on the effect of solar farms on agricultural land values in North Carolina, while also finding evidence that a solar farm may increase those agricultural land values. Published by Dr. Nino Abashidze at the School of Economics, Georgia Institute of Technology, and titled "Utility Scale Solar Farms and Agricultural Land Values," the study examined 451 solar farms in North Carolina.

The study found **"no direct negative or positive spillover effect of a solar farm construction on nearby agricultural land values.** Although there are no direct effects of solar farms on nearby agricultural land values, we do find evidence that suggests construction of a solar farm may create a small, positive, option-value for landowners that is capitalized into land prices. Specifically, after construction of a nearby solar farm, we find that agricultural land that is also located near transmission infrastructure may increase modestly in value."

Other property value studies that find no evidence of decreased property values after construction of a solar farm:

- **MINNESOTA:** In 2017, the Chisago County (Minnesota) Assessor's Office conducted their own study on property pricesadjacent to and in the close vicinity of a 1,000 acre North Star solar farm in Minnesota. John Keefe, the Chisago County Assessor, concluded that the North Star solar farm had **"no adverse impact" on property values**. Almost all of the [Test Area] properties sold were at a price above the assessed value. He further stated that, "It seems conclusive that valuation has not suffered."[6]
- **NORTH CAROLINA:** In 2018, Kirkland Appraisals, LLC studied the value of properties adjacent to solar farms in North Carolina.[7] Kirkland's analyses strongly support the compatibility of solar farms with adjoining agriculture and residential uses and conclude that there was **no negative or positive impact in home values due to proximity of a solar farm**.
- **VIRGINIA:** Christian P. Kaila & Associates studied the value of properties adjacent to solar farms in Virginia.[8] The analysis concluded that adjacent property value (for both residential and agricultural property), was **not adversely affected by construction and operation of solar facilities**.
- Donald Fisher, ARA who has served six years as Chair of the American Society of Farm Managers and Rural Appraisers, and has prepared several market studies examining the impact of solar on residential values was quoted in a press release dated February 15, 2021 stating, "Most of the locations were in either suburban or rural areas, and all of these studies found either a neutral impact or, ironically, a positive impact, where values on properties after the installation of solar farms went up higher than time trends."
- CohnReznick, LLP has studied sale prices of single-family homes and agricultural land properties adjacent to solar farms in over 15 states, using appropriate Paired Sales methodology[9], as well as Before/After resale (appreciation rate) analysis, and concluded that the **solar farms did not adversely affect property values in either the short or long term**.
    - Their research also includes reviewing published studies prepared by academia, as well as other appraisers, and conducting interviews with county assessors and local real estate professionals, who have experience with properties transacting near existing solar facilities in their respective communities. The consensus is that solar farms in their areas had not impacted property values.

The utility-scale solar industry recognizes the importance of engaging with the host community to balance economic, environmental, safety, and social concerns when developing and operating their projects. In their siting and application process, successful solar developers have prioritized being a good neighbor and a long-termpartner with host communities.

---

[6] Chisago County Press: County Board Real Estate Update Shows No "Solar Effects" (11/03/2017).

[7] Kirkland, Richard C. 2018. Culpeper Solar Impact Study. Kirkland Appraisals, March 7, 2018.

[8] Christian P. Kaila & Associates. 2020. Property Impact Analysis of Round Hill Solar, Proposed Solar Power Plant Augusta County, Virginia. June 2020.

[9] Bell, Randall, PhD, MAI. Real Estate Damages. Third ed. Chicago, IL: Appraisal Institute, 2016. (Page 33).

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Photo credit: AES

SITING BOARD 1-74:

See Application, Attachment A Context Map. One church is within the 2,000-foot radius and located between sections of the proposed project footprint at the southern end. Another church is just beyond the 2,000-foot radius at the northwest side of the site within the Summer Shade community. One church is located within the two-mile radius at the eastern side of the site within the Beaumont community. Section 6 of the Application (Public Notice Report) does not contain any records of communication with church representatives.

a. Describe all correspondence with each church regarding the proposed project and any feedback. radius.

b. Explain if there are any other churches located within the two-mile.

Response: Please see response to Items 8 and 9 above.

a. Email outreach was made recently to the Goodson United Methodist Church, though according to the United Methodist Church Online Directory and Statistics website (https://www.umdata.org/church?church=380210) the Goodson Chapel Methodist Church closed in June of 2023. The Project did not receive a response to our outreach. The churches beyond the 2000-foot and 2-mile radius were not contacted due to their distances from the Project. Summer Shade is available to any church representatives to discuss the Project or any concerns at any time.

b. The following churches were identified within a 2-mile buffer of the project boundary:

- Cyclone Church of Christ (3,326-ft from project boundary)
- Summer Shade Christian Church (2,689-ft from project boundary)
- Beaumont United Methodist Church (7,846-ft from project boundary)
- Summer Shade Missionary Baptist Church (2,015-ft from project boundary)

- Goodson United Methodist Church (262-ft from project boundary)
- Corinth Church (6,201-ft from project boundary)
- Mount Moriah Church (7,578-ft from project boundary)
- Red Hill Church (8,022-ft from project boundary)

Witness: Aubree Muse

SITING BOARD 1-75:

Explain any plans to coordinate with local landowners or others in case of complaints or other issues that might arise during the course of construction or operations.

Response: A complaint resolution plan will be developed prior to construction and operations. The program may include an established hotline number to be provided to local landowners, an onsite management location to discuss in person with staff, an email address to submit written concerns to the construction manager and/or operations and maintenance staff, a portal to submit comments through a project website, and/or a mailing address provided to submit written complaint and comments.

Witness: Mark Carney

SITING BOARD 1-76:

Provide the Stormwater Pollution Prevention Plan for the project.

Response: The Stormwater Pollution Prevention Plan has not yet been completed for the Project.

It will be completed prior to construction.

Witness: Mark Carney

SITING BOARD 1-77:

Provide the Construction Dust Control Plan for the project.

Response: The Construction Dust Control Plan has not yet been completed for the Project. It will be completed prior to construction.

Witness: Mark Carney

SITING BOARD 1-78:

Provide a copy of the Groundwater Protection Plan.

Response: The Groundwater Protection Plan has not yet been completed for the Project. It will be completed prior to construction.

Witness: Mark Carney

SITING BOARD 1-79:

Provide a hydrological survey related to the drainage within and surrounding the project area.

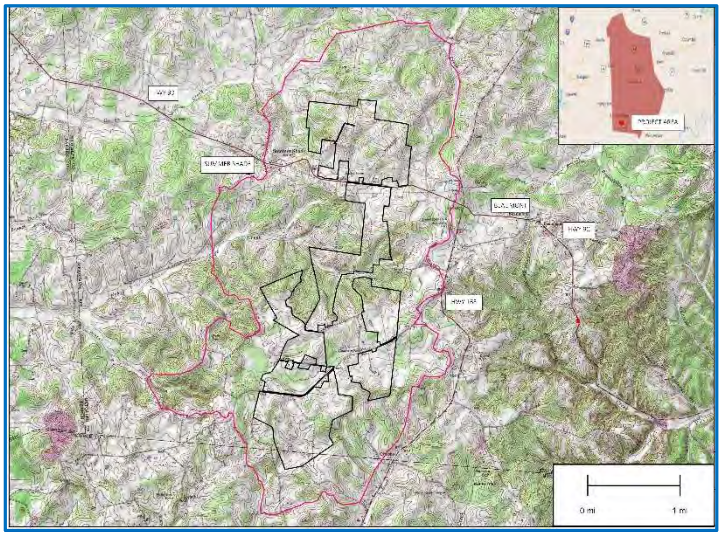
Response: Please refer to the survey below.

Witness: Alfonso Tovar

FINAL EXISTING CONDITIONS HYDROLOGY REPORT FOR

Summer Shade Solar Project

Metcalfe County, Kentucky



Prepared for:
Candela Renewables
500 Sansome Street, Ste 500
San Francisco, CA 94111

Prepared by:
Anderson Pine Corporation

Oakland, CA
June 2024

CHARLES ANDERSON
37083

FINAL EXISTING CONDITIONS HYDROLOGY REPORT FOR

Summer Shade Solar Project

TABLE OF CONTENTS

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2. Setting 2
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4. Modeling and Approach 3
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5. 2D Model Flood Depth and Velocity Results 4
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7. Appendices 7

1. PURPOSE

The purpose of this hydrology study is to evaluate existing drainage conditions at the site of the proposed Summer Shade Solar Project, and to estimate flood inundation extents, depths, and velocities associated with the 100-YR, 24-hour design storm event.

The scope of this study excludes temporary site drainage design and reporting associated with construction, stormwater pollution prevention plan (SWPPP), or requirements under the National Pollutant Discharge Elimination System (NPDES), Construction General Permitting. This study also excludes civil design of proposed grades, cuts/fills, culverts, and temporary or permanent stormwater facilities as may be shown on civil design drawings by others. The elevation data used for this study is based on site-specific and publicly available data as described below.

2. SETTING

The proposed Summer Shade Solar Project of approximately 1,793 acres is located in Metcalfe County and within a small portion of Monroe County, Kentucky. The project is west of HWY 163 and is bifurcated by HWY 90 at its northern reach. The Metcalfe / Barren County line is approximately 2.5 miles west of the project (Figure 1).

The project site is located within the following USGS Watershed Boundary Dataset, HUC-12:

- HUC 12 – 051100020303 Falling Timber Creek
- HUC 12 – 051100010606 Rodgers Creek – South Fork Little Barren River
- HUC 12 – 051100020302 Nobob Creek – Skaggs Creek
- HUC 12 – 051100020301 Headwaters Skaggs Creek

The modeled watershed of approximately 6,890 acres (11 sq.mi) was delineated from the above watersheds for the 2D flood analysis. Runoff from within the watershed collects within multiple named and unnamed creeks and channels, including Nobob Creek in the west and Glover Creek in the northwest. Runoff generally flows from the higher elevations at the middle of the modeled watershed and outwards to the perimeter (Figure 2).

3. FEMA

FEMA FIRM maps within the modeled watershed are as follows:

- Map 21169C0175C, effective 05/03/2010
- Map 21169C0250C, effective 05/03/2010
- Map 21171C0075A, effective 07/17/2012

The exhibits in Appendix C display the proposed project boundary superimposed on the FEMA FIRM maps noted above (Appendix C). These exhibits show the presence of Special Flood Hazard

Areas (SFHA), which are subject to inundation by FEMA's "100-year flood," also known as the "1% annual chance flood." The exhibits and FIRM maps show Zone A is present within the proposed project footprint, specifically at Nobob Creek (alluvial flooding) and within an isolated area (pluvial flooding) between Clifton Smith Rd to the north and Apple Grove Rd to the south. No floodways were computed as part of the FEMA FIS and therefore no Zone AE is present within the project footprint. Consultation with the floodplain administrator and or the Metcalfe County AHJ should be sought by the project development team as the project advances.

4. MODELING AND APPROACH

A summary of the data and software tools used in the study are provided below:

Table 4.1 Data and Primary Software

Data/Software	**Source / Notes**
Project Boundary	Layer *VB-PRCL,* received 4/2/2024, within *77604 – Candela – Boundary and Ground Run.dwg.*
Elevation / Surface	Onsite Elevation: *Summer Shade Surface,* received 4/2/2024, within *77604 – Candela – Surface.dwg.* Offsite Elevation: State of Kentucky 5-foot Bare Earth DEM, per Lidar collected Winter 2022 and 2023. DEM downloaded 4/15/2024 from *KYfromAbove.ky.org*
Precipitation	NOAA Atlas 14, *hdsc.nws.noaa.gov/pfds/*
Landcover (Existing) Offsite & Onsite	NLCD 2021 (*MRLC.gov*, downloaded 3/26/2024)
Landcover (Proposed) Offsite & Onsite	N/A
Hydrologic Soils Group	NRCS Web Soil Survey, *websoilsurvey.sc.egov.usda.gov*
Watersheds	HUC-12 National Hydrology Dataset, *datagateway.nrcs.usda.gov*
FEMA	*www.floodmaps.fema.gov/NFHL/status.shtml*
Curve Number	SCS TR-55

Data/Software	Source / Notes
FLO-2D	Flood Inundation, Depths, and Velocity Modeling, *flo-2d.com*
Win-TR-20	Site-Specific Rainfall Distribution, *www.ars.usda.gov/research/software/*
Global Mapper	GIS (FEMA, USGS Topo / Layer Development/Exhibits)

The 100-Year, 24-hour, rainfall precipitation of 7.45 inches was obtained from National Oceanic and Atmospheric Administration (NOAA) Atlas 14 for the project location. A site-specific rainfall distribution was determined using WinTR-20 and the site-specific Atlas 14 precipitation-frequency data (Appendix A). A spatially uniform rainfall distribution was assumed for the entire modeled watershed.

Landcover information was obtained from the National Land Cover Database (NLCD 2021). The modeled area is primarily covered by NLCD (81) Pasture-Hay (~45%), NLCD (41) Deciduous Forest (~37%), and NLCD (43) Mixed Forest (~6%) (Figure 3).

Hydrologic soil groups (HSG) identified via the NRCS Web Soil Survey are provided in Figure 4. The primary HSG within the 2D flood analysis watershed is Type B (~85%), followed by Type D (10%), and Type A (5%). Soil Types A/D, B/D, and C/D were assumed Type D in the modeling, which assumes a saturated antecedent soil condition. Soils without a provided HSG rating were also assumed Type D. Type D soils yield the highest runoff of the soil groups, whereas Type A soils generally yield the least runoff.

SCS Curve Number values were assigned based on landcover, hydrologic soil groups, Table 2-2 of NRCS TR-55 and other published resources (Figure 5 and Appendix B).

Site-specific survey elevation data was used per the boundaries of the site-specific survey and Kentucky 5-Foot DEM elevation data was used outside the surveyed boundary and within the modeled watershed. Elevation, precipitation, and SCS curve number information was used in the 2-dimensional FLO-2D hydrologic / hydraulic modeling software using a grid size of 25ft x 25ft. Outflow boundary conditions were identified at select locations along the perimeter of the modeled watershed.

5. 2D MODEL FLOOD DEPTH AND VELOCITY RESULTS

The results show maximum flood depths occurring within existing waterways and washes of the modeled boundary (Figure 6 series). Maximum flood depths per the 100-YR event of approximately 8.0 ft or greater exist within the proposed project footprint and often within areas of terrain depressions. See Figure 6 series and the associated shapefiles for details and results.

Flood inundation areas within the proposed PV footprint should be avoided with proper offsets or steel post reveal heights adjusted accordingly. Avoid development within jurisdictional waterbodies per AHJ requirements.

The FLO-2D results show that the existing flow conditions result in 100-YR peak velocities of approximately 1.0ft/s within the existing waterways and washes of the proposed project footprint (Figure 7 series). See Figure 7 series and the associated shapefiles for details and results.

The results capture existing waterbody water elevations as shown in the site-specific survey and publicly available DEM referenced above. These water elevations are modeled as base water elevations, and therefore, estimated flood depth results are measured above these existing water surfaces.

Flood depths are estimated in FLO-2D at each 25ft x 25ft grid cell. Each grid cell uses a single elevation data point from an interpolation of the elevation data. Therefore, some variation in depth should be expected when compared to the DEM and site-specific terrain.

The model and results do not reflect existing onsite culverts. Should the project development advance, a site-specific survey that includes culvert details (size, shape, type, length, inlet/outlet elevations) should be modeled to provide more refined results.

6. FIGURES

Figure 1: Project Location and Vicinity

Figure 2: Watersheds and Model Boundary

Figure 3: Landcover

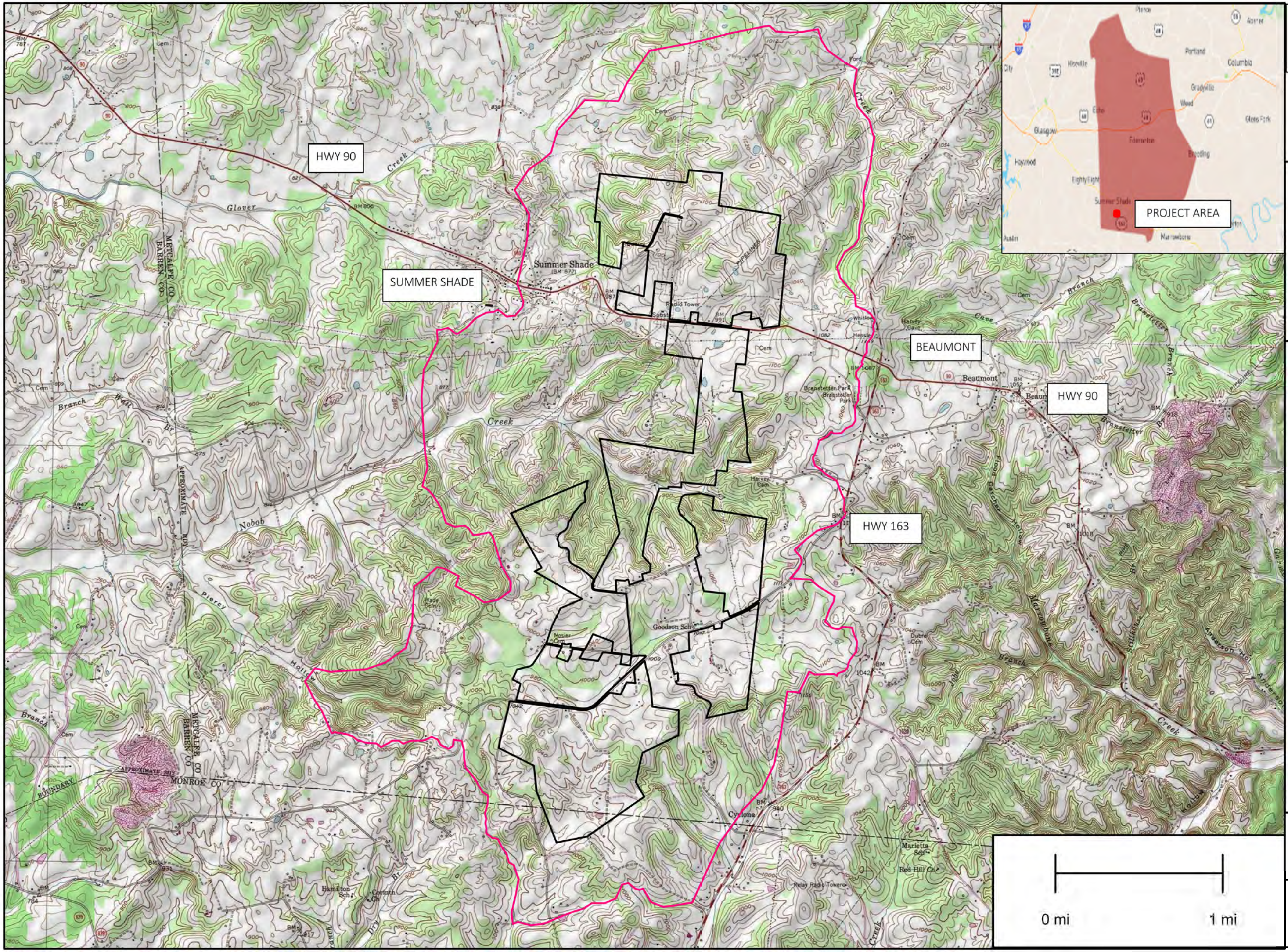
Figure 4: Hydrologic Soils Group

Figure 5: Curve Number

Figure 6 Series: Max Flow Depths

Figure 7 Series: Peak Velocities

Figure 8 Series: Elevation



ANDERSON PINE
CORP.

1901 HARRISON ST.
SUITE 1152
OAKLAND, CA 94612

N

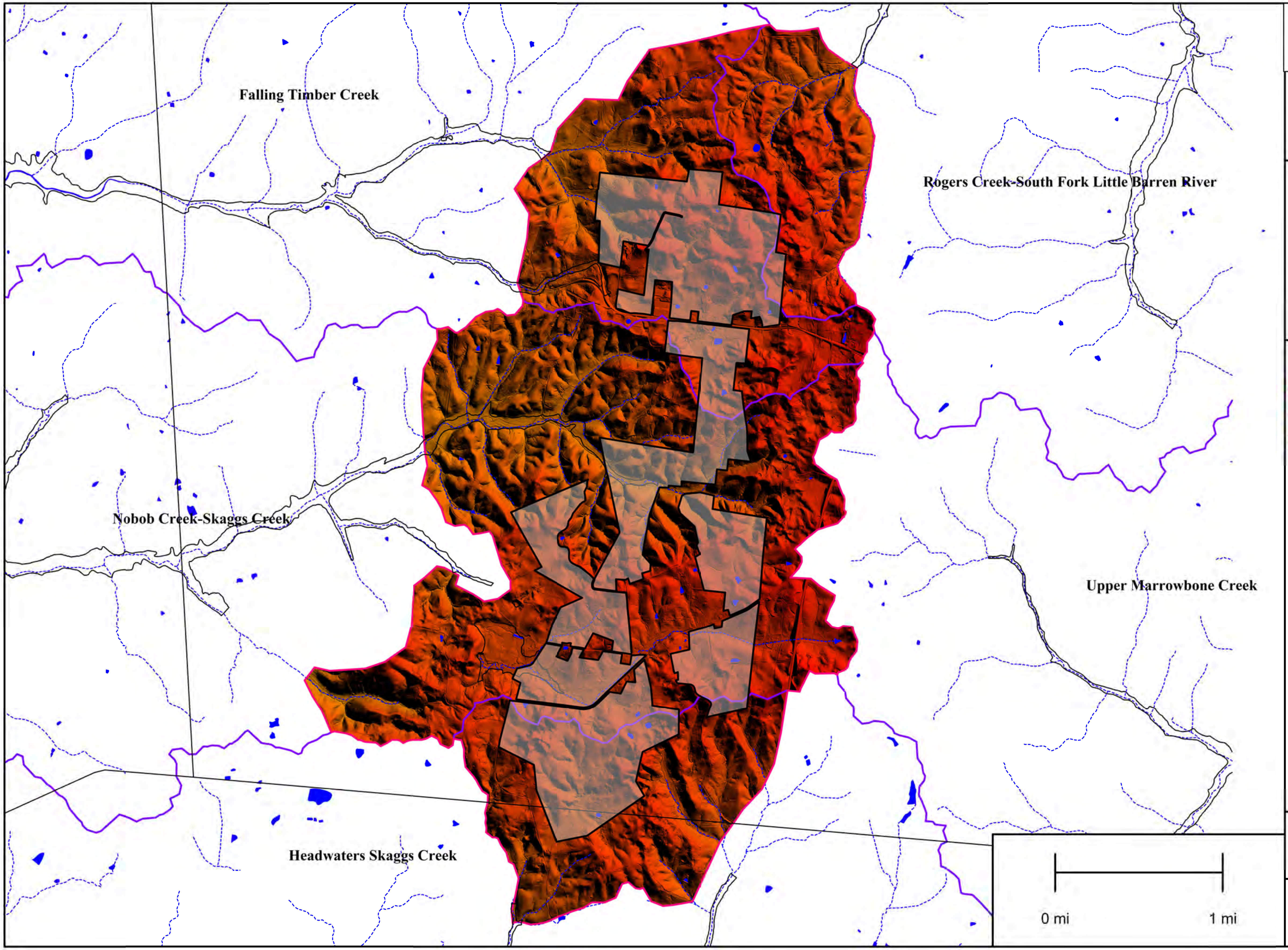
Summer Shade Solar

Metcalfe County, KY
June 2024

🟥 Model Boundary
⬛ Project Boundary

Location / Vicinity

Figure 1



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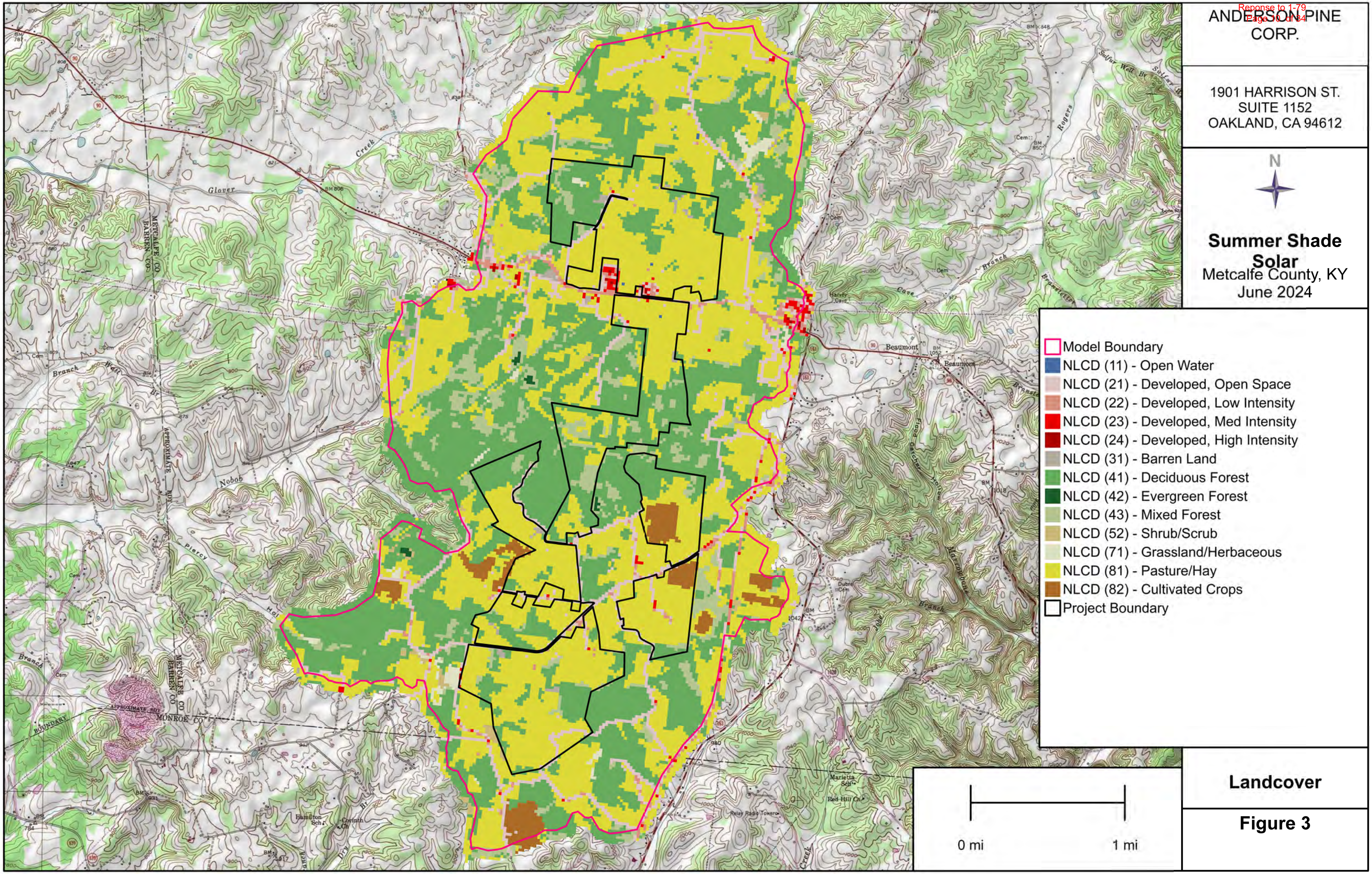
Metcalfe County, KY
June 2024

- ☐ HUC-12 Watershed
- ☐ Model Boundary
- ■ NHD - Area
- ▨ Project Boundary - Fill
- — FEMA
- ┄ NHD - Linear

Watersheds

Figure 2



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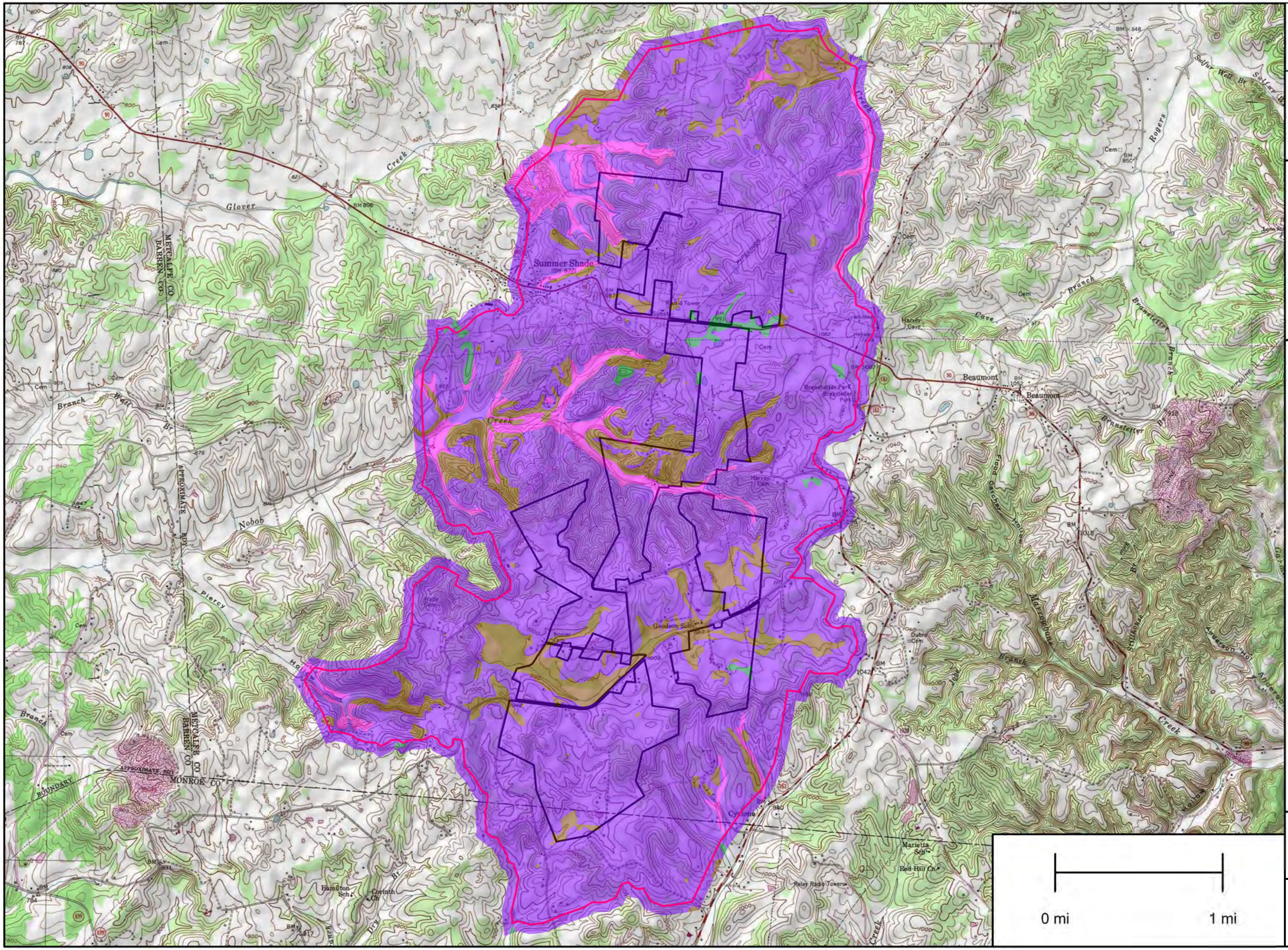
Summer Shade Solar
Metcalfe County, KY
June 2024

Landcover

Figure 3



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- 🟪 HSG - A
- 🟪 HSG - B
- 🟩 HSG - C
- 🟫 HSG - D (a/d, b/d,c/d)
- ☐ Model Boundary
- ☐ Project Boundary

Hydrologic Soils Group

Figure 4

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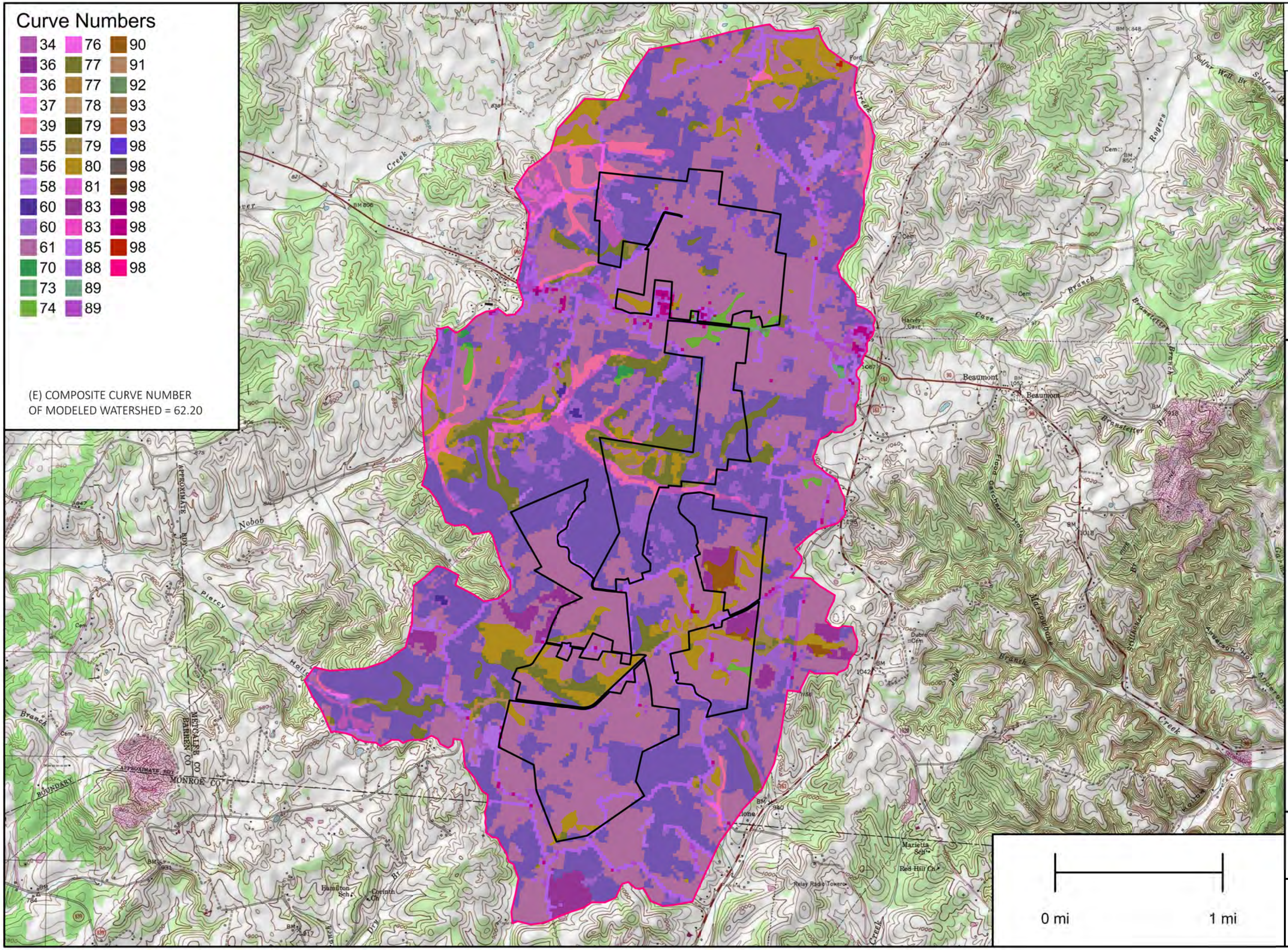

Summer Shade Solar
Metcalfe County, KY
June 2024

Curve Number

Figure 5

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N

Summer Shade Solar
Metcalfe County, KY
June 2024

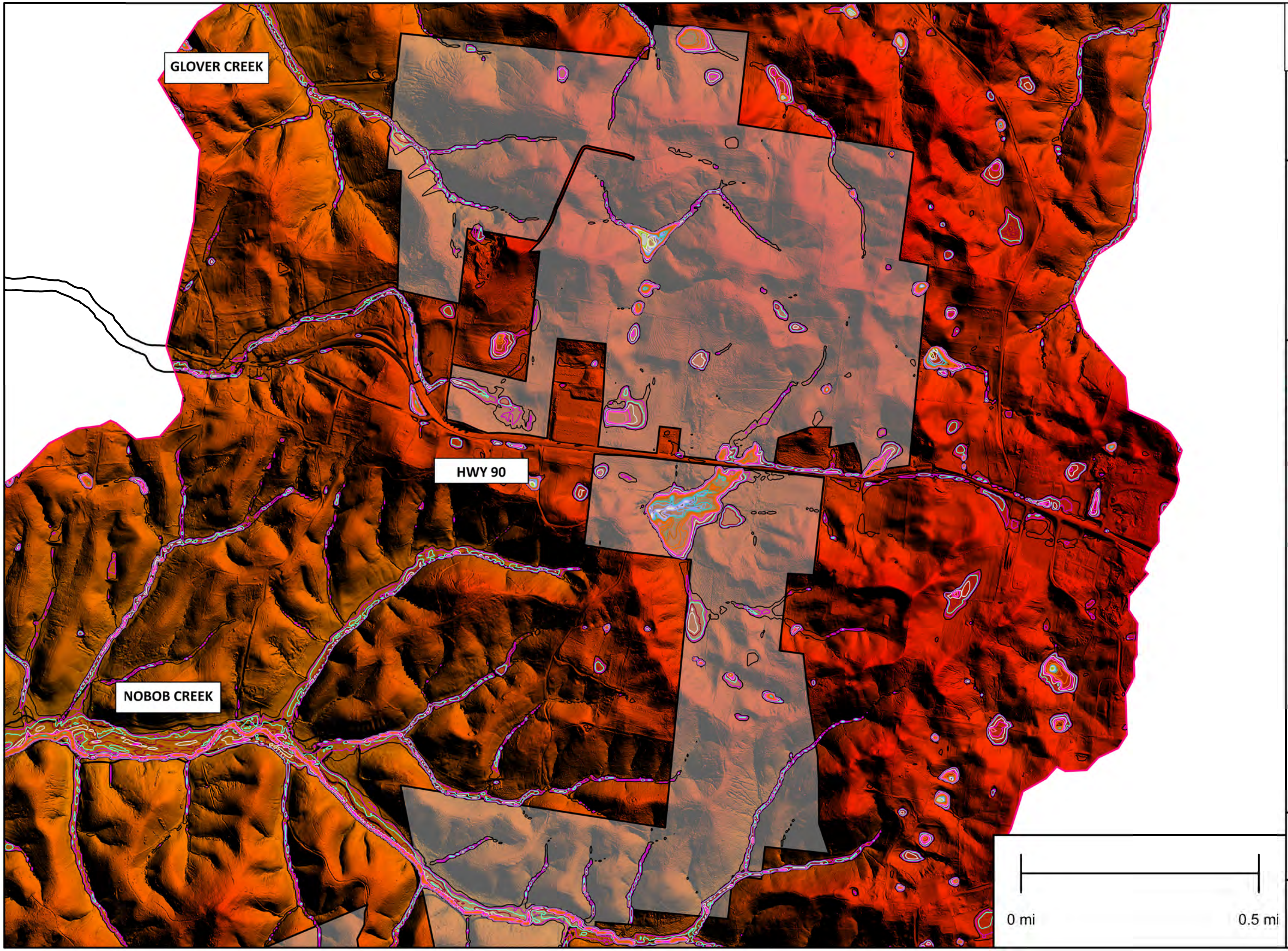
Units = Feet

☐ Model Boundary
▨ Project Boundary - Fill
— 0.50
— 1.00
— 1.50
— 2.00
— 2.50
— 3.00
— 3.50
— 4.00
— 5.00
— 6.00
— 7.00
— 8.00
— 9.00
— 10.00

0 mi
1 mi

100-YR Max Water Depth - Model Boundary

Figure 6.0



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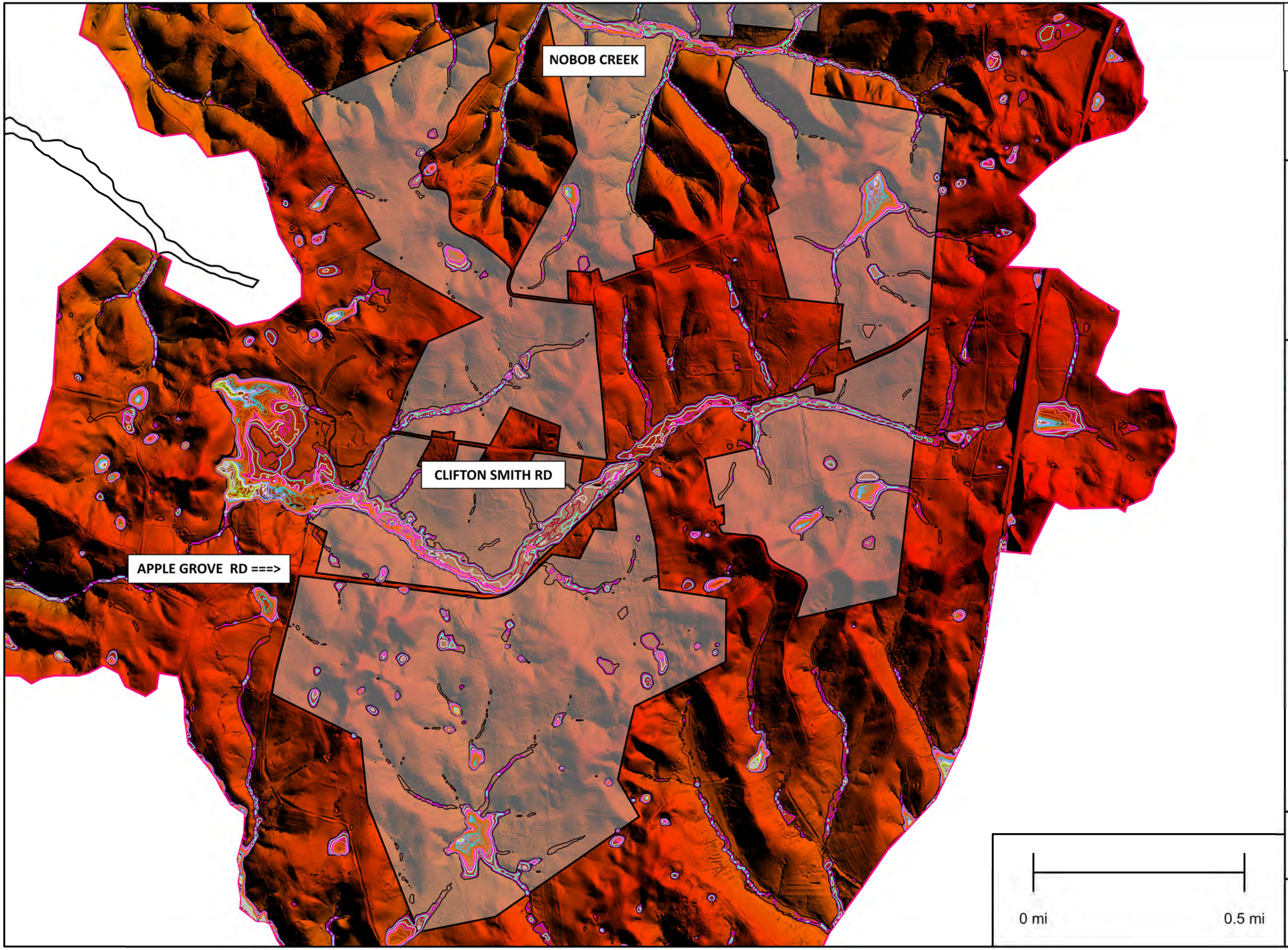
Summer Shade Solar
Metcalfe County, KY
June 2024

Units = Feet

🟥 Model Boundary
▨ Project Boundary - Fill
— FEMA
— 0.50
— 1.00
— 1.50
— 2.00
— 2.50
— 3.00
— 3.50
— 4.00
— 5.00
— 6.00
— 7.00
— 8.00
— 9.00
— 10.00

100-YR Max Water Depth - Project Boundary North

Figure 6.1



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Summer Shade Solar
Metcalfe County, KY
June 2024

Units = Feet

- □ Model Boundary
- ▨ Project Boundary - Fill
- — FEMA
- — 0.50
- — 1.00
- — 1.50
- — 2.00
- — 2.50
- — 3.00
- — 3.50
- — 4.00
- — 5.00
- — 6.00
- — 7.00
- — 8.00
- — 9.00
- — 10.00

100-YR Max Water Depth - Project Boundary South

Figure 6.2

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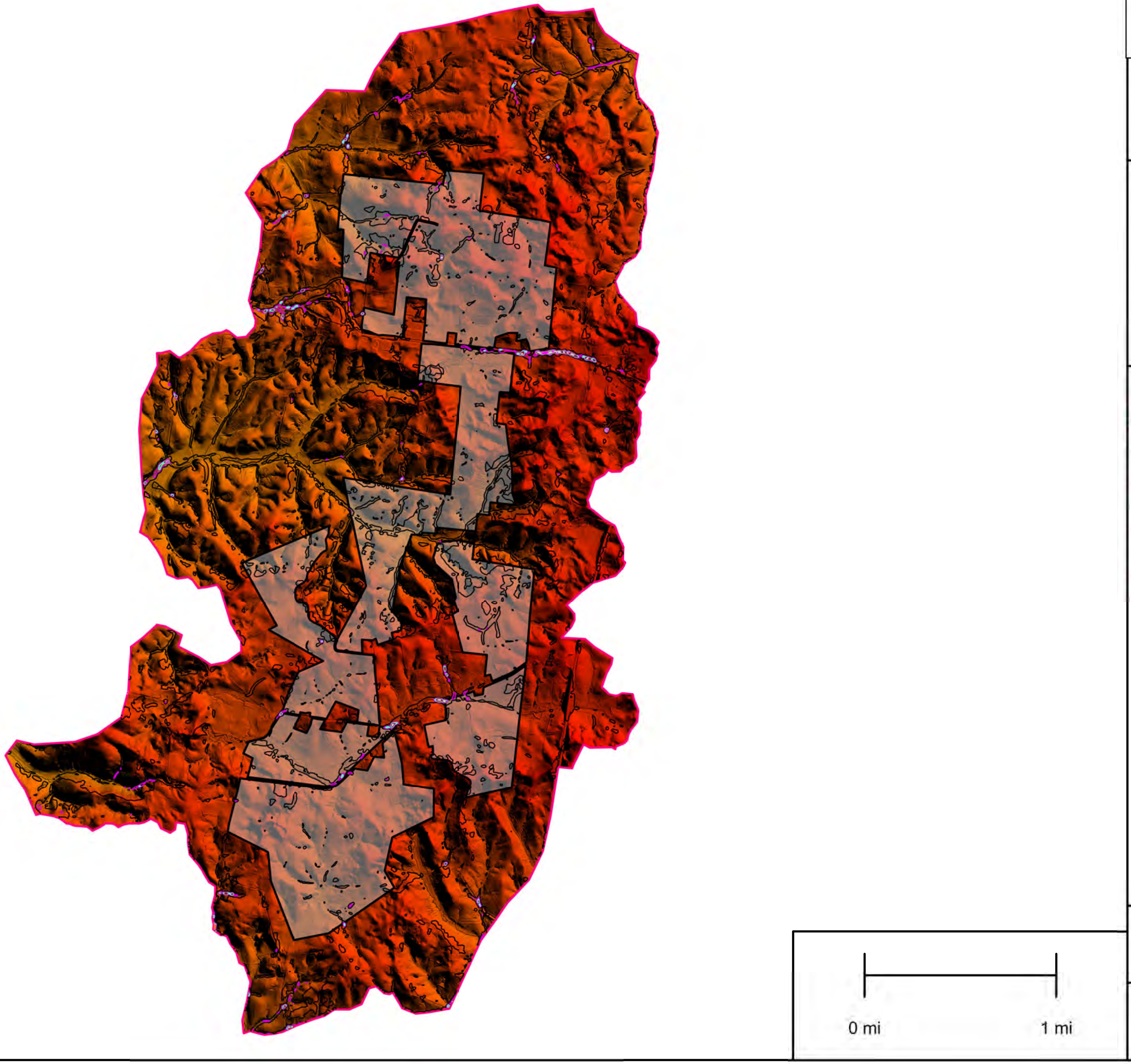


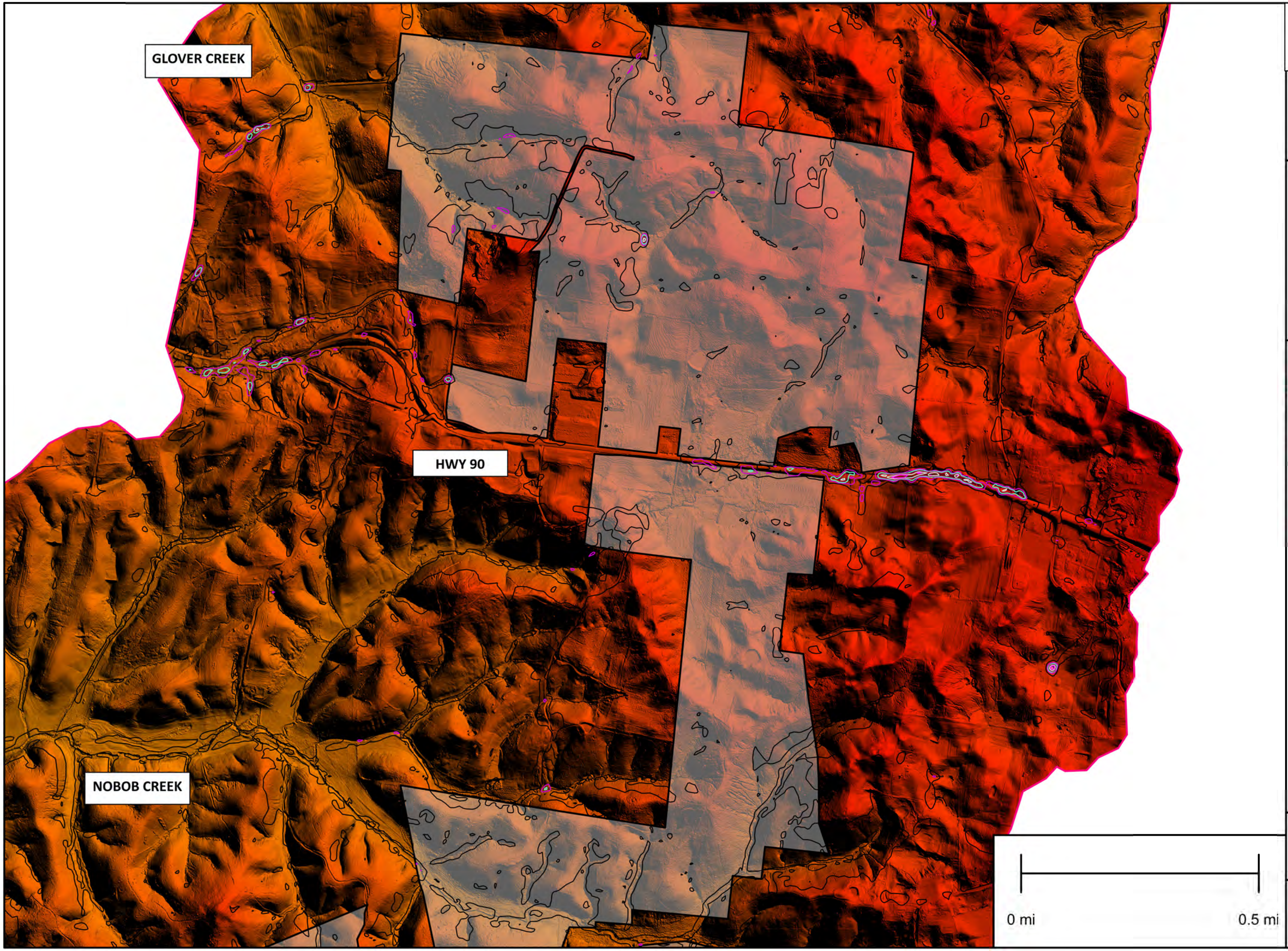
Summer Shade Solar
Metcalfe County. KY
June 2024

Units = Feet / Sec.

☐ Model Boundary
▨ Project Boundary - Fill
— 0.5
— 1
— 1.5
— 2
— 2.5
— 3
— 3.5
— 4
— 4.5

100-YR Peak Water Velocity - Model Boundary

Figure 7.0



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N

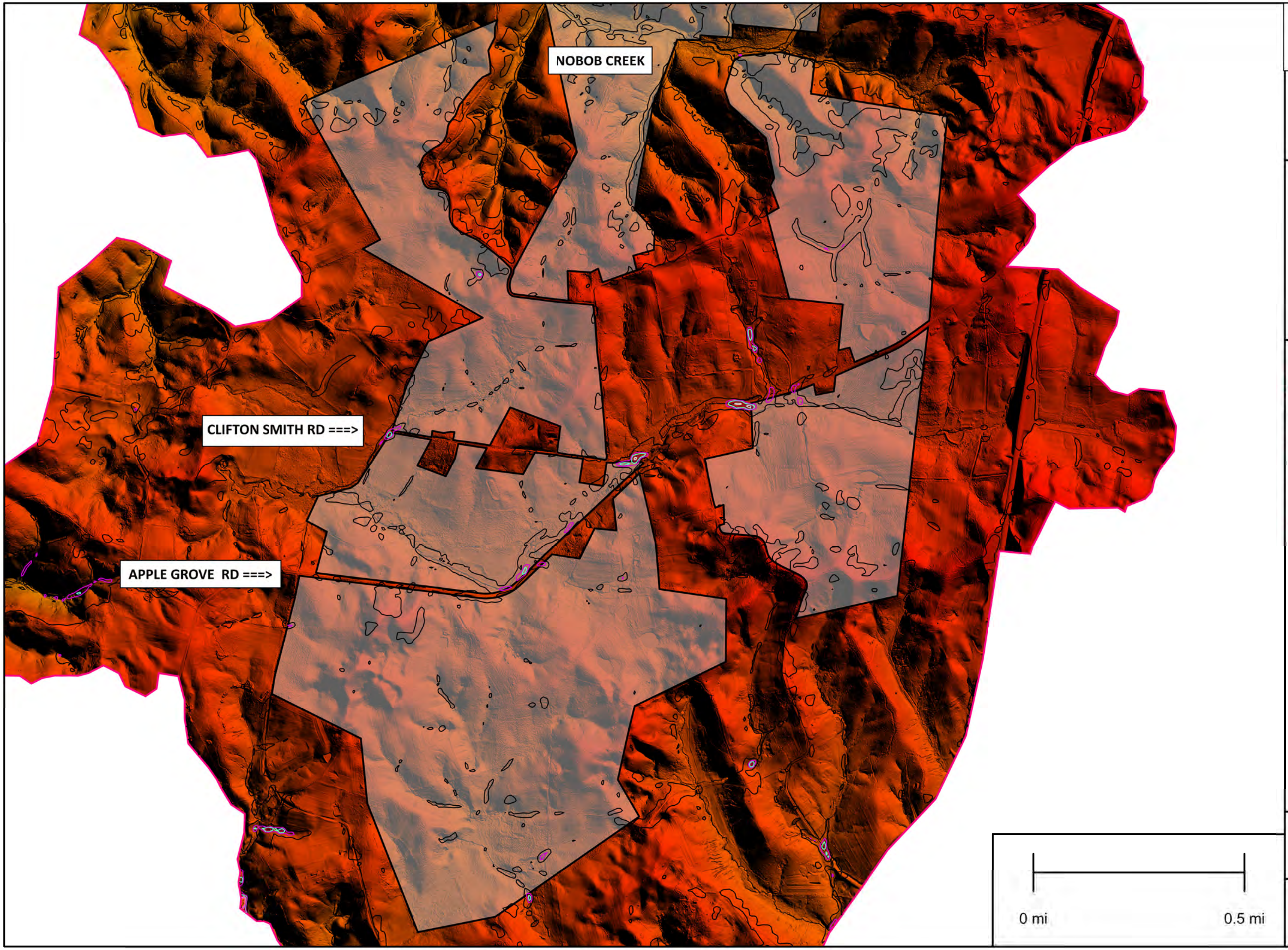
Summer Shade
Solar
Metcalfe County. KY
June 2024

Units = Feet / Sec.

☐ Model Boundary
▨ Project Boundary - Fill
— 0.5
— 1
— 1.5
— 2
— 2.5
— 3
— 3.5

100-YR Peak Water Velocity - Project Boundary North

Figure 7.1



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CORP.

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N

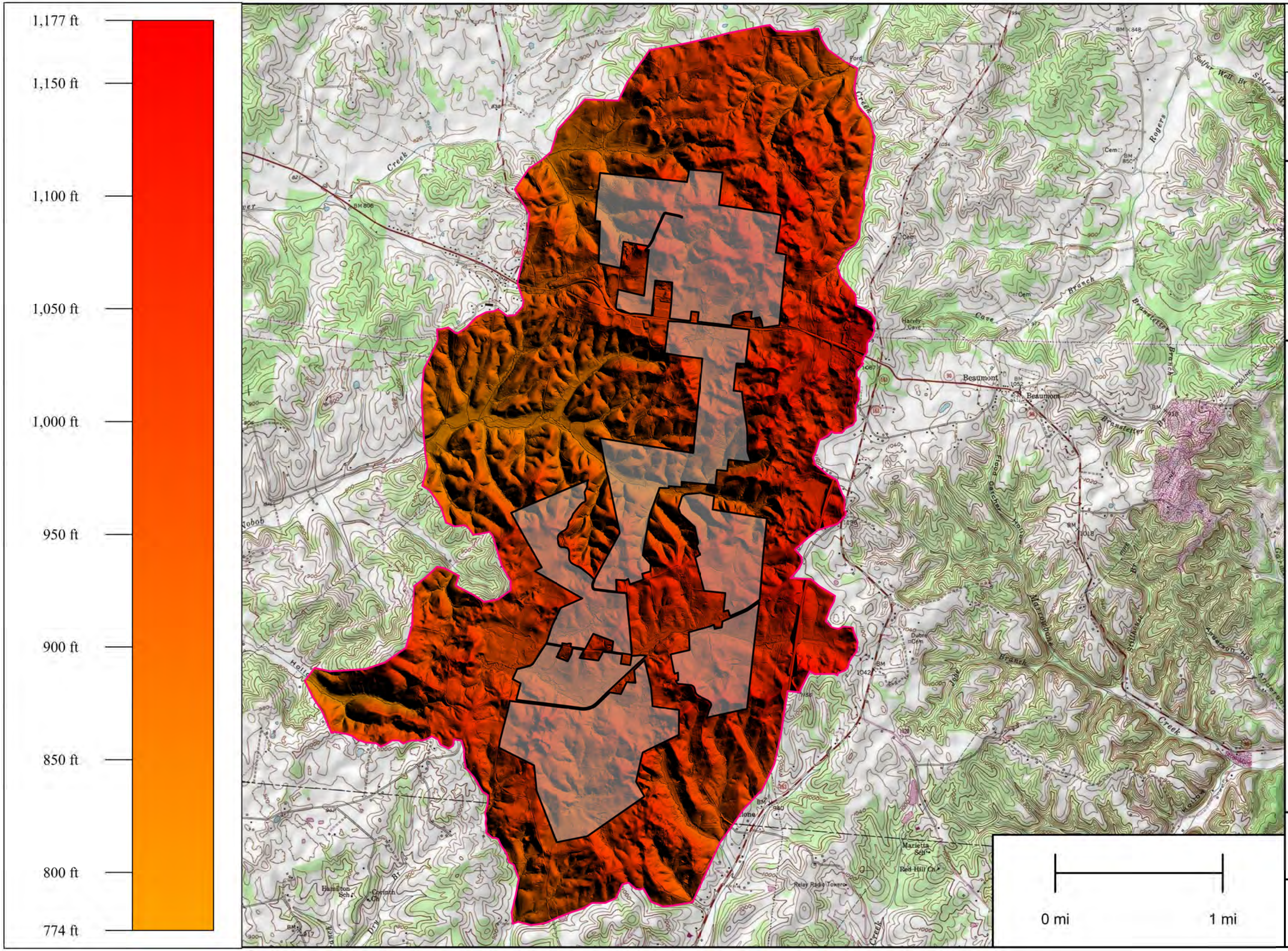
Summer Shade Solar
Metcalfe County. KY
June 2024

Units = Feet / Sec.

🟥 Model Boundary
▨ Project Boundary - Fill
— 0.5
— 1
— 1.5
— 2
— 2.5
— 3
— 3.5
— 4
— 4.5

100-YR Peak Water Velocity - Project Boundary South

Figure 7.2



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N

Summer Shade Solar
Metcalfe County, KY
June 2024

🟥 Model Boundary
▨ Project Boundary - Fill

Elevation

Figure 8

7. APPENDICES

Appendix A: Precipitation

Appendix B: Manning’s and Curve Number Tables

Appendix C: FEMA Firm Map(s)

Appendix A: Precipitation

NOAA Atlas 14, Volume 2, Version 3
Location name: Summer Shade, Kentucky, USA*
Latitude: 36.8636°, Longitude: -85.6863°
Elevation: 962 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.363 (0.326-0.403)	0.426 (0.385-0.473)	0.492 (0.443-0.546)	0.545 (0.492-0.604)	0.613 (0.549-0.677)	0.663 (0.592-0.733)	0.715 (0.635-0.790)	0.763 (0.674-0.844)	0.826 (0.723-0.915)	0.875 (0.759-0.972)
10-min	0.580 (0.521-0.644)	0.681 (0.616-0.756)	0.787 (0.710-0.874)	0.872 (0.786-0.966)	0.976 (0.875-1.08)	1.06 (0.944-1.17)	1.14 (1.01-1.26)	1.21 (1.07-1.34)	1.31 (1.14-1.45)	1.38 (1.20-1.53)
15-min	0.725 (0.652-0.804)	0.856 (0.774-0.951)	0.996 (0.898-1.10)	1.10 (0.994-1.22)	1.24 (1.11-1.37)	1.34 (1.20-1.48)	1.44 (1.28-1.59)	1.53 (1.35-1.69)	1.64 (1.44-1.82)	1.73 (1.50-1.92)
30-min	0.994 (0.893-1.10)	1.18 (1.07-1.31)	1.42 (1.28-1.57)	1.60 (1.44-1.77)	1.83 (1.64-2.03)	2.01 (1.80-2.23)	2.20 (1.95-2.43)	2.38 (2.10-2.63)	2.62 (2.29-2.90)	2.80 (2.43-3.11)
60-min	1.24 (1.11-1.38)	1.48 (1.34-1.65)	1.81 (1.64-2.01)	2.08 (1.88-2.30)	2.44 (2.19-2.70)	2.73 (2.44-3.02)	3.03 (2.69-3.35)	3.33 (2.94-3.69)	3.75 (3.28-4.16)	4.09 (3.55-4.54)
2-hr	1.47 (1.32-1.64)	1.75 (1.58-1.96)	2.13 (1.92-2.38)	2.45 (2.19-2.72)	2.90 (2.59-3.22)	3.27 (2.91-3.63)	3.66 (3.24-4.08)	4.08 (3.58-4.54)	4.68 (4.07-5.22)	5.18 (4.45-5.79)
3-hr	1.61 (1.44-1.80)	1.91 (1.71-2.15)	2.33 (2.08-2.60)	2.68 (2.39-3.00)	3.18 (2.82-3.55)	3.59 (3.18-4.01)	4.04 (3.55-4.51)	4.52 (3.94-5.05)	5.22 (4.49-5.83)	5.79 (4.93-6.49)
6-hr	1.96 (1.75-2.20)	2.32 (2.08-2.62)	2.82 (2.52-3.18)	3.26 (2.90-3.67)	3.90 (3.45-4.38)	4.44 (3.90-4.99)	5.03 (4.39-5.65)	5.66 (4.90-6.37)	6.61 (5.64-7.44)	7.40 (6.23-8.34)
12-hr	2.34 (2.12-2.61)	2.79 (2.52-3.11)	3.39 (3.07-3.78)	3.91 (3.52-4.36)	4.68 (4.18-5.20)	5.33 (4.73-5.92)	6.04 (5.32-6.71)	6.81 (5.94-7.57)	7.95 (6.83-8.86)	8.90 (7.56-9.97)
24-hr	2.87 (2.66-3.12)	3.42 (3.16-3.72)	4.18 (3.85-4.55)	4.82 (4.43-5.26)	5.78 (5.25-6.32)	6.58 (5.93-7.21)	7.45 (6.64-8.22)	8.41 (7.37-9.35)	9.81 (8.40-11.1)	11.0 (9.23-12.5)
2-day	3.44 (3.17-3.75)	4.10 (3.78-4.48)	5.03 (4.62-5.49)	5.82 (5.32-6.36)	6.96 (6.32-7.63)	7.93 (7.12-8.73)	8.98 (7.96-9.95)	10.1 (8.84-11.3)	11.8 (10.1-13.4)	13.2 (11.0-15.2)
3-day	3.68 (3.41-3.99)	4.38 (4.06-4.76)	5.36 (4.95-5.82)	6.16 (5.68-6.70)	7.31 (6.68-7.96)	8.27 (7.48-9.04)	9.28 (8.30-10.2)	10.4 (9.18-11.6)	12.1 (10.4-13.6)	13.5 (11.4-15.4)
4-day	3.92 (3.65-4.23)	4.67 (4.35-5.04)	5.68 (5.28-6.14)	6.51 (6.03-7.04)	7.67 (7.04-8.30)	8.60 (7.84-9.35)	9.58 (8.63-10.5)	10.7 (9.54-11.8)	12.4 (10.8-13.8)	13.8 (11.9-15.6)
7-day	4.72 (4.38-5.08)	5.62 (5.22-6.06)	6.84 (6.33-7.38)	7.84 (7.24-8.47)	9.27 (8.50-10.0)	10.5 (9.50-11.4)	11.7 (10.5-12.8)	13.0 (11.6-14.4)	14.9 (13.0-16.7)	16.4 (14.1-18.6)
10-day	5.40 (5.04-5.79)	6.44 (6.00-6.90)	7.76 (7.22-8.32)	8.81 (8.18-9.44)	10.2 (9.46-11.0)	11.4 (10.4-12.3)	12.5 (11.4-13.6)	13.7 (12.4-15.0)	15.3 (13.6-16.9)	16.7 (14.7-18.7)
20-day	7.39 (6.93-7.89)	8.77 (8.22-9.37)	10.4 (9.72-11.1)	11.6 (10.8-12.4)	13.2 (12.3-14.1)	14.4 (13.4-15.5)	15.6 (14.4-16.8)	16.8 (15.4-18.2)	18.3 (16.6-20.0)	19.4 (17.5-21.4)
30-day	9.08 (8.52-9.64)	10.7 (10.1-11.4)	12.6 (11.8-13.4)	14.0 (13.1-14.9)	15.8 (14.7-16.8)	17.2 (16.0-18.4)	18.6 (17.2-19.9)	19.9 (18.3-21.4)	21.6 (19.6-23.5)	22.9 (20.6-25.0)
45-day	11.4 (10.8-12.1)	13.4 (12.6-14.2)	15.5 (14.6-16.4)	17.0 (16.0-18.0)	19.0 (17.8-20.2)	20.5 (19.2-21.8)	21.9 (20.4-23.3)	23.2 (21.5-24.8)	24.8 (22.9-26.8)	26.0 (23.8-28.2)
60-day	13.7 (13.0-14.4)	16.1 (15.3-17.0)	18.4 (17.4-19.4)	20.1 (19.0-21.2)	22.2 (21.0-23.4)	23.7 (22.3-25.1)	25.1 (23.5-26.6)	26.4 (24.7-28.1)	27.9 (26.0-29.9)	29.0 (26.9-31.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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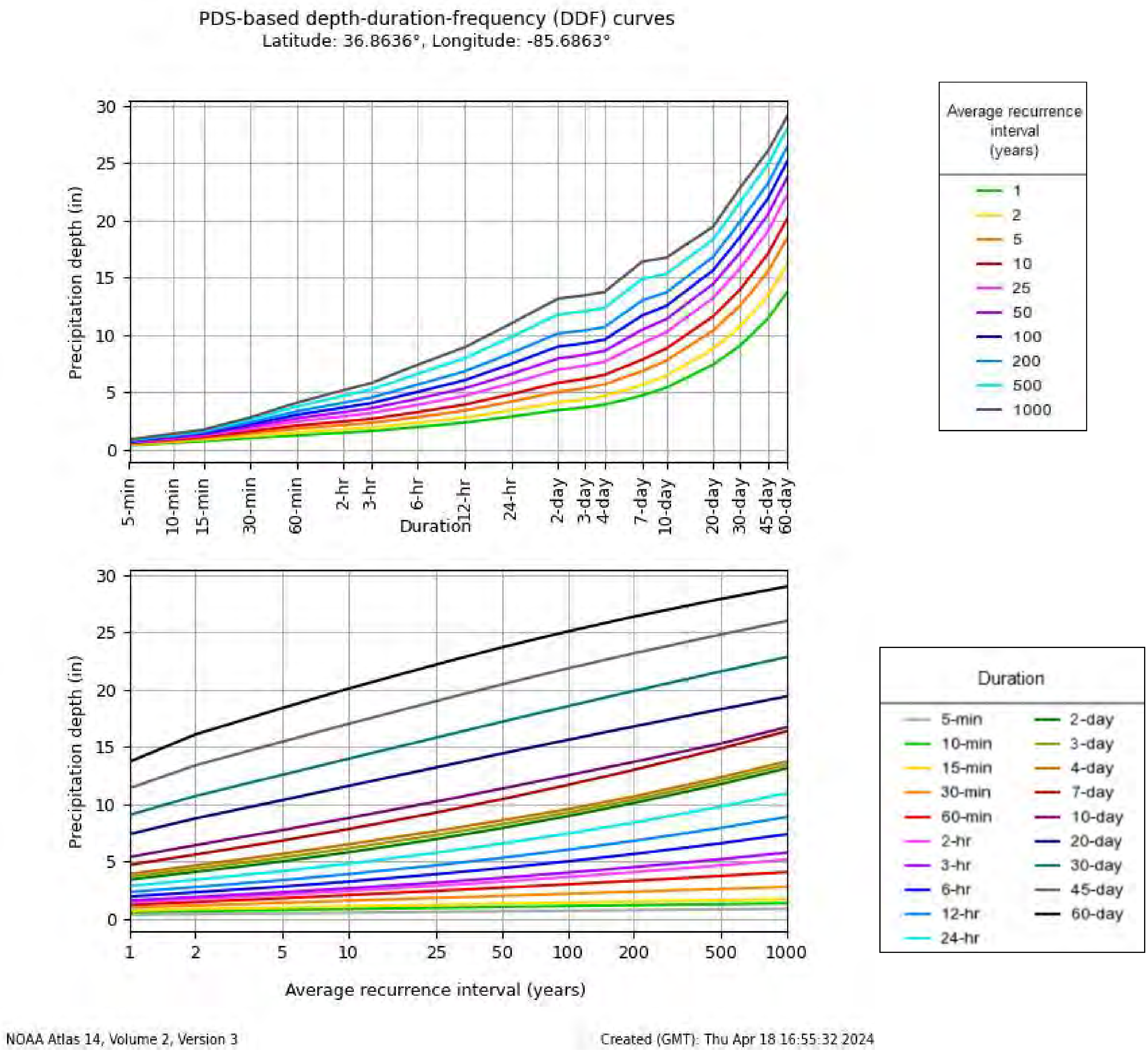
PF graphical



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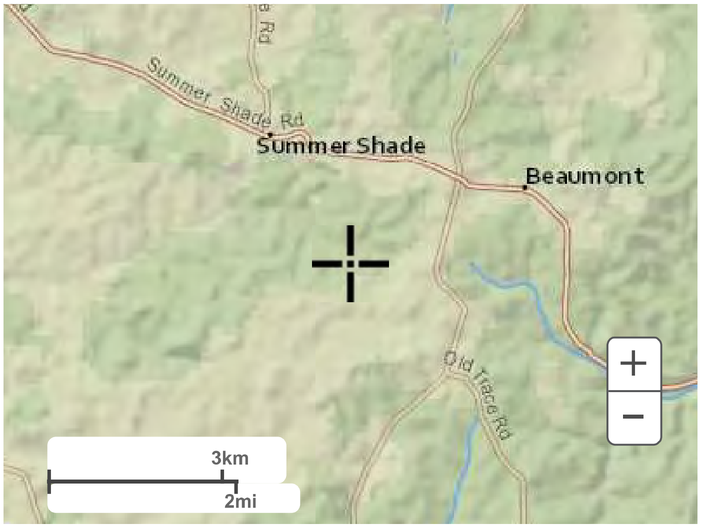
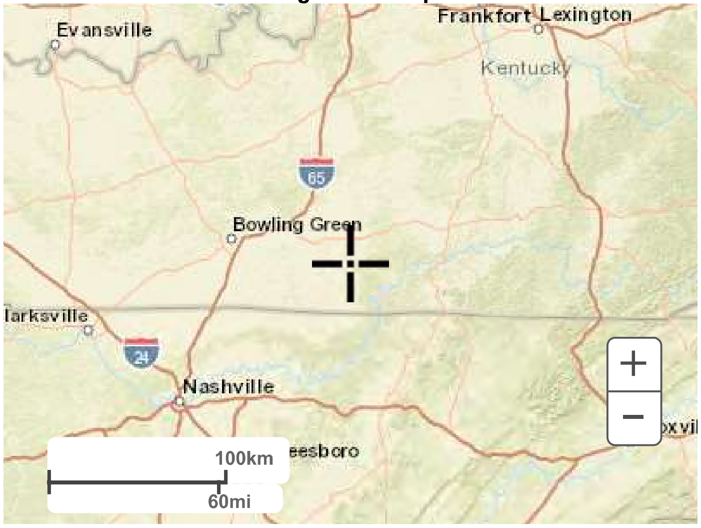
Maps & aerials

Small scale terrain

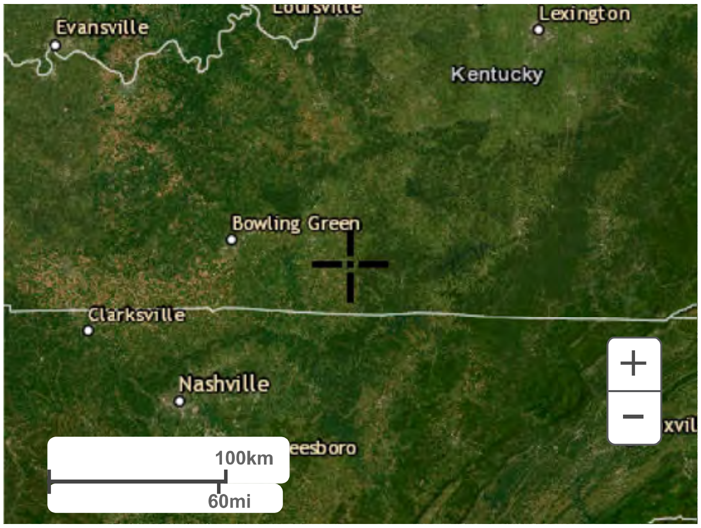


Large scale terrain

Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
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Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix B: Manning’s and Curve Number Tables

Overland Manning's

NCLD ID No.	Land Cover	Description	n-Value
11	Open Water	Areas of open water, generally with less than 25% cover of vegetation or soil.	0.018
21	Developed, Open Space	Areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.	0.040
22	Developed, Low Intensity	Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.	0.068
23	Developed, Medium Intensity	Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.	0.068
24	Developed, High Intensity	Highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.	0.040
31	Barren Land (Rock/Sand/Clay)	Areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.	0.011
41	Deciduous Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.	0.360
42	Evergreen Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.	0.320
43	Mixed Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.	0.400

Overland Manning's

NCLD ID No.	Land Cover	Description	n-Value
52	Shrub / Scrub	Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.	0.400
71	Grassland / Herbaceous	Areas dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are **not subject to intensive management such as tilling**, but can be utilized for grazing.	0.368
81	Pasture / Hay	Areas of grasses, legumes, or grass-legume mixtures planted **for livestock grazing or the production of seed or hay crops**, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.	0.325
82	Cultivated Crop	Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.	0.170
90	Woody Wetlands	Areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	0.086
91	Palustrine Forested Wetland		0.018
92	Palustrine Scrub / Shrub Wetland		0.018
93	Estuarine Forested Wetland		0.018
94	Estuarine Scrub / Shrub Wetland		0.018
95	Emergent Herbaceous Wetlands	Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	0.183

		NLCD 2021		
Number	**HSG**	**NLCD (2019)**	**2021 National Land Cover Dataset (NLCD)**	**Curve Number (Ag. Land 2-2c)**
1	**A**	**11**	**NLCD (11) - Open Water**	**98**
2	A	12	NLCD (12) - Perennial Snow/Ice	98
3	A	21	NLCD (21) - Developed, Open Space	76
4	A	22	NLCD (22) - Developed, Low Intensity	83
5	A	23	NLCD (23) - Developed, Medium Intensity	98
6	A	24	NLCD (24) - Developed, High Intensity	98
7	A	31	NLCD (31) - Barren Land	81
8	A	41	NLCD (41) - Deciduous Forest	34
9	A	42	NLCD (42) - Evergreen Forest	36
10	A	43	NLCD (43) - Mixed Forest	36
11	A	52	NLCD (52) - Shrub-Scrub	35
12	A	71	NLCD (71) - Grassland-Herbaceous	37
13	A	81	NLCD (81) - Pasture-Hay	39
14	A	82	NLCD (82) - Cultivated Crops	74
15	A	90	NLCD (90) - Woody Wetland	98
16	A	91,92,93,94	NLCD (91,92,93,94) - Forested & Shrub Wetlands	98
17	A	95	NLCD (95) - Emergent Herbaceous Wetlands	98
18	**B**	**11**	**NLCD (11) - Open Water**	**98**
19	B	12	NLCD (12) - Perennial Snow/Ice	98
20	B	21	NLCD (21) - Developed, Open Space	85
21	B	22	NLCD (22) - Developed, Low Intensity	89
22	B	23	NLCD (23) - Developed, Medium Intensity	98
23	B	24	NLCD (24) - Developed, High Intensity	98
24	B	31	NLCD (31) - Barren Land	88
25	B	41	NLCD (41) - Deciduous Forest	55
26	B	42	NLCD (42) - Evergreen Forest	60
27	B	43	NLCD (43) - Mixed Forest	60
28	B	52	NLCD (52) - Shrub-Scrub	56
29	B	71	NLCD (71) - Grassland-Herbaceous	58
30	B	81	NLCD (81) - Pasture-Hay	61
31	B	82	NLCD (82) - Cultivated Crops	83
32	B	90	NLCD (90) - Woody Wetland	98
33	B	91,92,93,94	NLCD (91,92,93,94) - Forested & Shrub Wetlands	98
34	B	95	NLCD (95) - Emergent Herbaceous Wetlands	98
35	**C**	**11**	**NLCD (11) - Open Water**	**98**
36	C	12	NLCD (12) - Perennial Snow/Ice	98
37	C	21	NLCD (21) - Developed, Open Space	89
38	C	22	NLCD (22) - Developed, Low Intensity	92
39	C	23	NLCD (23) - Developed, Medium Intensity	98
40	C	24	NLCD (24) - Developed, High Intensity	98
41	C	31	NLCD (31) - Barren Land	91
42	C	41	NLCD (41) - Deciduous Forest	70
43	C	42	NLCD (42) - Evergreen Forest	73
44	C	43	NLCD (43) - Mixed Forest	73
45	C	52	NLCD (52) - Shrub-Scrub	70

		NLCD 2021		
Number	**HSG**	**NLCD (2019)**	**2021 National Land Cover Dataset (NLCD)**	**Curve Number (Ag. Land 2-2c)**
46	C	71	NLCD (71) - Grassland-Herbaceous	71
47	C	81	NLCD (81) - Pasture-Hay	74
48	C	82	NLCD (82) - Cultivated Crops	88
49	C	90	NLCD (90) - Woody Wetland	98
50	C	91,92,93,94	NLCD (91,92,93,94) - Forested & Shrub Wetlands	98
51	C	95	NLCD (95) - Emergent Herbaceous Wetlands	98
52	**D**	**11**	**NLCD (11) - Open Water**	**98**
53	D	12	NLCD (12) - Perennial Snow/Ice	98
54	D	21	NLCD (21) - Developed, Open Space	91
55	D	22	NLCD (22) - Developed, Low Intensity	93
56	D	23	NLCD (23) - Developed, Medium Intensity	98
57	D	24	NLCD (24) - Developed, High Intensity	98
58	D	31	NLCD (31) - Barren Land	93
59	D	41	NLCD (41) - Deciduous Forest	77
60	D	42	NLCD (42) - Evergreen Forest	79
61	D	43	NLCD (43) - Mixed Forest	79
62	D	52	NLCD (52) - Shrub-Scrub	77
63	D	71	NLCD (71) - Grassland-Herbaceous	78
64	D	81	NLCD (81) - Pasture-Hay	80
65	D	82	NLCD (82) - Cultivated Crops	90
66	D	90	NLCD (90) - Woody Wetland	98
67	D	91,92,93,94	NLCD (91,92,93,94) - Forested & Shrub Wetlands	98
68	D	95	NLCD (95) - Emergent Herbaceous Wetlands	98

Appendix C: FEMA Firm Map(s)

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Kentucky State Plane coordinate system (FIPSZONE 1600). The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid or projection used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov/.

Base map information was derived from multiple sources. Digital orthophotography shown on this FIRM is provided by Kentucky Division of Geographic Information (KY DGI). These images were originally produced by Photo Science, Inc. in 2006 as 10,000-ft x 10,000-ft blocks with 2-foot pixel resolution and projected to State Plane Kentucky Single Zone with a NAD83 datum. The images have been combined as a mosaic to provide seamless coverage. Road centerlines published in 2006 and political boundary files dated 2008 were provided by the Kentucky Geographic Network. Stream centerlines were downloaded from the National Hydrography Dataset provided by the U.S. Geological Survey. Users of this FIRM should be aware that minor adjustments may have been made to specific base map features.

Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

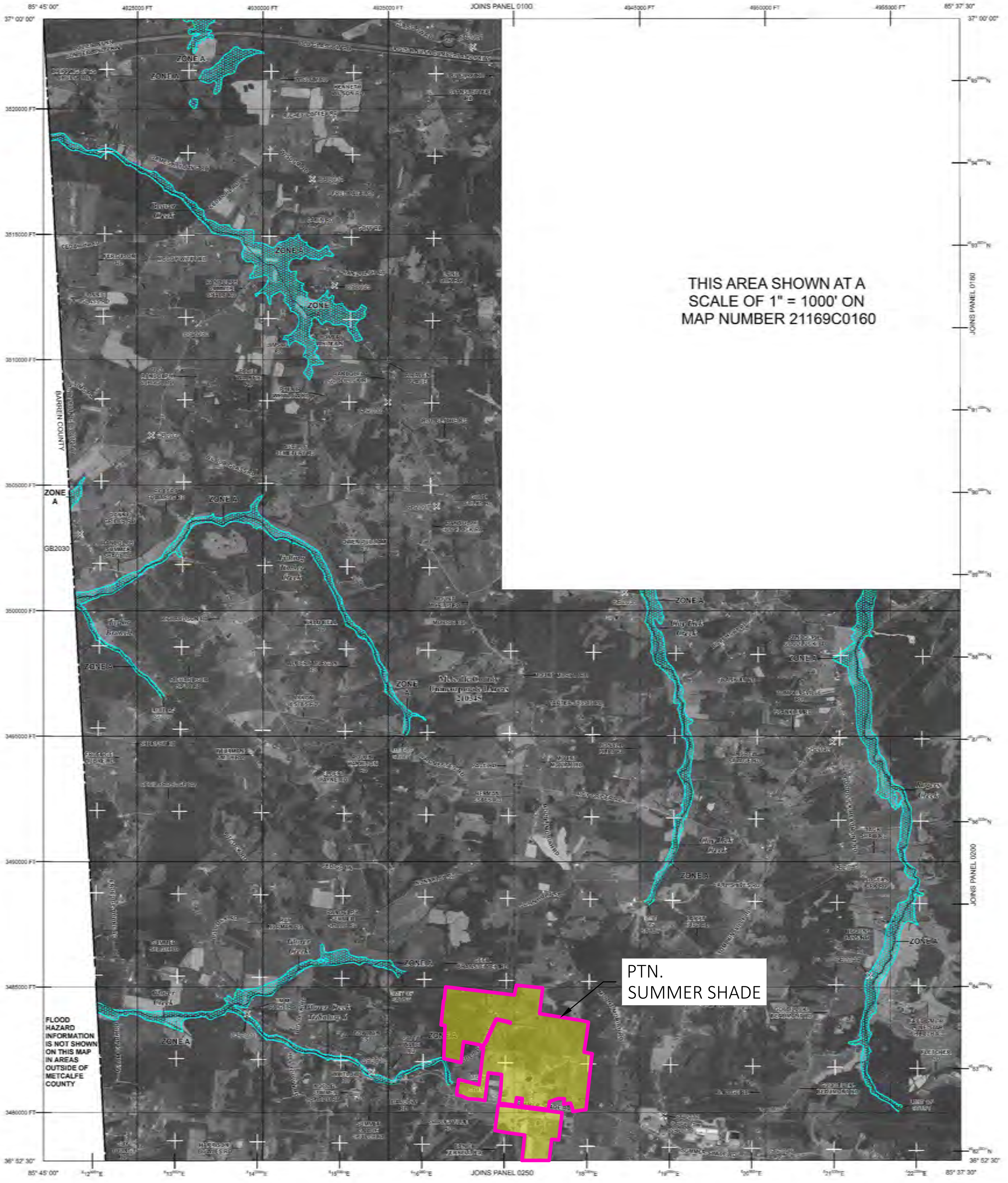
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and /or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

METCALFE COUNTY, KENTUCKY FIRM PANEL LOCATOR DIAGRAM

In cooperation with the Federal Emergency Management Agency (FEMA) and local communities in Kentucky, this Flood Insurance Rate Map was developed by the Kentucky Division of Water in a digital statewide format to assist communities in their efforts to minimize the loss of property and life through effectively managing development in flood-prone areas. The State of Kentucky has implemented a long term approach to floodplain management to reduce the impacts of flooding. This is demonstrated by the State's commitment to map floodplain areas at the local level. As part of this effort, the Kentucky Division of Water is working closely with FEMA as a Cooperating Technical Partner to produce and maintain this digital FIRM.



LEGEND

▨ SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

▨ FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

▒ OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

☐ OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

▧ COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

▧ OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

——	1% annual chance floodplain boundary
——	0.2% annual chance floodplain boundary
— —	Floodway boundary
— — —	Zone D boundary
▬	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
●●●●●●	CBRS and OPA boundary
━ ━ ━	International, State, or County boundary
━ ━ ━	Corporate, Extraterritorial Jurisdiction, or Urban Growth boundary
━━━	Area Not Included boundary
- — - —	Military Reservation, Native American Lands boundary
~~ 513 ~~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*
	* Referenced to the North American Vertical Datum of 1988
Ⓐ——Ⓐ	Cross section line
㉓------㉓	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}76^{000m}$E	1000-meter Universal Transverse Mercator grid values, zone 16
600000 FT	5000-foot grid ticks: Kentucky State Plane coordinate system (FIPS 1600), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
● M1.5	River Mile
├----┤	Aqueduct, Culvert, Flume, Penstock, or Storm Sewer
)==(	Road or Railroad Bridge

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
May 3, 2010

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0175C

FIRM
FLOOD INSURANCE RATE MAP

METCALFE COUNTY, KENTUCKY
AND INCORPORATED AREAS

PANEL 175 OF 300
(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
METCALFE COUNTY	210345	0175	C

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

EFFECTIVE DATE	MAP NUMBER
MAY 3, 2010	21169C0175C

State of Kentucky
Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Kentucky State Plane coordinate system (FIPSZONE 1600). The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid or projection used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov/.

Base map information was derived from multiple sources. Digital orthophotography shown on this FIRM is provided by Kentucky Division of Geographic Information (KY DGI). These images were originally produced by Photo Science, Inc. in 2006 as 10,000-ft x 10,000-ft blocks with 2-foot pixel resolution and projected to State Plane Kentucky Single Zone with a NAD83 datum. The images have been combined as a mosaic to provide seamless coverage. Road centerlines published in 2006 and political boundary files dated 2008 were provided by the Kentucky Geographic Network. Stream centerlines were downloaded from the National Hydrography Dataset provided by the U.S. Geological Survey. Users of this FIRM should be aware that minor adjustments may have been made to specific base map features.

Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

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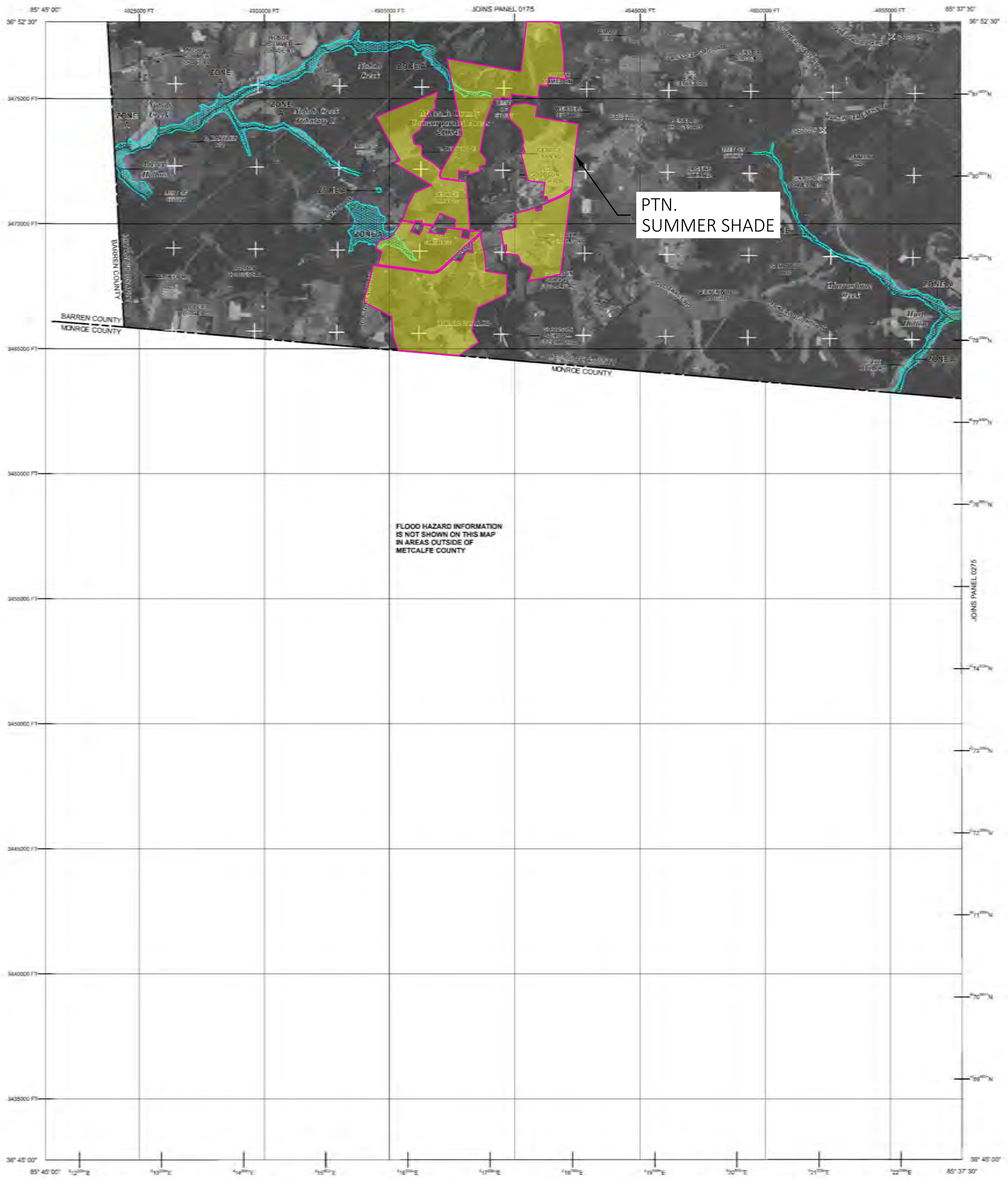
Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and /or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

METCALFE COUNTY, KENTUCKY FIRM PANEL LOCATOR DIAGRAM

In cooperation with the Federal Emergency Management Agency (FEMA) and local communities in Kentucky, this Flood Insurance Rate Map was developed by the Kentucky Division of Water in a digital statewide format to assist communities in their efforts to minimize the loss of property and life through effectively managing development in flood-prone areas. The State of Kentucky has implemented a long term approach to floodplain management to reduce the impacts of flooding. This is demonstrated by the State's commitment to map floodplain areas at the local level. As part of this effort, the Kentucky Division of Water is working closely with FEMA as a Cooperating Technical Partner to produce and maintain this digital FIRM.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAS)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
CBRS and OPA boundary
International, State, or County boundary
Corporate, Extraterritorial Jurisdiction, or Urban Growth boundary
Area Not Included boundary
Military Reservation, Native American Lands boundary

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*
	* Referenced to the North American Vertical Datum of 1988
Ⓐ——Ⓐ	Cross section line
㉓——㉓	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}76^{000m}$E	1000-meter Universal Transverse Mercator grid values, zone 16
600000 FT	5000-foot grid ticks: Kentucky State Plane coordinate system (FIPS 1600), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
● M1.5	River Mile
	Aqueduct, Culvert, Flume, Penstock, or Storm Sewer
	Road or Railroad Bridge

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
May 3, 2010

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'
1000 0 2000 4000 FEET
600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0250C

FIRM
FLOOD INSURANCE RATE MAP

METCALFE COUNTY, KENTUCKY
AND INCORPORATED AREAS

PANEL 250 OF 300
(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
METCALFE COUNTY	210345	0250	C

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

EFFECTIVE DATE	MAP NUMBER
MAY 3, 2010	21169C0250C

State of Kentucky
Federal Emergency Management Agency

NOTES TO USERS

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Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Kentucky State Plane coordinate system (FIPSZONE 1600). The **Horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid or projection used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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MONROE COUNTY, KY FIRM PANEL LOCATOR DIAGRAM

*PANEL NOT PRINTED

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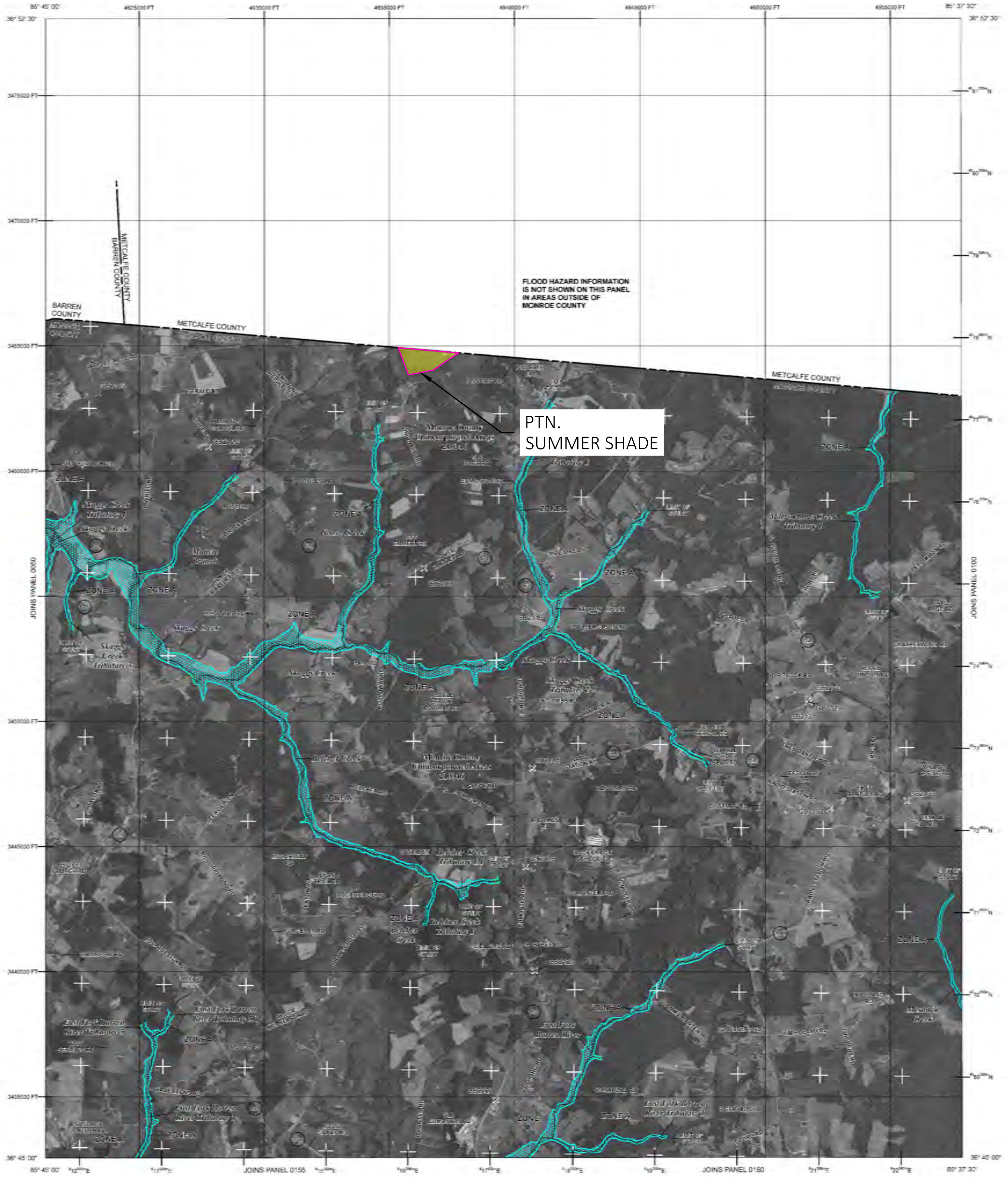

LEGEND

▨ SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

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ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

▨ FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

▒ OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

☐ OTHER AREAS

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▨ COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

▨ OTHERWISE PROTECTED AREAS (OPAS)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

―	1% annual chance floodplain boundary
―	0.2% annual chance floodplain boundary
– –	Floodway boundary
– –	Zone D boundary
▬	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
•••••	CBRS and OPA boundary
— - —	International, State, or County boundary
— - —	Corporate, Extraterritorial Jurisdiction, or Urban Growth boundary
―	Area Not Included boundary
- · -	Military Reservation, Native American Lands boundary
~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*
	* Referenced to the North American Vertical Datum of 1988
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87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
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600000 FT	5000-foot grid ticks: Kentucky State Plane coordinate system (FIPS 1600), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
● M1.5	River Mile
├──┤	Aqueduct, Culvert, Flume, Penstock, or Storm Sewer
)──(	Road or Railroad Bridge

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
JULY 17, 2012

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'

1000	0	2000	4000	FEET
600	0	600	1200	METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0075A

FIRM
FLOOD INSURANCE RATE MAP

MONROE COUNTY, KENTUCKY
AND INCORPORATED AREAS

PANEL 75 OF 350
(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MONROE COUNTY	[illegible]	[illegible]	A

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

EFFECTIVE DATE	MAP NUMBER
JULY 17, 2012	21171C0075A

State of Kentucky
Federal Emergency Management Agency

SITING BOARD 1-80:

Provide a list of permits from other local, state, or federal agencies that have been or will be obtained prior to construction or operations.

Response: The Project will require the Certificate to Construct from the Kentucky Siting Board on Electric Generation and Transmission, a USACE Nationwide wetlands permit with Section 7 and 106 reviews and Section 404 certification, driveway and heavy haul permits as needed from the Kentucky Transportation Cabinet, and KPDES construction stormwater permit(s) from the Energy and Environment Cabinet. Metcalfe County construction permits will also be required.

Witness: Mark Carney

SITING BOARD 1-81:

Provide copies of documents submitted to other agencies, other than what is provided in the application.

Response: Additional documents submitted to the U.S. Fish and Wildlife Service are attached below. This is the only set of documentation submitted to other agencies.

Witness: Shane Kelley

Stantec

Memo

To: Summer Shade Solar, LLC
500 Sansome St
Suite 500
San Fransisco, CA 94104

From: Shane Kelley
Senior Biologist
Stantec Consulting
9200 Shelbyville Road, Suite 800
Louisville, KY 40222

Project/File: 172658275

Date: February 27, 2025

Reference: Summer Shade Solar Hibernacula Survey – Cave-01

On behalf of Summer Shade Solar, LLC (Summer Shade) (the "Client"), Stantec conducted an interior cave survey on Cave-01. The purpose of the interior survey was to conduct a hibernacula survey to determine if Cave-01 was being used by gray bats (*Myotis grisescens)* during the summer (signs of guano piles and staining will be identified if present), identify and locate winter hibernating bats, and to map the cave to determine its length and general direction to see if it could be impacted by the pile driving activities that will take place as a part of the solar facility construction. This memo has been prepared for the benefit of state and federal agencies permitting or commenting on the Project.

Stantec personnel located one proposed endangered tricolored bat (*Perimyotis subflavus)* hibernating within 50 feet of the entrance. No signs of gray bats were observed such as staining on the walls or accumulations of guano piles on ledges; however, the actively flowing stream would likely wash away any guano that would accumulate on the cave floor. The cave was mapped using a Leica DistoX310 that is capable of measuring distance, azimuth, and inclination. Surveyors set 30 stations and mapped a total of 589.97 feet of linear passage. Data was processed using Compass cave mapping software to create a line plot of the cave. Results show that the cave is trending south-southeast and is located approximately 465 feet east of the proposed solar panel site (**Figure 1**).

Stantec Consulting Services Inc.'s professional opinion is that due to the distance from the closest solar panels (~465 feet) on Summer Shade Solar the pile driving activities associated with solar facility construction will not impact the cave. Additionally, it is unlikely that the cave is used as a hibernacula by listed bat species including the Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), or gray bat as none were observed during the hibernacula survey or caught during six weeks of fall swarming harp trap surveys. However, the cave is a hibernaculum for the proposed endangered tricolored bat as two were captured during fall swarming harp trap surveys and one was observed during the hibernacula survey. It is also unlikely that the cave is utilized as a summer roost by gray bats due to the lack of observed guano or staining throughout the cave passage.

The opinions stated above are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes.

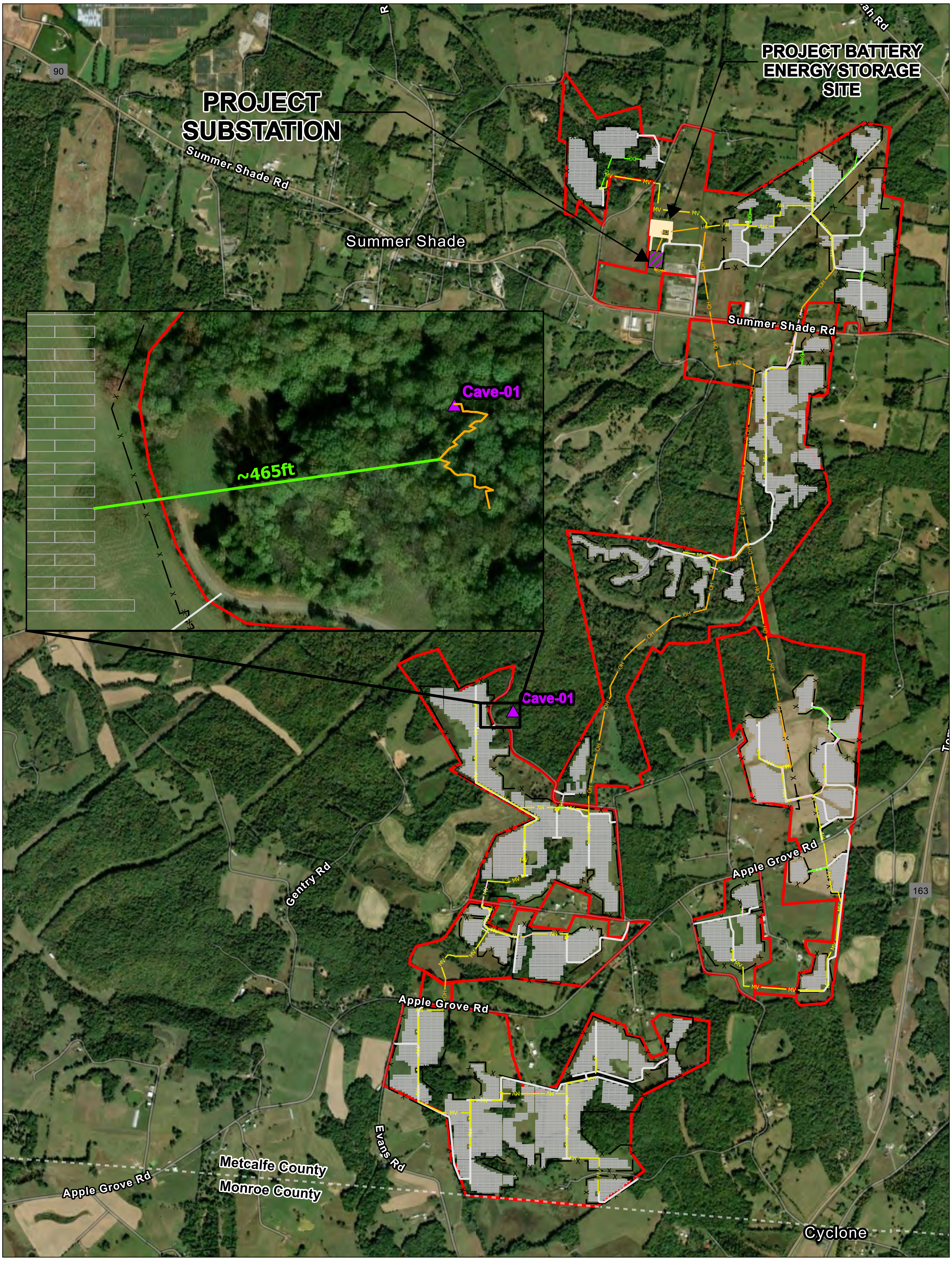
Regards,

STANTEC CONSULTING SERVICES INC.

Shane Kelley

Shane Kelley QHP
Senior Biologist
Mobile: 502-269-8994
shane.kelley@stantec.com

Appendix A Figures



Legend

- 🟥 PROJECT BOUNDARY
- ▲ CAVE-01 ENTRANCE
- — CAVE-01 SURVEY PATH

SITE FACILITIES

- —x— PROPOSED SECURITY FENCING
- — PROPOSED GRAVEL ACCESS ROADS
- —DC— PROPOSED DC COLLECTION
- —MV— PROPOSED MV COLLECTION
- —OH— PROPOSED OVERHEAD COLLECTION
- — PROPOSED UNDERGROUND COLLECTION
- ☐ PROPOSED BATTERY ENERGY STORAGE SITE
- ▨ PROPOSED PROJECT SUBSTATION
- ☐ PROPOSED FIXED TILT ARRAY

0 1,750 3,500 Feet
(At original document size of 11x17)
1 inch = 1,750 feet

N

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri Aerial Imagery Basemap

Stantec

Project Location
Metcalfe County,
Kentucky

Prepared by MNA on 2025-02-21
TR by HL on 2025-02-21
IR by SPK on 2025-02-21

Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
Cave Survey

Figure No.
1

Title
Cave Survey Map

C:\Users\mangel\Documents\ArcGIS\Projects_2024\Summer_Shade_Solar\SummerShadeSolar_Maps\SummerShadeSolar_Maps.aprx Revised: 2025-02-21 By: mangel

Appendix B Photolog

Client:	**Summer Shade Solar, LLC**	**Project:**	**Hibernacula Surveys and Cave Mapping**
Site Name:	**Cave-01**	**Site Location:**	**Summer Shade, Kentucky**

Photograph ID: 1

Photo Location:
C-01

Direction:
East

Survey Date:
2/21/2025

Comments:
Cave entrance.

Photograph ID: 2

Photo Location:
C-01

Direction:
North/Northwest

Survey Date:
2/21/2025

Comments:
Adjacent stream in the same sinkhole that flows from east to west.

Client:	**Summer Shade Solar, LLC**	**Project:**	**Hibernacula Surveys and Cave Mapping**
Site Name:	**Cave-01**	**Site Location:**	**Summer Shade, Kentucky**

Photograph ID: 3

Photo Location:
C-01

Direction:
N/A

Survey Date:
2/21/2025

Comments:
Tricolored bat (Perimyotis subflavus).

Photograph ID: 4

Photo Location:
C-01

Direction:
N/A

Survey Date:
2/21/2025

Comments:
Tricolored bat (Perimyotis subflavus).

Photographic Log

Client:	**Summer Shade Solar, LLC**	**Project:**	**Hibernacula Surveys and Cave Mapping**
Site Name:	**Cave-01**	**Site Location:**	**Summer Shade, Kentucky**

Photograph ID: 5

Photo Location:
C-01

Direction:
N/A

Survey Date:
2/21/2025

Comments:
Formations inside of cave.

Photograph ID: 6

Photo Location:
C-01

Direction:
N/A

Survey Date:
2/21/2025

Comments:
Narrow, canyon-like passage. Solutional dome features were present and may allow roosting habitat for bats.

Client:	**Summer Shade Solar, LLC**	**Project:**	**Hibernacula Surveys and Cave Mapping**
Site Name:	**Cave-01**	**Site Location:**	**Summer Shade, Kentucky**

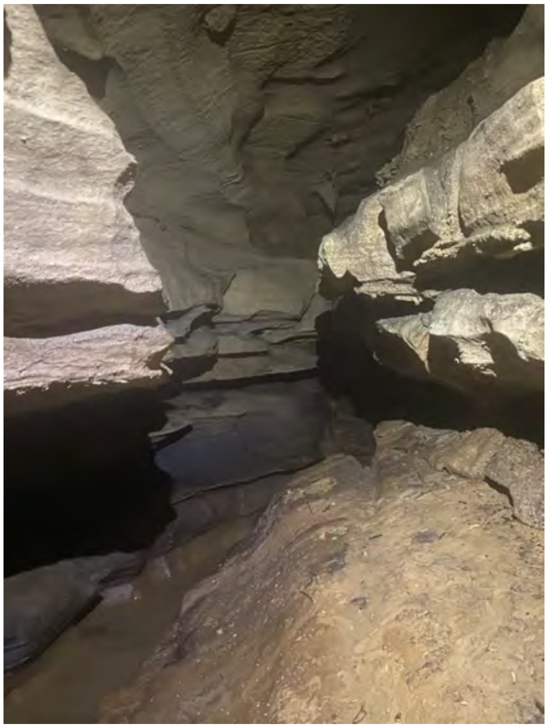
Photograph ID: 7

Photo Location:
C-01

Direction:
N/A

Survey Date:
2/21/2025

Comments:
Dry ledges in some sections of the cave may provide roosting habitat for bats.



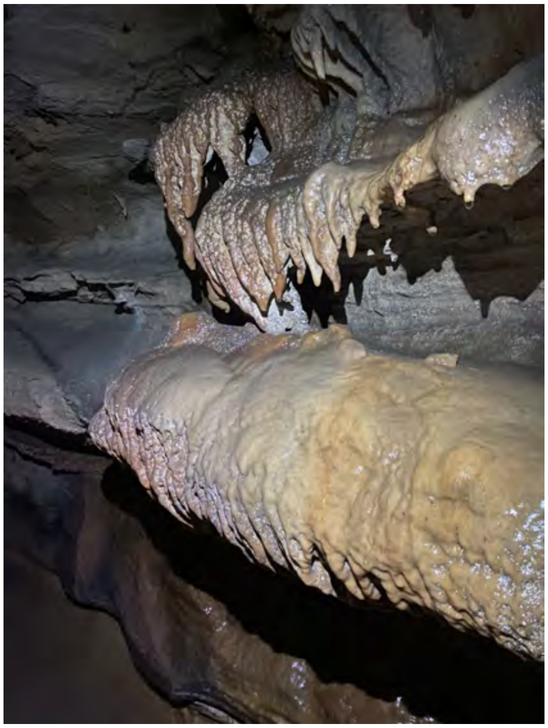
Photograph ID: 8

Photo Location:
C-01

Direction:
N/A

Survey Date:
2/21/2025

Comments:
Cave formations with the presence of iron.



Client:	**Summer Shade Solar, LLC**	**Project:**	**Hibernacula Surveys and Cave Mapping**
Site Name:	**Cave-01**	**Site Location:**	**Summer Shade, Kentucky**

Photograph ID: 9

Photo Location:
C-01

Direction:
N/A

Survey Date:
2/21/2025

Comments:
Wide passage approximately 3-4ft tall, water depth ranges from 1" to 8".

Photograph ID: 10

Photo Location:
C-01

Direction:
N/A

Survey Date:
2/21/2025

Comments:
End of survey, passage continues.

BAT MIST NET SURVEY FOR SUMMER SHADE SOLAR PROJECT IN METCALFE AND MONROE COUNTIES, KENTUCKY

July 25, 2024

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Sign-off Sheet

The conclusions in the Report titled Bat Mist Net Survey for Summer Shade Solar in Metcalfe and Monroe Counties, Kentucky are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

Stantec has assumed all information received from Summer Shade Solar LLC (the "Client") and third parties in the preparation of the Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein.

This Report is intended solely for use by the Client in accordance with Stantec's contract with the Client. While the Report may be provided by the Client to applicable authorities having jurisdiction and to other third parties in connection with the project, Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any third party, and will not be liable to such third party for any damages or losses of any kind that may result.

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Reviewed by: Kristen Clemens
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Printed Name

Approved by: ______________________
Signature

Shane Kelley, Senior Biologist
Printed Name

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Executive Summary

Summer Shade Solar LLC (Summer Shade) (the “Client”) is planning to develop a new solar energy facility in Metcalfe and Monroe Counties, Kentucky (the “Project”). The Project area is 1,526.21 acres in size and contains 523.08 acres of forest which was determined to be potential summer habitat for the federally endangered Indiana bat (*Myotis sodalis*) and northern long-eared bat (*Myotis septentrionalis*), as well as the proposed federally endangered tricolored bat (*Perimyotis subflavus*). Up to 246 acres of tree clearing will be required to complete the Project. Stantec Consulting Services, Inc. (Stantec) was retained by Summer Shade to complete a presence or probable absence mist net survey targeting these species; and, if captured, conduct a radio-tracking study to identify roost locations.

The objective of this survey was to assess the presence or probable absence of Indiana bats, northern long-eared bats, and tricolored bats using potential summer habitat within the proposed Project area. The survey methods followed the Range-wide Indiana Bat & Northern Long-eared Bat Survey Guidelines dated March 2024, and Stantec completed the Study Plan Form for Bat Surveys and Monitoring (v.2.0), which was approved on June 6, 2024, by the U.S. Fish and Wildlife Service (USFWS) Kentucky field office.

Twenty-two net nights of survey effort completed at six mist net sites captured a total of three (3) gray bats (*Myotis grisescens*), 20 evening bats (*Nycticeus humeralis*), 15 eastern red bats (*Lasiurus borealis*), and 37 big brown bats (*Eptesicus fuscus*). The eastern red bat, evening bat, and big brown bat are not federally or state-listed as endangered or threatened. The gray bat is a cave-obligate species that is federally listed as endangered. Caves identified in the Project area did not exhibit suitable habitat for gray bats; therefore, a May Affect, Not Likely to Adversely Affect determination is anticipated from the USFWS Kentucky Field Office.

Weather restrictions were followed, and mist net locations were distributed in areas where bats were likely to be found traveling and/or foraging; however, the only federally listed bat species captured was the gray bat. The data collected during the USFWS-approved 2024 mist net survey effort indicates the probable absence of listed or proposed listed bat species; therefore, a May Affect, Not Likely to Adversely Affect determination is anticipated from the USFWS Kentucky Field Office for Indiana and northern long-eared bat. Until the tricolored bat is federally listed an Informal Conference can only be completed for this species and a finding of Not Likely to Jeopardize the Continued Existence” finding is anticipated.

1 Introduction

Summer Shade Solar LLC (Summer Shade) is planning to develop a new solar energy facility in Metcalfe and Monroe Counties, Kentucky (the "Project"). The Project involves the construction of a photovoltaic (PV) electrical generating facility. The facility is proposed to be sited to the east-southeast of the town of Summer Shade. Proposed Project activities include the panel array installation, ancillary equipment, transmission interconnection, and equipment staging.

The Project area is 1,526.21 acres in size and is primarily composed of agricultural fields, forested riparian areas, upland forest tracts, and tree lines along field edges. Up to 246 acres of tree clearing within forested bat habitat will be required to complete the Project. The Project area can be seen in **Figures 1 and 2** in **Appendix A**.

The Project area is within the ranges of the federally endangered Indiana bat (*Myotis sodalis*) and northern long-eared bat (*Myotis septentrionalis*), as well as the proposed federally endangered tricolored bat (*Perimyotis subflavus*) according to the USFWS Information for Planning and Consultation (IPaC) environmental review tool (Project Code: 2024-0100621). Tree clearing within potentially suitable forested bat habitat will be required to complete the Project; therefore, Stantec Consulting Services, Inc. (Stantec) was retained by Summer Shade to complete a mist net survey targeting these three bat species; and, if captured, conduct a radio-tracking study to identify roost locations.

The objectives of this survey were as follows:

- Determine presence or probable absence of Indiana bats, northern long-eared bats, and tricolored bats within the Project area;
- Establish baseline data on bat species composition within the Project area; and
- If captured, radio-track Indiana, northern long-eared, or tricolored bats to identify their roosting habitat and locations.

1.1 Purpose

The purpose of this document is to provide a report detailing the mist net survey efforts for Summer Shade for use in consultation with USFWS. The report includes a description of methods, results and summarized data, and discussion regarding the survey. Maps, agency notifications, field data sheets, and representative photographs are provided as appendices in the report (**Appendices A, B**, **C**, and **D** respectively). This report will also be used by Stantec for annual coordination of Section 10 federal recovery permit activities with USFWS and with the Kentucky Department of Fish and Wildlife Resources (KDFWR) to meet state scientific collection permit conditions.

1.2 Regulatory Background

1.2.1 ENDANGERED SPECIES ACT

The Endangered Species Act (ESA) [16 U.S.C. 1531 et seq.] became federal law in 1973 and provides for the listing, conservation, and recovery of endangered and threatened species of plants and wildlife. Under the ESA, the USFWS strives to protect and monitor the numbers and populations of listed species. Many states enacted similar laws.

Section 7(a)(2) of the ESA states that each federal agency shall ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in destruction or adverse modification of designated critical habitat. Federal actions include expenditure of federal funds for roads, buildings, or other construction projects, and approval of a permit or license, and the activities resulting from such permit or license. This is true regardless of if involvement is apparent, such as issuance of a federal permit, or less apparent, such as federal oversight of a state-operated program, or federal funding of state highways.

Section 9 of the ESA prohibits the take of listed species. Take is defined by the ESA as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect.” The definition of harm includes adverse habitat modification. Actions of federal agencies that do not result in jeopardy or adverse modification, but that could result in a take, must be addressed under Section 7 of the ESA.

1.2.2 KENTUCKY REGULATIONS

Kentucky wildlife and their habitats are protected under Title XII, Chapter 150 of the Kentucky Revised Statutes (K.R.S.) and Title 301 of the Kentucky Administrative Regulations (K.A.R.) Chapter 3, Section 061 (Endangered Species) and Chapter 4 (Wildlife). The KDFWR and the Office of Kentucky Nature Preserves (OKNP) follow federal regulations and guidance for the protection of threatened and endangered species. The KDFWR provides scientific collection permits and project-specific authorization to surveyors proposing to capture listed species.

1.3 Project Setting

The Project is located between the towns of Summer Shade, which lies to the west and north of the Project, and Beaumont, which lies to the east, and is approximately 13 miles southeast of the city of Glasgow, Kentucky within Metcalfe, and Monroe Counties. The Project is sited between KY HWY 163 which borders the Project’s eastern boundary, and KY HWY 678, which borders the Project’s southern boundary, KY HWY 839 which creates a western boundary and KY HWY 90 which is straddled by the Project as a northern boundary (**Appendix A, Figure 1**). The Project is primarily contained within the Skaggs Creek watershed (HUC-10 0511000203), though a small portion in the northeast corner of the Project overlaps the Little Barren River watershed (HUC-10 0511000106). The entire Project area lies within the Green watershed (HUC-6 051100). The Project is drained by Nobob Creek, which flows east to west through the central portion of the Project. Glover Creek and its tributaries are also located outside of the Project, with one tributary directly adjacent to the northwesternmost parcel in the Project area. The Project can be found on the Summer Shade, and Sulfur Lick, Kentucky United States Geological Survey (USGS) 7.5-Minute Quadrangle.

1.3.1 GEOLOGY AND TOPOGRAPHY

According to geospatial data on the physiographic provinces of the United States, the Project area falls within the Highland Rim section (11a) of the Interior Low Plateaus physiographic province (Fenneman and Johnson 1946), and within the Mississippian Plateaus region of Kentucky (KGS 2012). The Eastern Highland Rim region is a diverse ecoregion with undulating plains, hills, and karst. Near the Cumberland River, steep bluffs, springs, cascades, and wide bottomlands occur (KGS 2012; Woods et al 2002). The Eastern Highland Rim region is mostly underlain by Mississippian limestone, chert, shale, siltstone, and sandstone (KGS 2012; Woods et al 2002). The Mississippian Plateau or Pennyroyal Region, shown in orange on the map, consists of a limestone plain characterized by tens of thousands of sink holes, sinking streams, streamless valleys, springs, and caverns. The term "karst" is used to define this type of terrain. The Karst terrain of the Mississippian Plateau occurs because the bedrock in the eastern and southern parts of the region is dominated by thick deposits of Mississippian-age limestones. These limestones are soluble (i.e. will dissolve) under the right conditions, which means they can easily be eroded by waters moving through the ground (KGS 2012). Potential natural vegetation is mapped as oak–hickory forest but, in ravines near the Cumberland Plateau, forests are mixed mesophytic in character. Today, white oak dominates upland forests and bottomland trees grow along streams (Woods et al 2002).

1.4 Suitable Summer Habitat for Endangered Bats

Key characteristics of forested bat habitat include the size and relative abundance of large trees and snags that may potentially serve as roost trees, canopy closure, understory clutter/openness, distance to water, stream or pond characteristics, and flight areas. Anthropogenic structures such as bridges, culverts, bat houses, and abandoned buildings and barns may also serve as suitable roosting habitat for bats.

Habitat characterization for bats in forested areas identifies components of the dominant canopy species (diameter at breast height [DBH] >16 inches) and subdominant canopy species (DBH < 16 in). Large trees in the canopy (> 16 in DBH) have the greatest likelihood of being used by maternity colonies of Indiana bats. Many smaller trees are often also found in the canopy, and in some situations the canopy can be entirely composed of smaller-diameter trees.

The subcanopy, or understory, vegetation layer is well defined in classical ecological literature as the portion of the forest structure between the ground vegetation (up to approximately 2 feet [0.6 meters]) and the canopy layers, usually beginning at approximately 25 feet (7.6 meters).

Vegetation in the understory may come from:

- Lower branches of overstory trees;
- Young overstory trees; or
- Small trees and shrubs that are confined to the understory.

The amount of vegetation in the understory is termed “clutter”. Many species of bats, including the Indiana bat, tend to avoid areas of high clutter, while northern long-eared bats may utilize the protection these areas provide.

The Indiana bat is known to roost in several different species of trees, including oaks (*Quercus* spp.), hickories (*Carya* spp.), and ashes (*Fraxinus* spp.) (USFWS 2007). Suitable roost trees may be live trees or snags and have a DBH > 5 in (12.7 cm). In addition to forested habitat, Indiana bats use emergent wetlands, agricultural fields, fencerows, and riparian areas for traveling and foraging. Indiana bats have also been documented using bat houses and bridges for roosting (USFWS 2024a).

Habitat for the northern long-eared bat appears far more general than that of the Indiana bat (Schultes and Elliott 2002; Whitaker and Mumford 2009). While some studies have found this species using larger, older forests and roosts (Lacki and Schwierjohann 2001; Henderson and Broders 2008), others have found the species using smaller roosts and forest tracts (Whitaker and Mumford 2009; Schultes and Elliott 2002).

Tricolored bat habitat is not as well understood as Indiana bat habitat. Tricolored bats have been documented roosting among the leaves of live or recently dead deciduous trees, as well as pine trees (*Pinus* spp.), Spanish moss (*Tillandsia usneoides*), and man-made structures such as bridges and culverts for roosting (USFWS 2024b).

Due to the overlap in foraging and traveling habitat usage between these three species, conditions for the capture of Indiana and northern long-eared bats were considered adequate for determining presence or probable absence of tricolored bats, as outlined in the USFWS 2024 guidelines.

1.4.1 HABITAT ASSESSMENT

A desktop habitat and field assessments were completed by qualified personnel (as per USFWS 2024a) to assess potential suitable summer habitat within the Project area. The Project area consisted primarily of agricultural crop fields with distinct blocks of young forest dispersed throughout, especially surrounding water features. Short flyway corridors with canopy cover separating field sections were visible within these forest blocks.

Additionally, a team of two biologists conducted a pedestrian habitat assessment of the Project area from October 4-10, 2021, April 18-27, 2022, and February 26-29, 2024. Field findings from this assessment supported the findings of the desktop analysis, confirming the overall landcover of the Project. Forested areas typically consisted of mature riparian and upland forest with high amounts of invasive species such as shrub honeysuckle (*Lonicera mackii*) and winter creeper (*Euonymus fortunei*).

Water resources identified during the desktop and field assessments that could potentially serve as drinking sources or flyways for bats were mapped using publicly available data and Global Positioning Systems (GPS) in the field. The National Hydrography Database (NHD) identified 13 stream channels with intermittent flow (USGS 2024) and the National Wetlands Inventory (NWI) identified 13 ponded areas (USFWS 2024c) within the Project area, locations of which were confirmed in the field.

Locations of karst features (especially caves) that may provide suitable habitat for listed bat species were reviewed upon receipt of data from the Kentucky Speleological Society (KSS). The KSS (2023) reported that there are two caves (Piercy Cave and Buzzards Nest Cave) within a one-mile buffer of the Project. These entrances are approximately 3,000 feet west of the southernmost project boundary. One cave was identified within the Project during the habitat assessment fieldwork that could serve as potential habitat for northern long-eared and tricolored bats but were unsuitable for Indiana and gray bats. An additional cave was identified several hundred feet outside of the Project and is potentially suitable for Indiana, gray, northern long-eared, and tricolored bats. No bridges or culverts were identified within the Project boundary.

The Project area did not overlap any known summer or swarming buffers for Indiana bat (USFWS 2019a) but does overlap Summer 1 habitat for the northern long-eared bat (USFWS 2019b). No maternity colonies or hibernacula for Indiana bats have been documented in Metcalfe or Monroe Counties. Northern long-eared bat maternity colonies have been documented in Metcalfe and Monroe Counties (KDFWR 2024a). A tricolored bat maternity colony has previously been documented in Monroe County via correspondence with USFWS and it was indicated that the location is approximately 0.53 miles west of the southern portion of the Project (**Appendix B**). Indiana bats have no record of being captured in neither Metcalfe nor Monroe Counties. Capture records for the northern long-eared bat within Metcalfe and Monroe Counties were documented prior to 2006 before the onset of white-nose syndrome (WNS) in Kentucky (KDFWR 2024a). The latest capture records for tricolored bats in Metcalf and Monroe Counties were in 2008 and 2014 respectively (KDFWR 2024a).

2 Methods

2.1 Study Plan for Bat Surveys and Monitoring

Prior to conducting field surveys, Stantec biologists completed the Study Plan Form for Bat Surveys and Monitoring (v.2.0) for the submittal to the USFWS Kentucky field office for approval and authorization to conduct the mist net survey. Data from the desktop review and the October 4-10, 2021, April 18-27, 2022, and February 26-29, 2024 field habitat assessments were used to determine the level of effort required for the survey as well as proposed mist net site locations. (**Appendix B**).

The level of effort required for presence or probable absence surveys for endangered bat species is outlined in the 2024 USFWS Range-Wide Indiana Bat and Northern Long-Eared Bat Summer Survey Guidance dated March 2024 (USFWS 2024). When using mist nets to physically capture bats, the level of effort is defined in this guidance using “net nights”. One net night equals one mist net set deployed for one calendar night. The survey effort required to adequately survey for the presence or probable absence of a species is dependent on the species (i.e., Indiana bat or northern long-eared bat) and differs based on the active range of the species, as outlined on page 10 of the 2024 USFWS Guidance. When the ranges of Indiana, northern long-eared, and tricolored bats overlap, the level of effort required for northern long-eared bats is used when surveying for the other two species because it is the greater amount of effort.

The state of Kentucky is within the range of the northern long-eared bat (USFWS 2024). The level of effort required for presence or probable absence surveys of non-linear Projects in this range is ten net nights per 123 acres of suitable forested habitat. Approximately 246 acres of suitable forested habitat may be removed in the Project area; therefore, the study plan proposed deploying three to four mist net sets for six calendar nights in three distinct areas of the Project (sites) for a minimum of 20 net nights of survey effort.

Aerial imagery was used to propose six potential mist net site locations in the Project area. NHD streams, NWI wetlands, flyways such as roads with canopy cover, forest gaps in woodlots between fields, and the presence of anthropogenic structures such as bridges, culverts, or barns are all considered when choosing potential mist net sites during the desktop stage. Although these desktop resources can provide useful planning tools for the selection of potential mist net sites, due to changes since aerial imagery was captured and inherent limitations in how landscape-scale databases are developed, final mist net locations were determined in the field.

Proposed mist net sites (PMS) outlined in the study plan were located along water resources and within forest gaps dispersed across the Project area. PMS-01 was in the south portion of the Project area and targeted the perennial streams flowing through that area. PMS-02 was in the northwest portion of the Project area and targeted the ridge top above a spring-fed perennial stream. PMS-03 was in the forested area located in the west central part of the Project area. PMS-04 was in the center of the Project area along the perennial stream Nobob Creek. PMS-05 was in the center of the Project area and targeted forested corridors between pasture. PMS-06 was located in the south portion of the Project area and targeted open forested corridors between pastureland.

No visual assessment surveys of bridges and culverts were proposed in the study plan form since no structures large enough to support roosting bats were identified on aerial imagery or during past site visits to the Project area.

Stantec submitted a project-specific Study Plan Form for Bat Survey and Monitoring (**Appendix B**) to the USFWS Kentucky Field Office and KDFWR on June 5, 2024, requesting concurrence that the proposed level of effort is sufficient to determine the presence or probable absence of Indiana, northern long-eared, and tricolored bats within the Project area.

Authorization was received from both agencies on June 6, 2024, confirming the proposed survey methods and level of effort with the following conditions:

1) Band any Indiana bats, tricolored bats, and little brown bats (*Myotis lucifugus*) captured with appropriately sized KDFWR bands using banding pliers. Do not band northern long-eared bats.

2) Ensure net set placements reflect variation of habitats present on site and preferred by Indiana, northern-long eared, and tricolored bats.

3) Ensure transmitters are thoroughly tested for proper functioning prior to the study per the 2024 Summer Survey Guidance.

4) Attach transmitters to the first two Indiana bats captured regardless of sex/age and then all Indiana bat females and juveniles captured after. For northern long-eared bats and tricolored bats, transmitter all individuals captured. Not meeting these conditions may result in denial of survey results.

2.2 Mist Net Surveys

2.2.1 MIST NET SITE SELECTION

A federally permitted biologist chose suitable mist net locations within the Project area based on habitat suitability, targeting areas that were suspected to have high amounts of bat activity. Survey sites were limited to parcels where landowners could be contacted, and permission granted for the survey. Net placement was based on a variety of characteristics, including canopy cover, presence of potential flight areas, proximity to water, and forest conditions. General habitat types selected included the following characteristics:

- Large trees (>16 inches DBH) that can support primary maternity roosts for Indiana and northern long-eared bats;
- Canopy cover along potential travel areas which way help funnel bats to the net locations; and
- Stream area (or other water source) for drinking and prey presence.

While mist net sites in riparian areas are typically successful, upland areas (e.g., trails or logging roads) also provide suitable sites (Kiser and MacGregor 2005). In upland areas, road ruts or other areas of standing water frequently facilitate capture of a variety of bat species. The actual location and orientation of each mist net set was determined in the field.

2.2.2 BAT CAPTURE

Protocols for bat capture, handling, and equipment decontamination for WNS were followed during mist net surveys. Any bats captured in mist nets were carefully removed and placed individually in disposable brown paper bags to keep bats isolated and reduce any risk of cross-exposure of WNS. This procedure was followed for all bats regardless of if they show signs of WNS or not. After use, each paper bag was disposed of into a large plastic sealable bag. Biologists wore disposable gloves when handling individual bats, and their hands were periodically disinfected with hand sanitizer. All measuring equipment and surfaces for processing were decontaminated after each bat.

Morphological characteristics used to identify bats include ear and tragus, calcar, pelage, size/weight, forearm length, and overall appearance of the animal. The species, sex, reproductive condition, age, weight, length of right forearm, time and location, and net site of capture were recorded for all bats. Age (adult or juvenile) of each bat was determined by examining epiphyseal-diaphyseal fusion (calcification) of long bones in the wing. Weight was measured to 0.1 gram using a Pesola spring scale. Length of the right forearm of each bat was measured in millimeters using a field ruler or calipers. The reproductive condition of captured bats was classified as non-descended male, descended male, non-reproductive female, pregnant female (based on gentle abdominal palpation), lactating female, or post-lactating female.

Bat processing and data collection was typically completed within 15 minutes of the time the bat was removed from the net. Bats were caught live and released unharmed near the point of capture after processing.

2.2.3 WEATHER

Weather conditions were monitored each night of the survey. Conditions recorded include temperature, wind speed and direction, percent cloud cover, and moon phase. A standard digital thermometer was used to record temperature, wind speed was estimated by using the Beaufort wind scale, and cloud cover was estimated visually. The moon phase, moon rise and set times, and sunset times for each night were obtained from online resources.

3 Results

3.1 Mist Net Surveys

3.1.1 MIST NET SITE DESCRIPTIONS

Mist Net Site 01 (MS-01) contained four net sets deployed in the southwest portion of the Project area, as proposed in the study plan. There were several perennial streams and a wetland for bats to use for drinking and foraging. Net A was situated over a palustrine forested (PFO) wetland. Net B was parallel to one of the perennial streams covering the corridor between two cow pastures. Net C was located across a perennial stream in the forest, it was positioned to cover potential bats drinking from the stream and foraging for food as well as the adjacent forested area. Net D was placed in the open forest west of the wetland.

The forest at MS-01 had an open canopy dominated by 10-to-12-inch DBH tulip poplar (*Liriodendron tulipifera*), red maple (*Acer rubrum*), American beech (*Fagus grandifolia*), and American sycamore (*Platanus occidentalis*). The subcanopy was moderately cluttered and dominated by 3-to-8-inch DBH Sweetgum (*Liquidambar styraciflua*), box elder (*Acer negundo*), and green ash (*Fraxinus pennsylvanica*).. The shrub layer was moderately cluttered and dominated by spicebush (*Lindera benzoin*), eastern redbud (*Cercis canadensis*), American pawpaw (*Asimina triloba*), and multiflora rose (*Rosa multiflora*). There were both large trees and snags in the area that could serve as potential roosting habitat. The potential for roost tree habitat was estimated to be moderate, and an overall habitat rating of moderate was assigned to this site.

Mist Net Site 02 (MS-02) contained four net sets deployed in the northwest portion of the Project area, as proposed in the study plan. The net sets were on a ridgetop road corridor that bats may use for travel and foraging. Net A and Net B were situated over the ridgetop road in an upland forest. Net C was at the intersection of two road corridors. Net D was situated east of Net C past an area that had been logged. In the valley below the site was a spring fed perennial stream and rock shelter with potential night roost habitat for listed bats.

The forest at MS-02 had a moderately-open canopy dominated by 10-to-16-inch DBH shagbark hickory (*Carya ovata*), sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*), and bitternut hickory (*Carya cordiformis*). The subcanopy was moderately cluttered and dominated by 4-to-8-inch DBH sugar maple, black locust (*Robinia pseudoacacia*), chinkapin oak (*Quercus muehlenbergii*), and Kentucky coffeetree (*Gymnocladus dioicus*). The shrub layer was highly cluttered and dominated by saplings of overstory trees, eastern redbud, coral berry (*Symphoricarpos orbiculatus*), and Carolina buckthorn (*Rhamnus caroliniana*). The upland forest had both large trees and snags in the area that could serve as potential roosting habitat. The potential for roost tree habitat was estimated to be moderate, and an overall habitat rating of moderate was assigned to this site.

Mist Net Site 03 (MS-03) contained three net sets deployed in the west central portion of the Project area. The net sets were on a ridgetop road corridor for bats to use for foraging. Net A and Net B were situated over the ridgetop road in an upland forest, with Net A being over a water filled road rut. Net C was in the adjacent open midstory upland forest.

The forest at MS-03 had a closed canopy dominated by eight-to-16-inch DBH tuliptree, southern red oak (*Quercus falcata*), shagbark hickory, and white oak (*Quercus alba*). The subcanopy was moderately cluttered and dominated by 3-to-7-inch DBH sweetgum, red maple, American elm (*Ulmus americana*), and tulip poplar. The shrub layer was highly cluttered and dominated by saplings of overstory trees, eastern redbud, multiflora rose, and flowering dogwood (*Cornus florida*) The upland forest had snags in the area that could serve as potential roosting habitat. The potential for roost tree habitat was estimated to be low, and an overall habitat rating of poor was assigned to this site.

Mist Net Site 04 (MS-04) contained four net sets deployed in the central portion of the Project area. The net sets were on and adjacent to the largest perennial stream on the Project, Nobob Creek. Net A and C were situated over a pool in Nobob Creek that bats could use for drinking and foraging. Net B was parallel to Nobob Creek and was situated in a corridor between two open fields separated by Nobob Creek. Net D covered the convergence of several dry creek beds into a dry section of Nobob Creek.

The forest at MS-04 had a moderately open canopy dominated by 14-to-20-inch DBH American sycamore, sweetgum, and sugar maple. The subcanopy was moderately cluttered and dominated by 4-to-8-inch DBH sugar maple, American elm, black walnut (*Juglans nigra*), and tulip poplar. The shrub layer was moderately cluttered and dominated by saplings of overstory trees, spice bush, multiflora rose, and pawpaw. The upland forest had large trees and snags in the area that could serve as potential roosting habitat. The potential for roost tree habitat was estimated to be moderate, and an overall habitat rating of moderate was assigned to this site.

Mist Net Site 05 (MS-05) contained three net sets deployed in the central portion of the Project area. The net sets were on a ridgetop dirt road between a large pasture and a large overhead utility line corridor. Net A, B, and C were all situated over the dirt road in select spots of closed canopy and potential bat travel corridors.

The forest at MS-05 had a moderately open canopy dominated by 10-to-16-inch DBH black locust, red cedar (*Juniperus virginiana*), and shagbark hickory. The subcanopy was moderately cluttered and dominated by 3-to-8-inch DBH hackberry (*Celtis occidentalis*), red cedar, and American hophornbeam (*Ostyra virginiana*). The shrub layer was moderately cluttered and dominated by multiflora rose, black locust, and tree of heaven (*Ailanthus altissima*). The upland forest had large trees and snags in the area that could serve as potential roosting habitat. The potential for roost tree habitat was estimated to be moderate, and an overall habitat rating of moderate was assigned to this site.

Mist Net Site 06 (MS-06) contained four net sets deployed in the southern portion of the Project area. The net sets were situated in upland mature forest between livestock pasture fields. A cattle pond was located approximately 300ft away from the net sets providing a place for bats to forage and drink. Net A and D were situated in smaller openings of the upland mature forest where the canopy created travel corridors. Net B and C were situated across a large section of forest to capture any bats which did not use a travel corridor.

The forest at MS-06 had a moderate to open canopy dominated by 16-to-24-inch DBH white ash, shagbark hickory, American beech, and bitternut hickory. The subcanopy was moderately cluttered and dominated by 4-to-12-inch DBH sugar maple, American beech, tulip poplar, and sassafras (*Sassafras albidum*). The shrub layer was moderately cluttered and dominated by spicebush, leatherwood (*Eucryphia lucida*), multiflora rose, and pawpaw. The upland forest had large trees and snags in the area that could serve as potential roosting habitat. The potential for roost tree habitat was estimated to be moderate to high, and an overall habitat rating of good was assigned to this site.

3.1.2 BAT CAPTURE

The mist net survey was conducted from, June 12 to June 17, 2024. The survey resulted in the capture of three (3) gray bats, 20 evening bats, 15 eastern red bats, and 37 big brown bats. The three (3) gray bats captured were banded during the survey (KYFW B28112, B28113, and B28114). **Table 1** outlines the capture site, date of capture, time of capture, species, sex, reproductive condition, age, mass, right forearm (RFA) measurement, band number and type (if applicable), and Reichard's wing damage index score (Reichard and Kunz. 2009). Field data sheets can be found in **Appendix B**.

Surveys were conducted by James Kiser and Lucas Downs under USFWS Recovery Permit #ES38821A-5 and KDFWR Scientific Wildlife Collecting Permit #SC2411181.

Table 1: Capture Summary for the Summer Shade Solar Bat Survey Metcalfe and Monroe Counties, Kentucky, June 12 – 17, 2024.

Survey Start Date	Site Number	Net ID	Time of Capture (24 hr)	Species	Sex[1]	Reproductive Condition[2]	Age[3]	Mass (g)	Right Forearm Length (mm)	Wing Score[4]
12-Jun-24	MS-01	B	20:50	*Lasiurus borealis*	M	NR	A	10.75	38.6	0
12-Jun-24	MS-01	B	21:00	*Lasiurus borealis*	F	L	A	11.25	38.6	0
12-Jun-24	MS-01	C	21:00	*Eptesicus fuscus*	M	NR	A	17.50	46.8	0
12-Jun-24	MS-01	C	21:00	*Eptesicus fuscus*	M	NR	A	17.50	47.9	0
12-Jun-24	MS-01	A	21:00	*Nycticeius humeralis*	F	P	A	13.25	37.5	0
12-Jun-24	MS-01	C	21:50	*Myotis grisescens*	F	L	A	11.50	42.6	0
12-Jun-24	MS-01	B	23:10	*Lasiurus borealis*	F	NR	A	11.00	39.2	0
12-Jun-24	MS-01	B	23:10	*Myotis grisescens*	F	L	A	11	41.4	0
12-Jun-24	MS-01	B	1:45	*Lasiurus borealis*	F	L	A	Escaped		0
13-Jun-24	MS-02	C	20:10	*Lasiurus borealis*	M	NR	A	10.75	40.5	0
13-Jun-24	MS-02	D	20:10	*Lasiurus borealis*	F	L	A	12.00	41.0	0
13-Jun-24	MS-02	B	22:30	*Lasiurus borealis*	F	L	A	13.00	39.8	0
13-Jun-24	MS-02	B	22:45	*Nycticeius humeralis*	M	NR	A	8.75	34.7	0
13-Jun-24	MS-02	C	23:15	*Lasiurus borealis*	M	NR	A	11.75	41.2	0
13-Jun-24	MS-02	A	23:30	*Eptesicus fuscus*	M	NR	A	19.25	47.1	0
13-Jun-24	MS-02	B	23:45	*Eptesicus fuscus*	Escaped					
13-Jun-24	MS-02	D	0:55	*Nycticeius humeralis*	M	NR	A	8.40	36.0	0
14-Jun-24	MS-03	No Captures								
15-Jun-24	MS-04	A	20:15	*Eptesicus fuscus*	F	L	A	16.25	47.0	0
15-Jun-24	MS-04	A	20:15	*Eptesicus fuscus*	F	L	A	18.25	46.9	0
15-Jun-24	MS-04	A	20:15	*Eptesicus fuscus*	F	L	A	21.00	49.4	0
15-Jun-24	MS-04	A	20:15	*Eptesicus fuscus*	F	L	A	19.75	49.8	0
15-Jun-24	MS-04	A	20:15	*Eptesicus fuscus*	F	L	A	19.25	47.7	0
15-Jun-24	MS-04	C	20:20	*Eptesicus fuscus*	F	L	A	16.50	46.2	0
15-Jun-24	MS-04	A	20:20	*Lasiurus borealis*	Escaped					

Survey Start Date	Site Number	Net ID	Time of Capture (24 hr)	Species	Sex[1]	Reproductive Condition[2]	Age[3]	Mass (g)	Right Forearm Length (mm)	Wing Score[4]
15-Jun-24	MS-04	B	20:20	*Lasiurus borealis*	F	L	A	11.50	42.4	0
15-Jun-24	MS-04	B	20:20	*Nycticeius humeralis*	M	NR	A	8.00	36.6	0
15-Jun-24	MS-04	C	20:36	*Eptesicus fuscus*	F	L	A	19.75	47.9	0
15-Jun-24	MS-04	B	20:48	*Eptesicus fuscus*	F	L	A	16.75	47.6	0
15-Jun-24	MS-04	A	20:48	*Nycticeius humeralis*	M	NR	A	8.50	37.5	0
15-Jun-24	MS-04	D	21:00	*Nycticeius humeralis*	M	NR	A	9.75	35.8	0
15-Jun-24	MS-04	A	21:00	*Eptesicus fuscus*	F	L	A	19.50	49.3	0
15-Jun-24	MS-04	B	21:00	*Nycticeius humeralis*	M	NR	A	8.75	33.9	0
15-Jun-24	MS-04	A	21:00	*Nycticeius humeralis*	M	NR	A	9.50	35.3	0
15-Jun-24	MS-04	A	21:20	*Eptesicus fuscus*	M	NR	A	22.10	48.2	0
15-Jun-24	MS-04	A	21:20	*Nycticeius humeralis*	F	L	A	12.75	35.8	0
15-Jun-24	MS-04	D	21:30	*Nycticeius humeralis*	F	L	A	11.25	34.8	0
15-Jun-24	MS-04	A	21:35	*Lasiurus borealis*	F	L	A	11.25	40.8	0
15-Jun-24	MS-04	B	22:05	*Nycticeius humeralis*	F	L	A	11.75	36.8	0
15-Jun-24	MS-04	B	22:30	*Lasiurus borealis*	M	NR	A	8.50	38.1	0
15-Jun-24	MS-04	A	22:30	*Eptesicus fuscus*	M	NR	A	17.25	42.9	0
15-Jun-24	MS-04	B	23:00	*Nycticeius humeralis*	M	NR	A	9.00	35.5	0
15-Jun-24	MS-04	A	23:00	*Eptesicus fuscus*	F	L	A	21.00	47.5	0
15-Jun-24	MS-04	A	23:18	*Eptesicus fuscus*	F	L	A	24.25	48.1	0
15-Jun-24	MS-04	D	23:18	*Myotis grisescens*	F	L	A	11.30	44.2	0
15-Jun-24	MS-04	A	23:35	*Eptesicus fuscus*	M	NR	A	22.00	45.8	0
15-Jun-24	MS-04	B	23:47	*Eptesicus fuscus*	M	NR	A	20.75	48.7	0
15-Jun-24	MS-04	B	0:28	*Lasiurus borealis*	F	L	A	14.25	41.3	0
15-Jun-24	MS-04	A	0:28	*Nycticeius humeralis*	M	NR	A	9.10	35.8	0
15-Jun-24	MS-04	A	0:30	*Eptesicus fuscus*	F	L	A	22.75	49.0	0
15-Jun-24	MS-04	A	0:45	*Nycticeius humeralis*	F	L	A	12.00	38.2	0
15-Jun-24	MS-04	A	1:05	*Eptesicus fuscus*	F	L	A	Escaped		

Survey Start Date	Site Number	Net ID	Time of Capture (24 hr)	Species	Sex[1]	Reproductive Condition[2]	Age[3]	Mass (g)	Right Forearm Length (mm)	Wing Score[4]
16-Jun-24	MS-05	C	21:27	*Lasiurus borealis*	F	L	A	14.00	40.8	0
16-Jun-24	MS-05	C	21:27	*Nycticeius humeralis*	M	NR	A	8.25	36.1	0
16-Jun-24	MS-05	C	23:20	*Lasiurus borealis*	M	Escaped				
17-Jun-24	MS-06	B	21:00	*Nycticeius humeralis*	F	L	A	11.75	36.4	0
17-Jun-24	MS-06	C	21:28	*Eptesicus fuscus*	M	NR	J	12.00	44.5	0
17-Jun-24	MS-06	B	21:45	*Eptesicus fuscus*	F	NR	J	12.80	46.5	0
17-Jun-24	MS-06	A	21:58	*Eptesicus fuscus*	M	NR	J	10.75	42.2	0
17-Jun-24	MS-06	A	21:58	*Eptesicus fuscus*	M	NR	J	11.00	44.7	0
17-Jun-24	MS-06	B	22:35	*Nycticeius humeralis*	F	L	A	10.75	37.3	0
17-Jun-24	MS-06	B	22:35	*Nycticeius humeralis*	F	L	A	11.00	36.6	0
17-Jun-24	MS-06	A	22:50	*Eptesicus fuscus*	M	NR	J	11.75	44.5	0
17-Jun-24	MS-06	C	23:05	*Eptesicus fuscus*	M	NR	J	12.00	44.3	0
17-Jun-24	MS-06	A	23:44	*Eptesicus fuscus*	M	NR	J	12.50	43.6	0
17-Jun-24	MS-06	C	23:55	*Eptesicus fuscus*	M	NR	J	12.00	44	0
17-Jun-24	MS-06	C	23:55	*Eptesicus fuscus*	M	NR	A	20.75	47.6	0
17-Jun-24	MS-06	D	23:55	*Nycticeius humeralis*	M	NR	A	9.50	35.5	0
17-Jun-24	MS-06	B	0:00	*Eptesicus fuscus*	M	NR	J	11.75	44.4	0
17-Jun-24	MS-06	C	0:15	*Eptesicus fuscus*	F	L	A	23.00	47.8	0
17-Jun-24	MS-06	A	0:15	*Eptesicus fuscus*	F	L	A	22.75	48.6	0
17-Jun-24	MS-06	A	1:05	*Eptesicus fuscus*	F	NR	J	14.75	49.1	0
17-Jun-24	MS-06	A	1:10	*Eptesicus fuscus*	F	L	A	20.50	48.4	0
17-Jun-24	MS-06	B	1:15	*Eptesicus fuscus*	M	NR	J	13.75	46.5	0
17-Jun-24	MS-06	B	1:15	*Eptesicus fuscus*	F	L	A	21.00	46.7	0
17-Jun-24	MS-06	A	1:50	*Nycticeius humeralis*	M	NR	A	8.50	35.7	0

[1] F = Female, M = Male, U = Unknown (escaped)
[2] NR = Non-Reproductive, TD = Testes Descended, P = Pregnant, L = Lactating, PL = Post-Lactating
[3] A = Adult, J = Juvenile, U = Unknown (escaped)
[4] Reichard's wing damage index is a scale from 0-3 measuring scarring and/or blotching that may indicate damage from WNS

3.1.3 WEATHER

Weather during the survey period typically started in the high 70s (Fahrenheit [°F]) and continued decreasing throughout the night into the low 70's °F. June 12th, 2024 was an outlier to this trend, with the temperature starting in the mid 60's °F and ending in the high 50's °F. Cloud cover ranged from 0 percent to 90 percent during survey period. Wind speed ranged between 0 and 2 on the Beaufort Wind Scale during the survey period. **Table 2** contains onsite weather data collected during the survey period.

Table 2: Weather Recordings for the Summer Shade Solar Bat Survey Metcalfe and Monroe Counties, Kentucky, June 12 – 17, 2024.

Site	Date	Temp °F			Wind Speed[1]			Cloud Cover %		
		2000h	2200h	0100h	2000h	2200h	0100h	2000h	2200h	0100h
MS-01	12-Jun-24	64.2	59.5	57.7	0	0	0	10	0	0
MS-02	13-Jun-24	80.4	76.5	72.2	0	0	0	0	0	0
MS-03	14-Jun-24	78.3	75.6	73	0	1	0	0	0	0
MS-04	15-Jun-24	73.2	68.5	65.9	0	1	1	20	10	50
MS-05	16-Jun-24	79.7	74.6	76.3	2	0	2	75	90	75
MS-06	17-Jun-24	80.3	76.4	74.8	0	1	2	40	60	50

[1] Beaufort wind scale. 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

4 Discussion

Mist net surveys targeting endangered bat species were conducted from June 12 to June 17, 2024 in the proposed Summer Shade Solar Project area in Metcalfe and Monroe Counties, Kentucky. The primary objective of this survey was to assess the presence, or probable absence, of Indiana, northern long-eared, and tricolored bats using summer habitat within the Project area. The survey followed the Range-wide Indiana Bat & Northern Long-eared Bat Survey Guidelines dated March 2024, and the Study Plan Form for Bat Surveys and Monitoring (v.2.0), which was approved on June 6, 2024 by the USFWS Kentucky field office (**Appendix B**).

No Indiana, northern long-eared, or tricolored bats were captured during the mist net survey although suitable habitat was present. The Project did not overlap any known summer or swarming buffers for the Indiana bat (USFWS 2019a) but is within Summer 1 habitat for the northern long-eared bat (USFWS 2019b). No maternity colonies or hibernacula for Indiana bats has been documented in Metcalfe or Monroe Counties and there are no capture records for this species in either county (KDFWR 2024a). Northern long-eared bat maternity colonies have been documented in Metcalfe and Monroe Counties (KDFWR 2024a). Capture records for the northern long-eared bat within Metcalfe and Monroe Counties were documented in 2006 before the onset of white-nose syndrome (WNS) in Kentucky (KDFWR 2024a). Via correspondence with USFWS, tricolored bat maternity colonies have previously been documented in Monroe County approximately 0.53 miles west of the southern portion of the Project (**Appendix B**). The latest capture records for tricolored bats in Metcalf and Monroe Counties were in 2008 and 2014, respectively (KDFWR 2024a).

The KSS (2023) reported that there are two caves (Piercy Cave and Buzzards Nest Cave) within a one-mile buffer of the Project which could serve as hibernacula for listed species. These entrances are approximately 3,000 feet west of the southernmost Project boundary. Caves and rock shelters identified within the Project area unsuitable for Indiana bats since they lacked true dark areas and cold air flow; however, northern long-eared and tricolored bats may use these features for summer night roosting or for hibernating singly in small cracks and crevices.

Three (3) gray bats were captured during the survey. Although not one of the target species, gray bats are federally endangered and live in caves year-round. The two caves identified by KSS may serve as potential habitat for this cave-obligate species; however, habitat in the form of caves and rock shelters located on the Project were assessed and determined to not be suitable habitat for gray bats due to their small size and lack of true dark zones. Since no caves suitable for gray bats were identified within the Project area, a May Affect, Not Likely to Adversely Affect determination is anticipated from the USFWS Kentucky Field Office for gray bats.

The second objective was to record baseline data for non-listed bats. Twenty-two (22) net nights of survey efforts within the Project resulted in the capture of three (3) gray bats, 20 evening bats, 15 eastern red bats, and 37 big brown bats. The three (3) gray bats were banded during the survey (KYFW; B28112, B28113, and B28114).

Weather restrictions were followed, and mist net set locations were distributed in areas where bats were likely to be found traveling and/or foraging; however, survey efforts did not capture any target species. The data collected during the USFWS-approved 2024 mist net survey effort indicates the probable absence of Indiana, northern long-eared, and tricolored bats; therefore, a May Affect, Not Likely to Adversely Affect determination is anticipated from the USFWS Kentucky Field Office for these three species.

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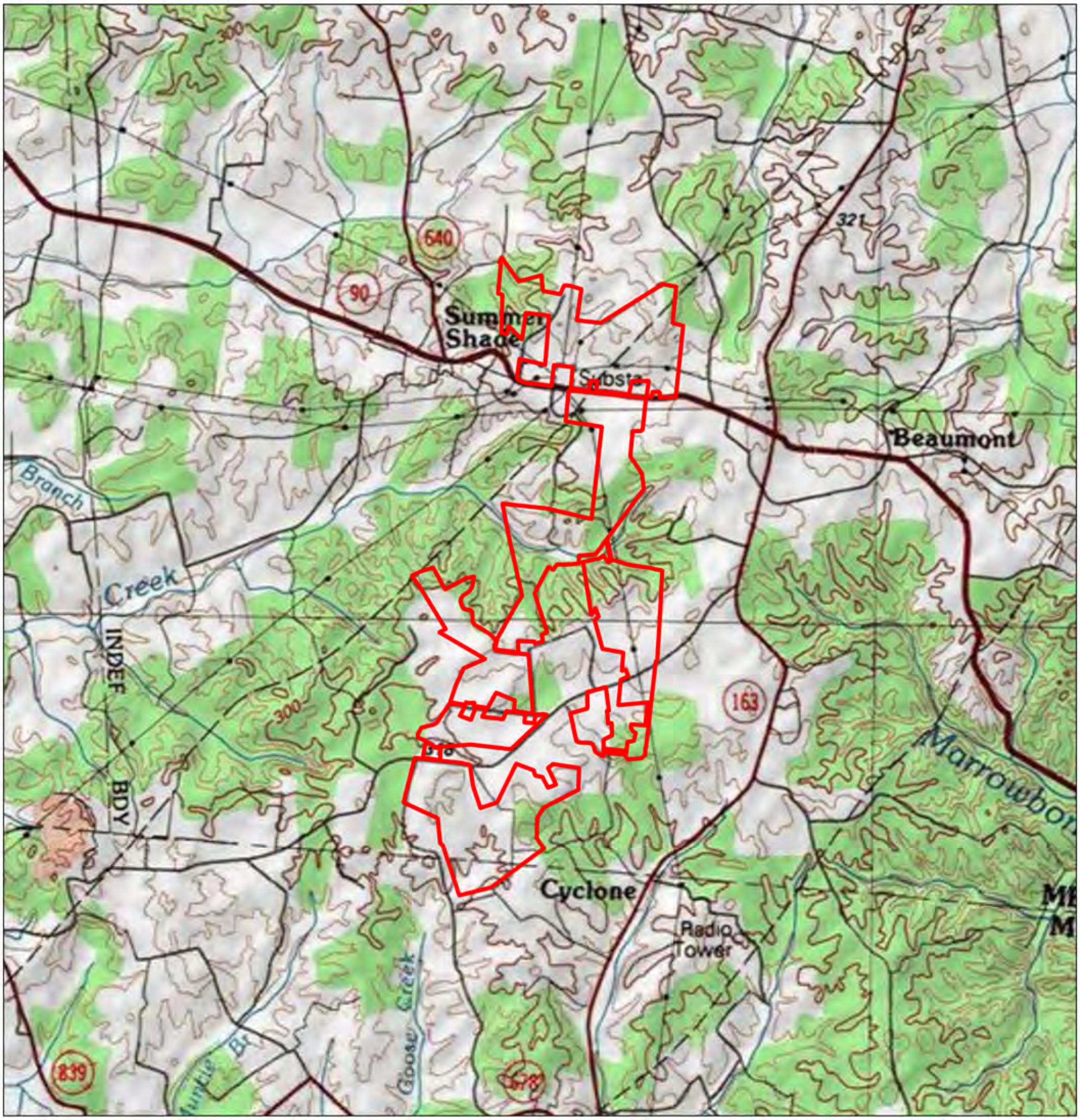
Appendix A Project Area Maps



Legend

🟥 Project Boundary

0 2,500 5,000 Feet

N

(At original document size of 8.5x11)
1 inch = 5,000 feet

Stantec

Project Location
Metcalfe and Monroe Counties, Kentucky

Prepared by MNA on 2024-07-11
TR by CK on 2024-07-12
IR by SPK on 2024-07-15

172658275

Client/Project
Summer Shade Solar, LLC
Summer Shade Solar Project
Bat Mist Net Survey Report

Figure No.
1

Title
Project Topographic Overview Map

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC, USGS
3. Background: 7.5" Quadrangle Topographic Basemap

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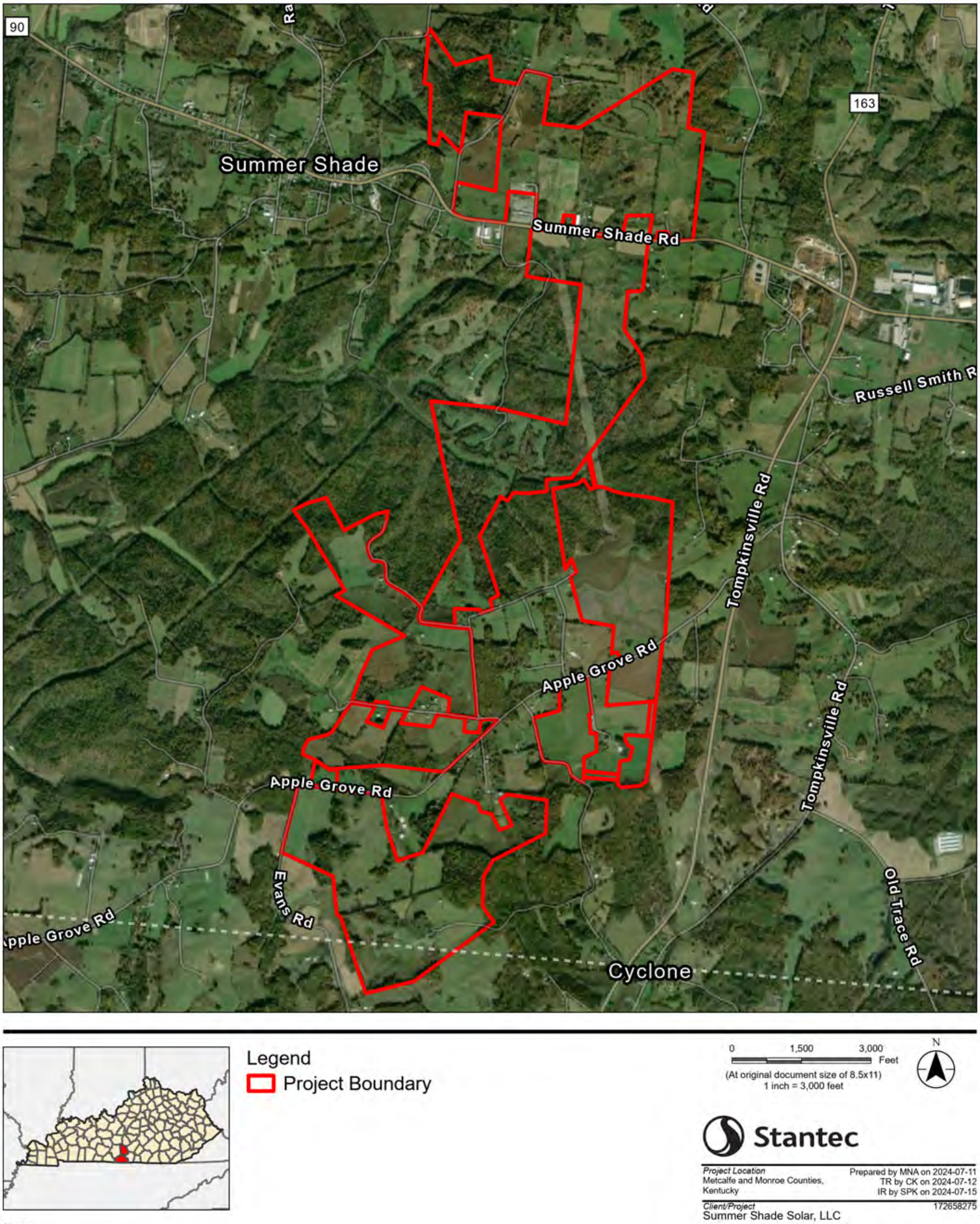

Stantec

Project Location
Metcalfe and Monroe Counties, Kentucky

Prepared by MNA on 2024-07-11
TR by CK on 2024-07-12
IR by SPK on 2024-07-15
172658275

Client/Project
Summer Shade Solar, LLC
Summer Shade Solar Project
Bat Mist Net Survey Report

Figure No.
2

Title
Project Overview Map

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri Aerial Imagery Hybrid Basemap

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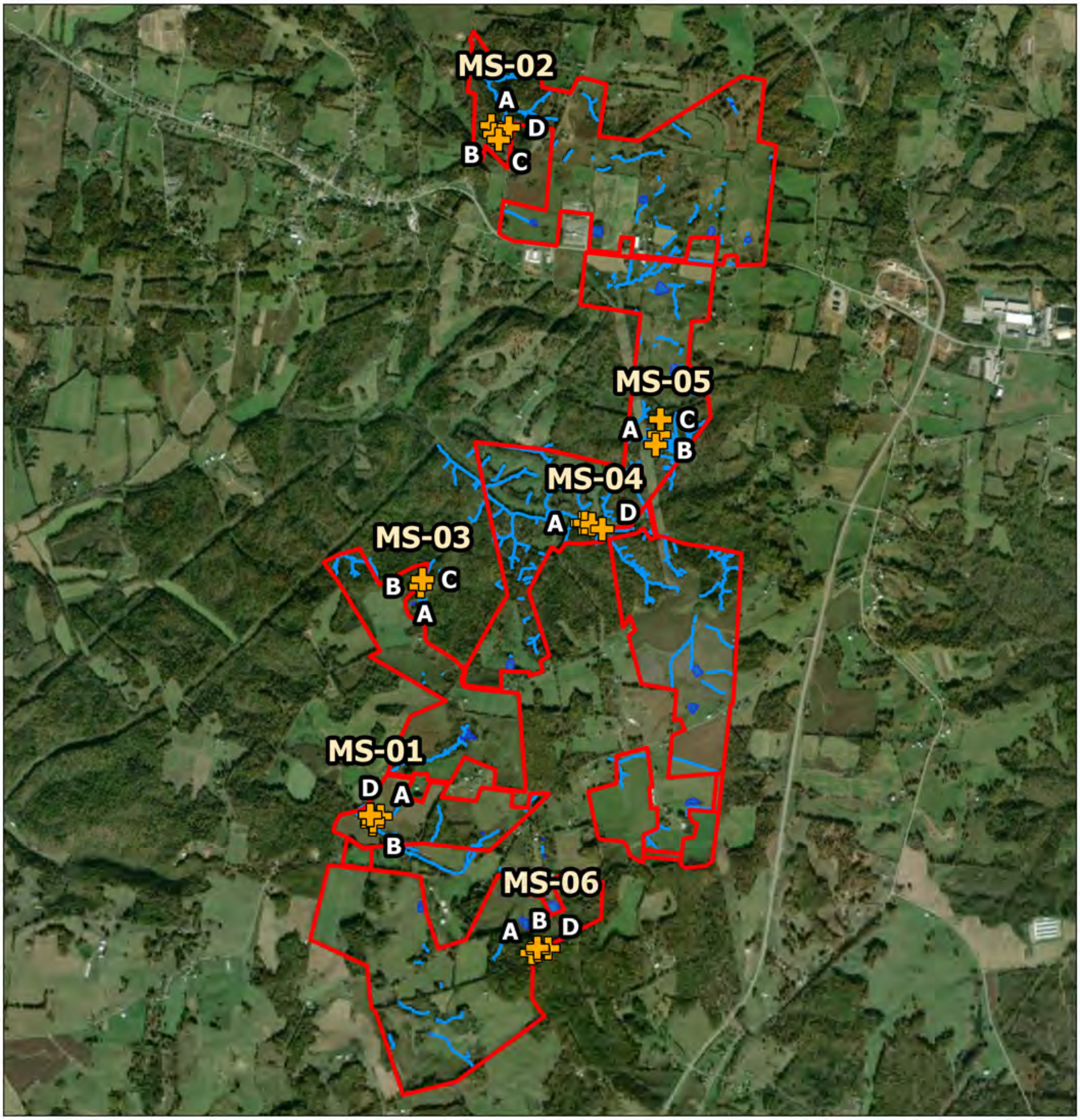

Legend

- 🟥 Project Boundary
- ✚ Mist Net Locations
- — Delineated Streams
- 🟦 Delineated Open Water

(At original document size of 8.5x11)
1 inch = 3,000 feet

Stantec

Project Location
Metcalfe and Monroe Counties,
Kentucky

Prepared by MNA on 2024-07-11
TR by CK on 2024-07-12
IR by SPK on 2024-07-15

172658275

Client/Project
Summer Shade Solar, LLC
Summer Shade Solar Project
Bat Mist Net Survey Report

Figure No.
3

Title
Bat Mist Net Locations Overview Map

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri Aerial Imagery Basemap

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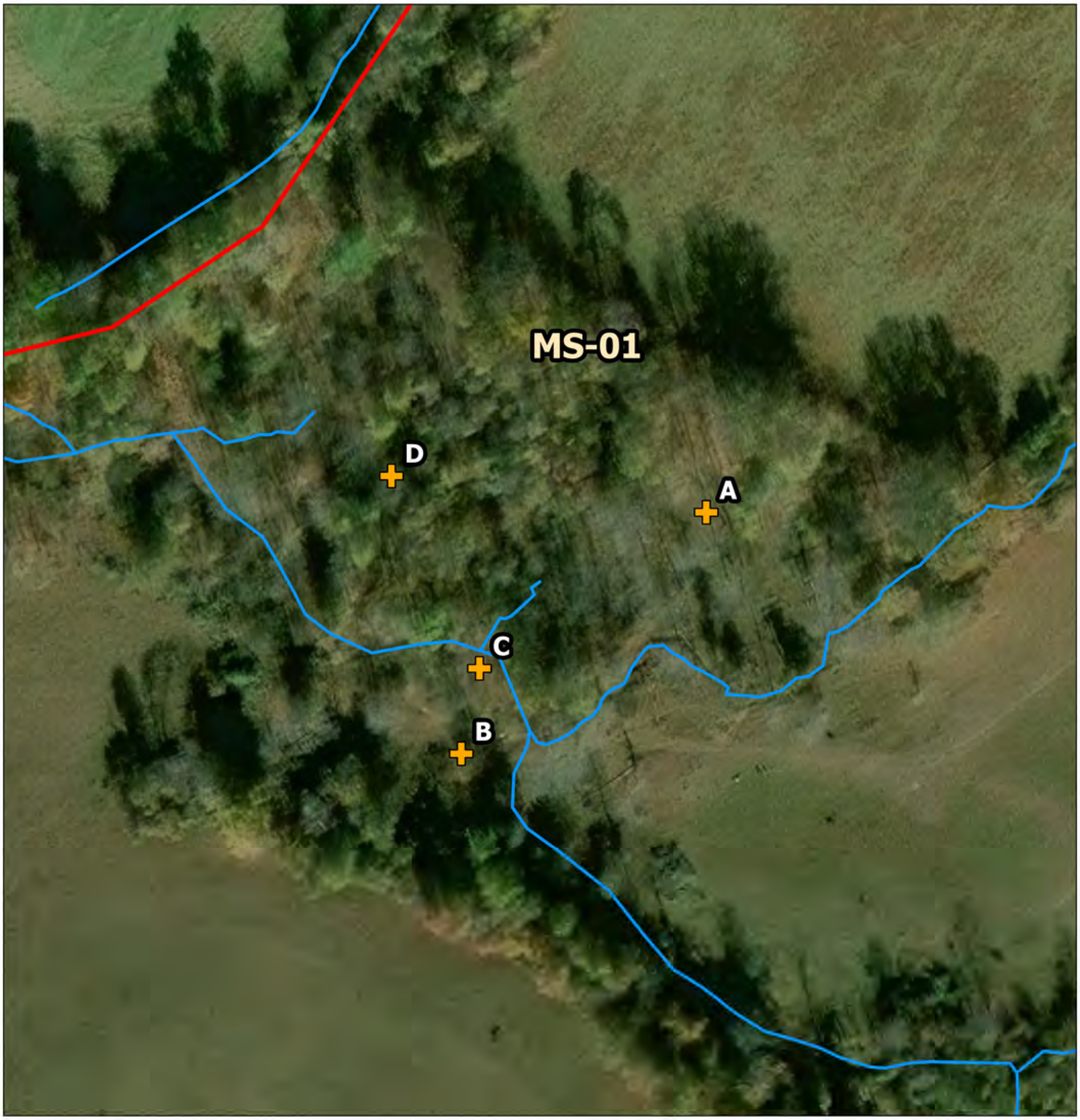

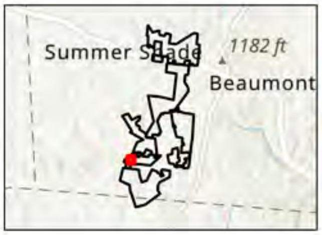

Legend
- 🟥 Project Boundary
- ✚ Mist Net Locations
- — Delineated Streams
- 🟦 Delineated Open Water

0 50 100 Feet
(At original document size of 8.5x11)
1 inch = 100 feet

N

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri Aerial Imagery Basemap

Stantec

Project Location
Metcalfe and Monroe Counties, Kentucky

Prepared by MNA on 2024-07-11
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Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
Bat Mist Net Survey Report

Figure No.
4

Title
Bat Mist Net Locations Map

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Legend

- 🟥 Project Boundary
- ✚ Mist Net Locations
- — Delineated Streams
- 🟦 Delineated Open Water

0 50 100 Feet

(At original document size of 8.5x11)
1 inch = 100 feet

N

Stantec

Project Location
Metcalfe and Monroe Counties,
Kentucky

Prepared by MNA on 2024-07-11
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172658275

Client/Project
Summer Shade Solar, LLC
Summer Shade Solar Project
Bat Mist Net Survey Report

Figure No.
5

Title
Bat Mist Net Locations Map

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri Aerial Imagery Basemap

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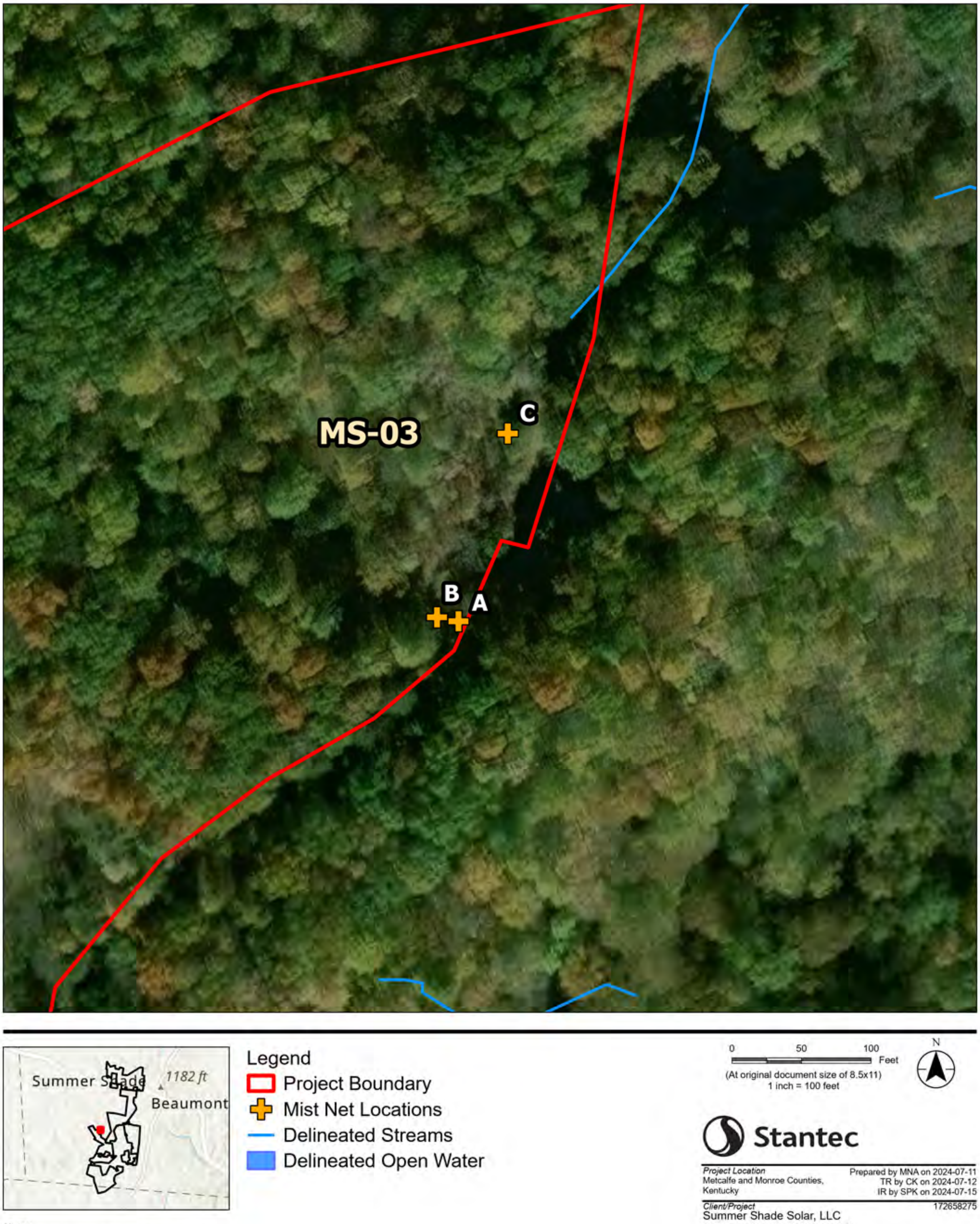

Stantec

Project Location
Metcalfe and Monroe Counties, Kentucky

Prepared by MNA on 2024-07-11
TR by CK on 2024-07-12
IR by SPK on 2024-07-15

172658275

Client/Project
Summer Shade Solar, LLC
Summer Shade Solar Project
Bat Mist Net Survey Report

Figure No.
6

Title
Bat Mist Net Locations Map

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri Aerial Imagery Basemap

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Legend
- 🟥 Project Boundary
- ✚ Mist Net Locations
- — Delineated Streams
- 🟦 Delineated Open Water

(At original document size of 8.5x11)
1 inch = 100 feet

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri Aerial Imagery Basemap

Stantec

Project Location
Metcalfe and Monroe Counties,
Kentucky

Prepared by MNA on 2024-07-11
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IR by SPK on 2024-07-15

172658275

Client/Project
Summer Shade Solar, LLC
Summer Shade Solar Project
Bat Mist Net Survey Report

Figure No.
7

Title
Bat Mist Net Locations Map

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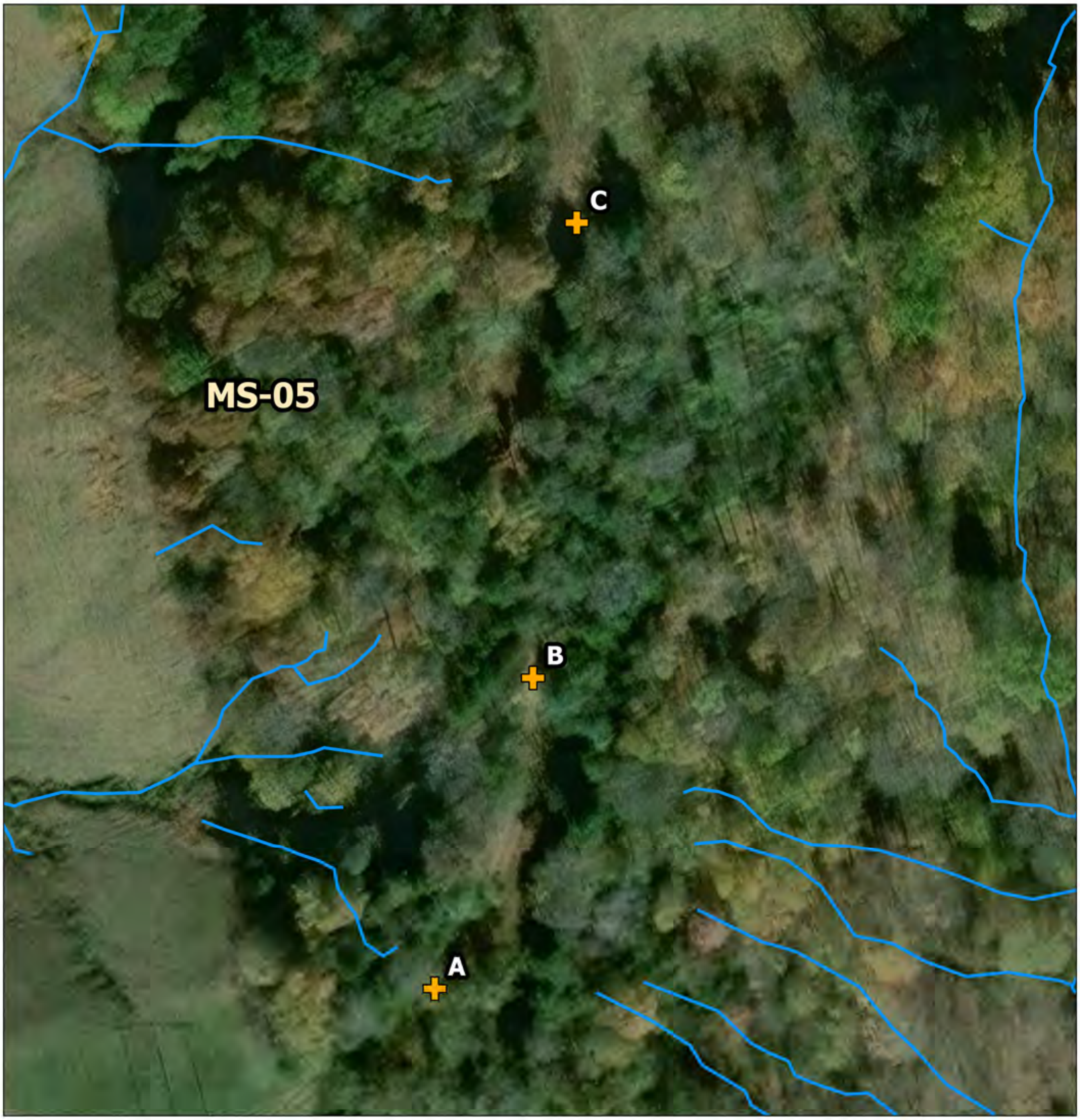


Legend

- 🟥 Project Boundary
- ✚ Mist Net Locations
- — Delineated Streams
- 🟦 Delineated Open Water

(At original document size of 8.5x11)
1 inch = 100 feet

Notes

1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri Aerial Imagery Basemap

Stantec

Project Location
Metcalfe and Monroe Counties,
Kentucky

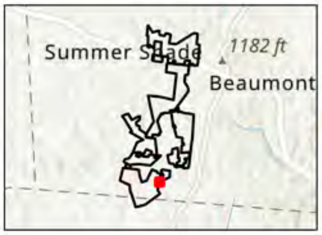
Prepared by MNA on 2024-07-11
TR by CK on 2024-07-12
IR by SPK on 2024-07-15

Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
Bat Mist Net Survey Report

Figure No.
8

Title
Bat Mist Net Locations Map

C:\Users\mangel\Documents\ArcGIS\Projects_2024\Summer_Shade_Solar\SummerShadeSolar_Maps\SummerShadeSolar_Maps.aprx Revised: 2024-07-11 By: mangel



Legend

- 🟥 Project Boundary
- ✚ Mist Net Locations
- — Delineated Streams
- 🟦 Delineated Open Water

0 50 100 Feet
(At original document size of 8.5x11)
1 inch = 100 feet

N

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri Aerial Imagery Basemap

Stantec

Project Location
Metcalfe and Monroe Counties, Kentucky

Prepared by MNA on 2024-07-11
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IR by SPK on 2024-07-15

172658275

Client/Project
Summer Shade Solar, LLC
Summer Shade Solar Project
Bat Mist Net Survey Report

Figure No.
9

Title
Bat Mist Net Locations Map

C:\Users\mangel\Documents\ArcGIS\Projects_2024\Summer_Shade_Solar\SummerShadeSolar_Maps\SummerShadeSolar_Maps.aprx Revised: 2024-07-11 By: mangel

Appendix B USFWS Study Plan Form for Bat Surveys and Monitoring

U.S. Fish and Wildlife Service

Study Plan Form for Bat Surveys and Monitoring (v. 2.0)[1]

PROJECT & SURVEY INFORMATION

Project Name: Summer Shade Solar

Proposed Survey Start Date: 6/12/2024

Project Proponent's Name (e.g., client/company/institution): Summer Shade Solar LLC

Project Location: State(s): Kentucky

County(s): Metcalfe & Monroe

Latitude: 36.859904

Longitude: -85.692516

REQUIRED: Attach or provide links to Google Earth® KMZ files (preferred) and/or shapefiles (mapping must show project boundaries, impacted forest habitat (if known) and all proposed survey sites)

Files are attached: Yes ☑ No ☑

File Links:

Project Summary. In the space provided below, please provide a description of the proposed action, including any activities that will permanently or temporarily alter the current environment and existing habitat features.

The Project consists of a proposed photovoltaic (PV) electrical generating facility comprised of approximately 1,468 acres. The facility is proposed to be sited east and south of the town of Summer Shade, Kentucky. Proposed Project activities include the panel array installation, ancillary equipment, transmission interconnection, and equipment staging.

Due to the presence of approximately 448 acres of forested potential summer habitat for the Indiana bat (Myotis sodalis), northern long-eared bat (M. septentrionalis), and tricolored bat (Perimyotis subflavus) within the Project, Stantec was retained by Summer Shade in order to complete a mist net survey for these three bat species. It is expected that between 123 acres and 246 acres of potential bat habitat tree clearing will occur for the Project.

CONTACT INFORMATION

Project Manager/Primary Point of Contact (POC): Shane Kelley

Phone: (502) 269-8994

Field Survey Crew Leader (if different from POC): James Kiser

Cell Phone: 502-396-3199

Institution/Company Name: Stantec Consulting

Mailing Address: 9200 Shelbyville Road Suite 800, Louisville, KY 40222

POC Email Address: Shane.Kelley@stantec.com, James.Kiser@stantec.com

USFWS Sec. 10(a)(1)(A) Permit No.(s) (if applicable): ES38821A-5

State Permit No.(s) (if applicable): SC2411181

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[1] Unless otherwise directed by the Service, surveyors may complete this fillable form, in lieu of a traditional narrative format, and submit it (and supporting files) to the Ecological Services Field Office in the state(s) where the work is to be completed (https://www.fws.gov/our-facilities). Use of this form is not a requirement at this time. Our goal is to improve pre-survey coordination and to expedite the Field Office review and approval process. Please submit your study plan at least 15 working days in advance of your proposed survey start date. Suggestions for improving this document may be sent to R4_Bat_Survey_Guidance@fws.gov.

Have project proponents been informed that abiding by protective time-of-year restrictions (where available) may be sufficient to avoid take of federally listed bats and (in some cases) may negate the need for a bat survey? Yes ☑ No ☐

Have project proponents been informed that the Service does not require presence/probable absence surveys for federally listed species and that presence can be assumed in a project area containing suitable habitat? Yes ☑ No ☐

Will this survey be conducted on private or public lands? *(Check both if applicable)*: Private ☑ Public ☐

Has permission of all necessary landowners/managing agencies been obtained? Yes ☑ No ☐

If no, explain: ____________________

Does this project have a federal nexus[2]? Yes ☑ No ☐ Unsure ☐

If yes, explain: An IP or nationwide permit may be needed (USACE)

IPaC[3] Consultation Code (if applicable): ____________________

Purpose of Survey: Official P/A Survey ☑ Research ☐ Monitoring ☐
Educational Outreach/Training Other: ____________________

Survey Target Species: Indiana bat (IBAT) ☑ Northern long-eared bat (NLEB) ☑
Tricolored bat (TCB) ☑ Other: ____________________

Has a Phase-1 Habitat Assessment* of the project area been conducted? Yes ☑ No ☐
If yes, how was the habitat assessment conducted? Field ☐ Desktop ☐ Combo ☑
*(*if available, attach a written report)*

Is suitable habitat[4] present (or assumed present) for all "target" species? Yes ☑ No ☐

If no, explain: ____________________

Does this project fall within the outer-tier[5] of any "target" species known home range? Yes ☐ No ☐ Unsure ☑

If yes, which species: ____________________

Project Configuration

Is this project **linear** (>1 km in total length)? Yes ☐ No ☑ Combo ☐ Unsure ☐

If yes, how many 1-km sections containing suitable IBAT/NLEB habitat will be impacted? ________

Is this project **non-linear**? Yes ☑ No ☐ Combo ☐ Unsure ☐

If yes, how many acres of suitable IBAT/NLEB habitat is in the overall project area? 360

If yes, how many acres of suitable IBAT/NLEB habitat will be directly impacted/cleared? 123 to 246

PROPOSED METHODS & SURVEY LEVEL OF EFFORT[6]

ACOUSTICS

Total number of detector sites proposed to be surveyed: ________ Number of detector nights/site: ________

---

[2] A project or action that is carried out, authorized, funded, and/or permitted by a federal agency.

[3] https://ipac.ecosphere.fws.gov/

[4] See Appendix A of the Guidelines regarding suitable habitat definitions.

[5] See Appendix G of the Guidelines if you are unclear what the out-tier of a known range includes.

[6] Survey level of effort (acoustic or netting) must be spread over at least two calendar nights/survey site.

Total number of detector nights for entire survey: ___________

Total proposed number of calendar nights to complete the entire survey: ____________________

Detector(s) (Brand, Model): ______________________ Microphone(s): directional ☐ omnidirectional ☐

Recording Format: Full Spectrum ☐ Zero-Crossing ☐

FWS-Approved[7] Acoustic Bat ID Software: KPro vers.____ KPro Classifier, NA vers. ____ BCID vers.____
Other Candidate Programs (e.g., Sonobat) vers.: ________________

Species to be included for automatic software ID classification analysis:

EPFU ☐ CORA ☐ COTO ☐ LABO ☐ LACI ☐ LANO ☐ LASE ☐ TABR ☐ MYCI ☐ MYEV ☐ MYGR ☐ MYLU ☐
MYLE ☐ MYSE ☐ MYSO ☐ MYTH ☐ MYVO ☐ NYHU ☐ PESU ☐ Others:____________________________

Will qualitative analysis (i.e., manual vetting) be used? Yes ☐ No ☐ Unsure ☐

Name(s) of qualified biologist(s) conducting qualitative/manual identifications (attach resume or link with qualifications):

____

MIST-NETTING

Total number of net sites to be surveyed: 6-7 Total number of net nights/site: 3-4

Total number of net nights for entire survey (No. of sites X No. of net nights/site): 20

Total proposed number of calendar nights to complete the entire survey: 7

A) Maximum number of net set-ups that will be operated/checked (10-min interval) on a given calendar night at a given survey site: 4
B) Minimum Number of personnel present to operate/check X (see A) net set-ups on a given site: 2
C) Proposed Staffing Rate (A divided by B): 2:1

Staffing Rate

Number of Section 10-permitted biologists per net site (or state-permitted in USFWS R5): 1

Do you propose to band bats? Yes ☑ No ☑

If yes, please answer the following:

What species will be banded? COTO ☑ MYGR ☑ MYLU ☑ MYSE ☑ MYSO ☑ PESU ☑
Others:________________________ All captured bats:
If banding *Myotis* sp. or PESU, specify band size: 2.9 for MYSO, MYSE, MYLU, 2.4 for PESU
Describe your proposed bands (color and letter-numbers) and banding scheme: KDFWR-provided metal lipped bands
Will banding pliers be used? Yes ☑ No ☐

Will any biological samples be collected from captured bats (e.g., guano, hair, swab, wing punch)? Yes ☑ No ☐

If yes, explain: guano, for a hormone study.

Name of institution or facility to conduct DNA analysis: NA

RADIO-TRACKING

Will any bats be radio-tagged and tracked? Yes ☑ No ☐

---

[7] https://www.fws.gov/media/automated-acoustic-bat-id-software-programs

If yes, please answer following:

Which species will be radio-tagged? MYSO, MYSE, PESU

Name of USFWS Section 10 permitted biologist(s) who will apply transmitter(s): James Kiser

Make/model and approximate weight of transmitter(s) to be used: Holohill LB-2

Manufacturer date and estimated life-span of transmitters to be used: 7-10 days

Frequency range (MHz) of transmitters (e.g., 150.xxx or 172.xxx): 150.xxx

If radio-tracking multiple targeted bats/species, what criteria will be used in selecting which bats will be tracked? MYSO and MYSE will be targeted first, but we will track all transmittered bats concurrently

Will all radio-tagged bats be tracked (min. of 4-hrs. search effort/day) to their diurnal roosts for the minimum recommended period of 7 days? Yes ☑ No ☐

If no, explain:

Will night-time foraging data/telemetry be collected? Yes ☐ No ☑

Glue used for attaching transmitters: Type: Silicone-based Surgical Adhesive Name: Uro-Bond III 5000

Manufacturer: 3M Other:

EMERGENCE SURVEYS

After diurnal roost sites of radio-tagged bats are identified, will emergence surveys be conducted at each identified roost (assuming landowner permission is obtained)? Yes ☑ No ☐

If yes, how many emergence surveys/roost? 2

Have you identified a small number (e.g., ≤10) of potentially suitable roost trees* that you propose to conduct emergence surveys for? Yes ☐ No ☑

*(*If yes, provide photographs of each tree documenting that all of the tree can be observed by the surveyor along with coordinates (lat/long and/or KML/shapefile) of all trees to be surveyed.)*

POTENTIAL HIBERNACULA SURVEYS

Are you aware of any known hibernacula used by the target species within the project area itself or nearby?

Yes ☐ No ☑ Unknown ☐

If yes or unknown, list sites or explain:

Has your desktop analysis identified any natural or man-made features that could be used as a hibernaculum by any of the target bat species? Yes ☑ No ☐ Unknown ☐

If yes, underground features (e.g., caves, mines, tunnels, bunkers, cisterns) present: Yes ☑ No ☐
If yes, above-ground features* (e.g., crawl spaces) present: Yes ☐ No ☑
If unknown, explain:

Are you requesting approval of a field survey for potential hibernacula at this time? Yes* ☐ No ☑
*(*If yes, attach a separate narrative explaining how the project area(s) will be surveyed for potential hibernacula.)*

Are you submitting the results of a Phase 1 Habitat Assessment of potentially suitable hibernacula identified from field surveys? Yes* ☐ No ☑
*(*If yes, provide a Phase 1 Habitat Assessment Data Sheet for each potential hibernaculum/portal(s)[8] identified to be surveyed.)*

BRIDGE & CULVERT ASSESSMENTS

Will any bridges or culverts be surveyed for bat presence? Yes ☐ No ☑

If yes, please answer the following:

---

[8] If multiple cave entrances/portals, please list all locations.

Structure type(s) (check all that apply): Bridge☐ Culvert☐ Other☐
If "other", explain: ____________________

Survey methodology for structure(s) (check all that apply):
Visual inspection☐ Guano collection☐ Emergence survey☐ Acoustics*☐
Mist-net*☐ Harp-trap*☐ Other ____________________
*(*Due to site-specific conditions of structures, coordination with the local USFWS Field Office and appropriate state agency(ies) is necessary before proceeding with these survey methodologies)*

Will guano be collected and analyzed to confirm species ID? Yes☐ No☑
If "yes", name of institution/entity performing analysis: ____________________

ADDITIONAL SURVEY INFORMATION[9]

Will the proposed bat survey deviate from the current version of the USFWS Survey Guidelines?[10] Yes☐ No☑

If yes, provide justification for <u>any departures or modifications</u> to the guidelines (if applicable) below:

I hereby acknowledge that the information being provided to the Service is accurate and complete as of today's date.

Signature: ____________________ Date: 6/5/2024

---

[9] Attach additional pages to this form, if needed.

[10] Proposed surveys deviating from the current Range-wide IBAT & NLEB Survey Guidelines will <u>only</u> be accepted with a thoroughly described justification. Coordinate with your local USFWS Field Office (https://www.fws.gov/our-facilities) for acceptable modifications.

*******FOR U.S. FISH AND WILDLIFE SERVICE USE ONLY**********

United States Department of the Interior

Fish and Wildlife Service

Kentucky ES Field Office

330 W. Broadway, Suite 265, Frankfort, KY 40601

Office Phone: (502) 695-0468

SITE-SPECIFIC AUTHORIZATION - BAT WORK

Our Field Office has reviewed your study plan and found it to contain sufficient information for our approval. When signed, this statement serves as your site-specific authorization to conduct the proposed activities at the specified locations included in the attached Study Plan Form and supporting files and must be carried with your federal permit when conducting work for this project. All activities must be carried out with strict adherence to permit conditions and authorizations specified in your federal permit as well as your state permit(s) (if needed). The section 10(a)(1)(A) permit authorizing the activities must remain with the surveyor at all times. This authorization is not valid if you have not obtained permission from the owner of the lands where activities will occur.

For federal permit reporting purposes, please use the appropriate USFWS bat survey data spreadsheet, available on the IBAT and NLEB Summer Survey Guidance website[1]. To mitigate the risk of humans transmitting viruses (e.g., SARS-CoV-2) to bats or viral transmission from bats to humans, the U.S. Fish and Wildlife Service requests anyone directly handling or working in close proximity to bats follow current guidelines prepared by the CDC[2] and IUCN Bat Specialist Group[3] in addition to the following the standard WNS decontamination protocols[4].

If the work expands beyond the scope of your original study plan or if there are adverse effects to bats that were not anticipated, cease all survey and/or research activities, and contact this office prior to continuing. Additionally, if a federally listed bat is captured, this USFWS Field Office must be notified within 48 hours with information regarding species, sex, age, and whether or not the bat has a transmitter attached.

Field Office POC: Mike Armstrong; Karah Jaffe

email: Mike_Armstrong@fws.gov; Karah_Jaffe@fws.gov phone: (502) 229-4632; (859) 797-9523

☐ **Authorized as Proposed**

☑ **Authorized with Conditions** (see below)

You are authorized to proceed provided that the following adjustment(s) and/or conditions are met.

(1) Do not band MYSE if captured. Also band any MYGR captured with appropriate sized KDFWR bands using banding pliers. (2) Ensure net set placements reflect variation of habitats present on site and preferred by MYSO, MYSE, and PESU. (3) Ensure transmitters are thoroughly tested for proper functioning prior to the study (see Appendix D of Survey Guidance). (4) attach

☐ **Not Authorized.**

Comments:

Signature & Date:

NOTE: Please check the appropriate box above before signing/locking the document.

---

[1] https://www.fws.gov/library/collections/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines
[2] https://www.cdc.gov/healthypets/covid-19/wildlife.html
[3] https://www.iucnbsg.org/uploads/6/5/0/9/6509077/amp_recommendations_for_researchers_final.pdf
[4] https://www.whitenosesyndrome.org/mmedia-education/national-wns-decontamination-protocol-u-s

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Metcalfe and Monroe counties, Kentucky

Local office

Kentucky Ecological Services Field Office

☎ (502) 695-0467
📠 (502) 695-1024
✉ kentuckyes@fws.gov

J C Watts Federal Building, Room 265
330 West Broadway
Frankfort, KY 40601-8670

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

---

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).

2. 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.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Gray Bat Myotis grisescens Wherever found This species only needs to be considered if the following condition applies: • The project area includes potential gray bat habitat. No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6329	Endangered
Indiana Bat Myotis sodalis Wherever found This species only needs to be considered if the following condition applies: • The project area includes 'potential' habitat. All activities in this location should consider possible effects to this species. There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/5949	Endangered
Northern Long-eared Bat Myotis septentrionalis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9045	Endangered

Birds

NAME	STATUS
Whooping Crane Grus americana No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/758	EXPN

Clams

NAME STATUS

Salamander Mussel Simpsonaias ambigua Wherever found There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/6208	Proposed Endangered

Insects

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

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

There are no critical habitats at this location.

You are still required to determine if your project(s) may have effects on all above listed species.

Bald & Golden Eagles

There are no documented cases of eagles being present at this location. However, if you believe eagles may be using your site, please reach out to the local Fish and Wildlife Service office.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf

- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply). To see a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs of bald and golden eagles in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur. Please contact your local Fish and Wildlife Service Field Office if you have questions.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats[3] should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Chimney Swift Chaetura pelagica This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Mar 15 to Aug 25
Field Sparrow Spizella pusilla This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds Mar 1 to Aug 15

Prothonotary Warbler Protonotaria citrea Breeds Apr 1 to Jul 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Red-headed Woodpecker Melanerpes erythrocephalus Breeds May 10 to Sep 10

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Wood Thrush Hylocichla mustelina Breeds May 10 to Aug 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (🟩)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the

probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (🟨)

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)

Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

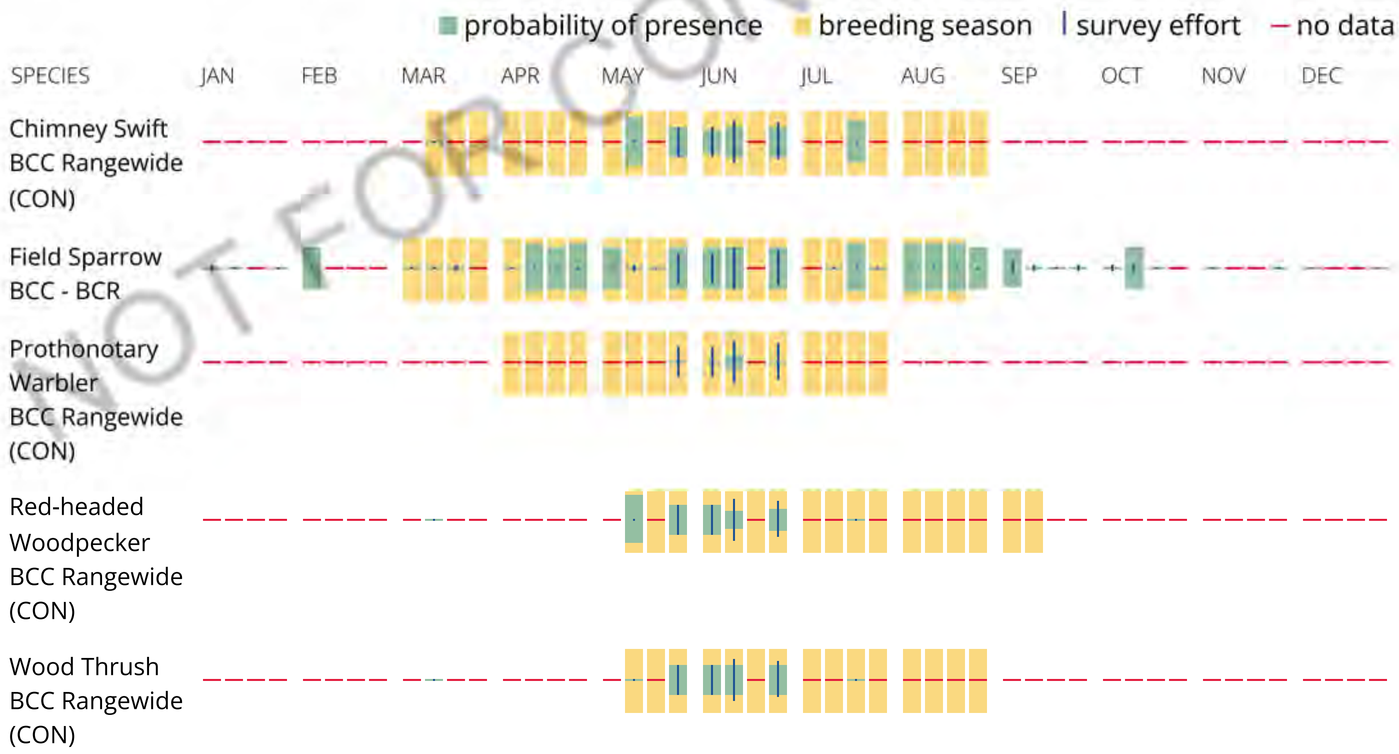
To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)

A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may query your location using the RAIL Tool and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);

2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

There are no refuge lands at this location.

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

FRESHWATER EMERGENT WETLAND

- PEM1F
- PEM1Fh

FRESHWATER POND

- PUBHh
- PUBH

RIVERINE

R4SBC

A full description for each wetland code can be found at the National Wetlands Inventory website

NOTE: This initial screening does **not** replace an on-site delineation to determine whether wetlands occur. Additional information on the NWI data is provided below.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Andy Beshear
Governor

Energy and Environment Cabinet
Office of Kentucky Nature Preserves
300 Sower Boulevard
Frankfort, Kentucky 40601
Telephone: 502-782-7828
EEC.KYBAT@ky.gov

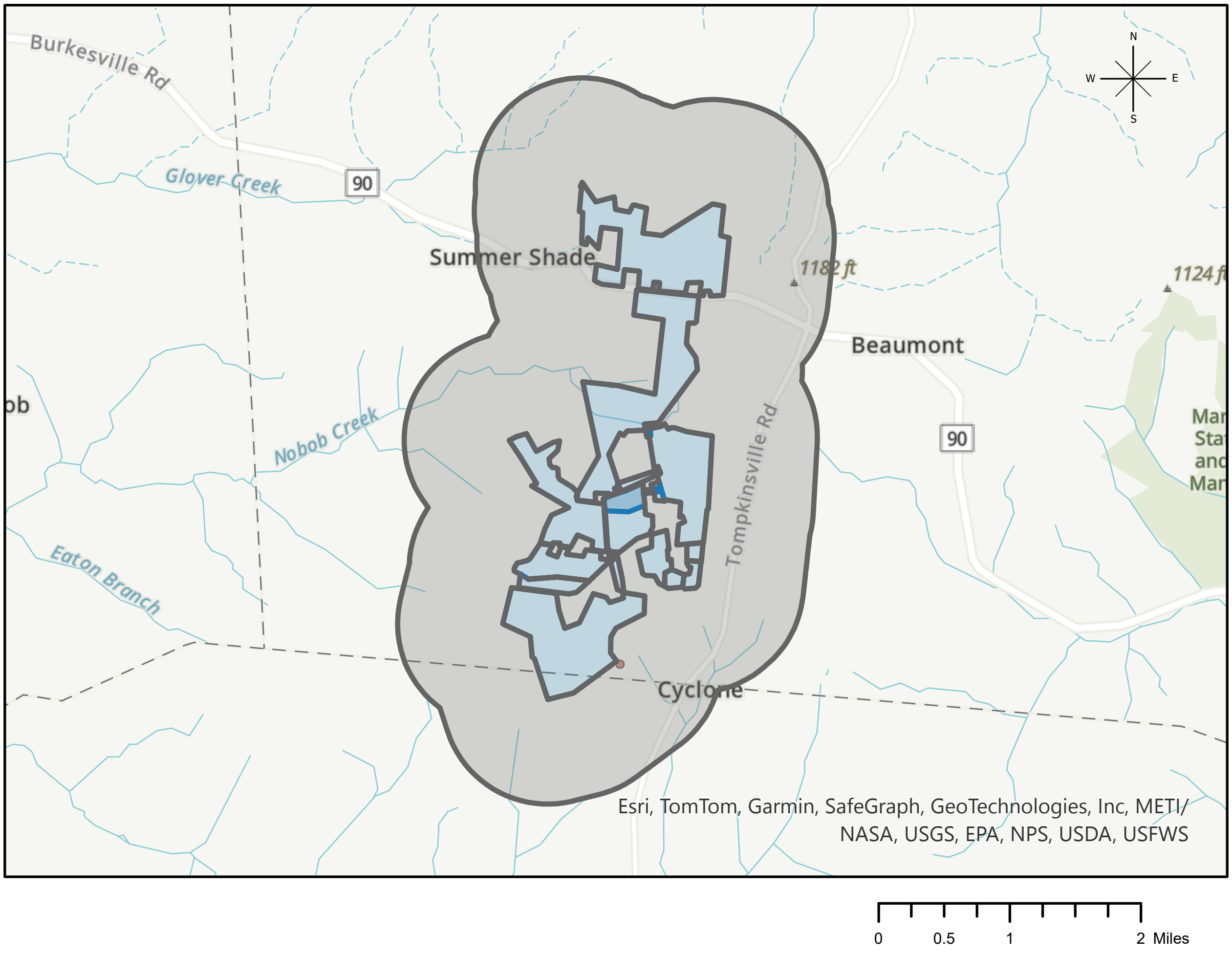
Rebecca W. Goodman
Secretary

Sunni Carr
Executive Director

Requested on Wednesday, March 13, 2024 by *Marissa Angel, Stantec*

Re: Kentucky Biological Assessment Data Request 240313M01
Summer Shade Solar, LLC - Summer Shade Solar Project
Energy Storage - Solar, 1 mile buffer.
METCALFE-MONROE County, Kentucky

This letter is in response to your data request for the project referenced above. We have reviewed our Natural Heritage Program Database to determine if any of the endangered, threatened, or special concern plants, animals, features or exemplary natural communities monitored by the Office of Kentucky Nature Preserves are noted within your submitted project area.



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Executive Director

This report includes the following items:
A - A report for occurrences which intersect the project area
B - A report for occurrences which intersect the buffer around the project area
C - A list of best management practices relevant to occurrences near to or within the project area
D - A list of best management practices relevant to the chosen project type

Thank you for using Office of Kentucky Nature Preserves' Biological Assessment Tool.

We would like to take this opportunity to remind you of the terms of the data request license, which you agreed upon in order to submit your request. The license agreement states "Data and data products received from the Office of Kentucky Nature Preserves, including any portion thereof, may not be reproduced in any form or by any means without the express written authorization of the Office of Kentucky Nature Preserves." The exact location of plants, animals, and natural communities, if released by the Office of Kentucky Nature Preserves, may not be released in any document or correspondence. These products are provided on a temporary basis for the express project (described above) of the requester, and may not be redistributed, resold or copied without the written permission of the Office of Kentucky Nature Preserves Biological Assessment Branch (300 Sower Blvd - 4th Floor, Frankfort, KY, 40601. Phone: 502-782-7828).

Please note that the quantity and quality of data collected by the Kentucky Natural Heritage Program are dependent on the research and observations of many individuals and organizations. In most cases, this information is not the result of comprehensive or site-specific field surveys; many natural areas in Kentucky have never been thoroughly surveyed and new plants and animals are still being discovered. For these reasons, the Kentucky Natural Heritage Program cannot provide a definitive statement on the presence, absence, or condition of biological elements in any part of Kentucky. Heritage reports summarize the existing information known to the Kentucky Natural Heritage Program at the time of the request regarding the biological elements or locations in question. They should never be regarded as final statements on the occurrences being considered, nor should they be substituted for on-site surveys required for environmental assessments. We would greatly appreciate receiving any pertinent information obtained as a result of on-site surveys.

If you have any questions, or if we can be of further assistance, please do not hesitate to contact our office by email at EEC.KYBAT@ky.gov or by phone at 502-782-7828.

Sincerely,

Alexis R. Schoenlaub
Geoprocessing Specialist
Office of Kentucky Nature Preserves

A.1. Project Area - Occurrence Report

The following table outlines occurrences found within your project footprint (if any). You can find more information about global and state rank status definitions on our Standard Occurrence Report Key . Please note that certain sensitive occurrences found within the buffer area may be listed in this table but are not represented on the map. Please contact the appropriate source as outlined in the “Directions” column should you have further questions related to sensitive occurrences found within the project area.

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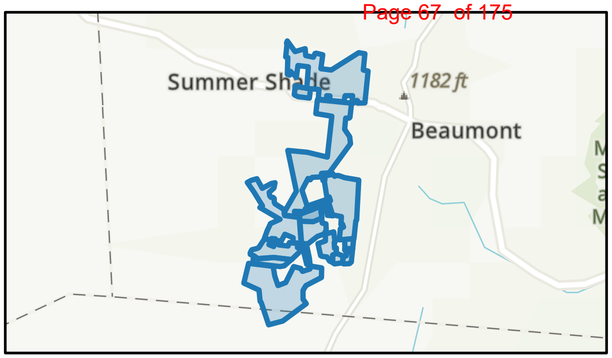
Ecological 🟩
Zoological 🟥



EO ID	Scientific Name	Common Name	G Rank	S Rank	Fed. Status	State Status	SWAP	Precision	Last Obs. Date
15783	*Lanius ludovicianus*	*Loggerhead Shrike*	*G4*	*S3S4B,S4N*	*None*	*S*	*Y*	*Q*	*1990-07-07*
15792	*Lanius ludovicianus*	*Loggerhead Shrike*	*G4*	*S3S4B,S4N*	*None*	*S*	*Y*	*Q*	*1990-07-06*

A.2. Project Area – Occurrence Habitat and Location

The following table provides supplemental occurrence information found within your project footprint (if any). You can find more information about global and state rank status definitions on our Standard Occurrence Report Key . Please note that certain sensitive occurrences found within the buffer area may be listed in this table but are not represented on the map. Please contact the appropriate source as outlined in the “Directions” column should you have further questions related to sensitive occurrences found within the

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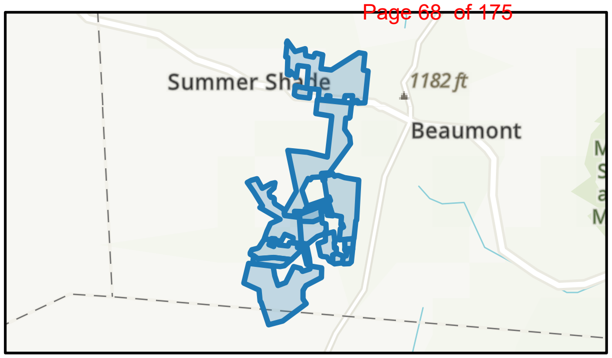

EOID	Scientific Name	Habitat	Location
15783	*Lanius ludovicianus*		*CW block of quad*
15792	*Lanius ludovicianus*		*CW block of quad*

B. Buffer Area - Occurrence Report

The following table outlines occurrences found within your buffered project footprint (if any). You can find more information about global and state rank status definitions on our Standard Occurrence Report Key. Please note that certain sensitive occurrences found within the buffer area may be listed in this table but are not represented on the map. Please contact the appropriate source as outlined in the "Directions" column should you have further questions related to sensitive occurrences found within the project area.

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Map Credits: Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, USFWS

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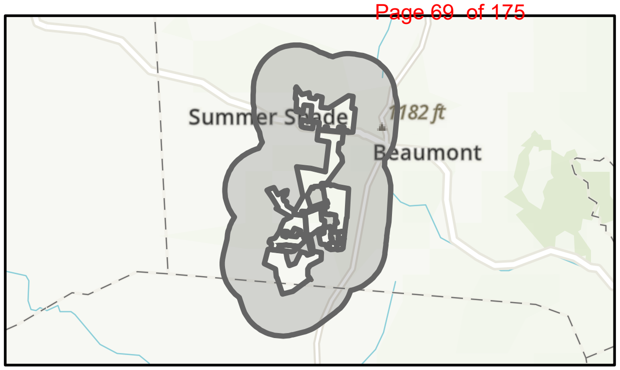

EO ID	Scientific Name	Common Name	G Rank	S Rank	Fed. Status	State Status	SWAP	Precision	Last Obs. Date
25527	*Myotis septentrionalis*	*Northern Long-Eared Bat*	*G2G3*	*S1*	*LE*	*E*	*Y*	*S*	*2006-08-09*
15783	*Lanius ludovicianus*	*Loggerhead Shrike*	*G4*	*S3S4B,S4N*	*None*	*S*	*Y*	*Q*	*1990-07-07*
15792	*Lanius ludovicianus*	*Loggerhead Shrike*	*G4*	*S3S4B,S4N*	*None*	*S*	*Y*	*Q*	*1990-07-06*
12429	*Nycticeius humeralis*	*Evening Bat*	*G5*	*S4*	*None*	*N*		*S*	*2006-08-09*

C. Occurrence References and Recommendations (1 of 2)

OKNP references the following references and recommendations regarding this project's potential impacts to natural resources within or surrounding the project area. Please contact the applicable office should you have further questions with regard to these references and recommendations related to the project area.

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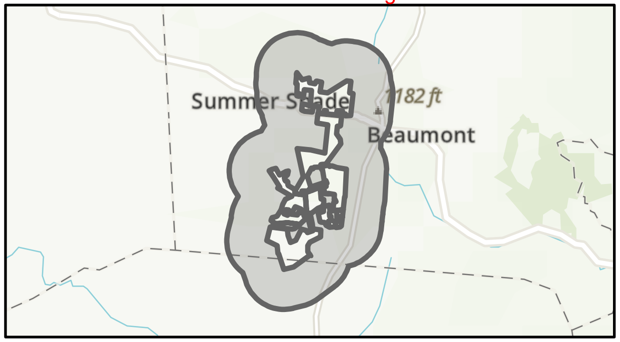

C. Occurrence References and Recommendations (2 of 2)

OKNP references the following references and recommendations regarding this project's potential impacts to natural resources within or surrounding the project area. Please contact the applicable office should you have further questions with regard to these references and recommendations related to the project area.

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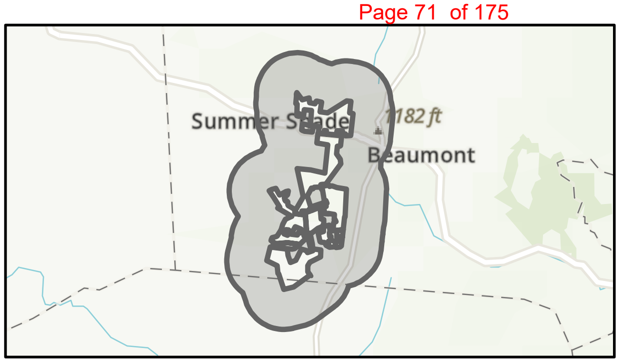

Per the U.S. Fish and Wildlife Service's recommendations: Birds covered under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) should be considered during project reviews. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish & Wildlife Service (50 C.F.R. § 10.12 and 16 U.S.C. § 668(a)). For more information regarding these acts go to: http://www.fws.gov/migratorybirds/RegulationsandPolicies.html.

The MBTA currently 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 a NEPA document (if there is a federal nexus), a Bird- or Eagle-specific Conservation Plan, or both. Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds to the project-related stressors; proponents should also implement a rigorous plan to monitor the effectiveness of conservation measure. For more information on avian stressors and recommended conservation measures go to: http://www.fws.gov/migratorybirds/ CurrentBirdIssues/Hazards/BirdHazards.html.

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 http://www.fws.gov/migratorybirds/AboutUS.html.

There are federally known Northern long-eared bat habitats (Summer 1) within your project footprint. Contact USFWS at (502) 695-0468 or KentuckyES@fws.gov

D. Project References and Recommendations (1 of 1)

OKNP references the following references and recommendations regarding this project's potential impacts to natural resources within or surrounding the project area. Please contact the applicable office should you have further questions with regard to these references and recommendations related to the project area.

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ENERGY AND ENVIRONMENT CABINET
OFFICE OF KENTUCKY NATURE PRESERVES

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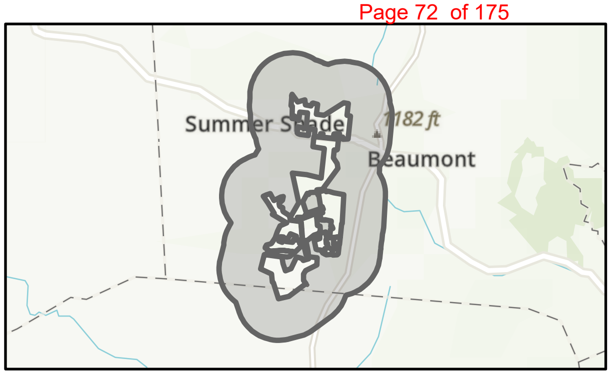
Botanical 🟩
Ecological 🟩
Zoological 🟥



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OFFICE OF KENTUCKY NATURE PRESERVES

Thank you for using the Office of Kentucky Nature Preserves Biological Assessment Tool.

OKNPs species dataset relies on continuous monitoring and surveying for species of concern throughout the state. Any records of species of concern found within this project area would greatly benefit the quality and comprehensiveness of the state wide dataset for rare, threatened and endangered species. If you would like to contribute any additional species information, please do not hesitate to contact our office by email at EEC.KYBAT@ky.gov or by phone at 502-782-7828.

Appendix C Mist Net Data Sheets

Stantec

Bat Capture Datasheet

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172658275

Project Name/No.: Summer Shade Solar

Date: June 12, 2024

Biologist(s): James Kiser, Lucas Dowis

Site ID: MS-01/Flowers Property Stream

County/State: Metcalfe Co, KY

Moon Phase: Waxing Crescent

Sunset: 20:02

Map Kilometer No./Quad: Flowers Property

Latitude: 36.850198

Longitude: -85.701992

Moonrise: 11:12am

Moonset: 12:17am

Nets Open: 20:00

Nets Closed: 01:05

General Site Description: Site is located on Flowers Property which is located south of Clifton Smith Road near the end. Site is located on unnamed stream that flows east to west and disappers into sink.

Time	Temp (F)	Wind[1]	% Cloud Cover
20:00	64.2	0	10
21:00	60.8	0	20
22:00	59.5	0	0
23:00	58.2	0	0
00:00	57.4	0	0
01:00	57.7	0	0

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	18	7.5	135m²	36.850816	-85.701668				X	Wetland
B	9	5.0	45m²	36.850384	-85.702214	X	X			
C	12	5.0	60m²	36.850537	-85.702174		X			
D	15	7.5	112.5m²	36.850822	-85.702370				X	Open Woods

* One net at full extension ~ 2.5m high

Weather Comments: Hot and humid today with high temps reaching low 80's, no rainfall and no-light Wind

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.[2]	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
1	Lasiurus borealis	20:50	A	M	NR	38.6	10.75	0	B	0.5		Photos: DSC_9657-63
2	Lasiurus borealis	21:00	A	F	L	38.6	11.25	0	B	1.0		—
3	Eptesicus fuscus		A	M	NR	46.8	17.5	0	C1	1.0		Photos: DSC_9665-81
4	Eptesicus fuscus		A	M	NR	47.9	17.5	0	C	0.5		—
5	Nycticeius humeralis	↓	A	F	P	37.5	13.25	0	A	7.0		Photos: DSC_9683-9736
6	Myotis grisescens	21:50	A	F	L	42.6	11.5	0	C1	0	KYFW B28112	Photos: DSC_9737-50; Guano-KY-11
7	Lasiurus borealis	23:10	A	F	NR	39.2	11.0	0	B	1		—
8	Myotis grisescens	↓	A	F	L	41.4	11.0	0	B	1	B28113	Photos: DSC_9751-9764; Guano-KY-12
9	Lasiurus borealis	01:45	A	F	L	EFN		0	B	3		Escaped from Net

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[1] **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

[2] For **females:** L = lactating, PL = post-lactating, NR = non-reproductive; for **males:** TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

Note: U (unknown) only to be used for ***escaped*** *bats*

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Net Site Description

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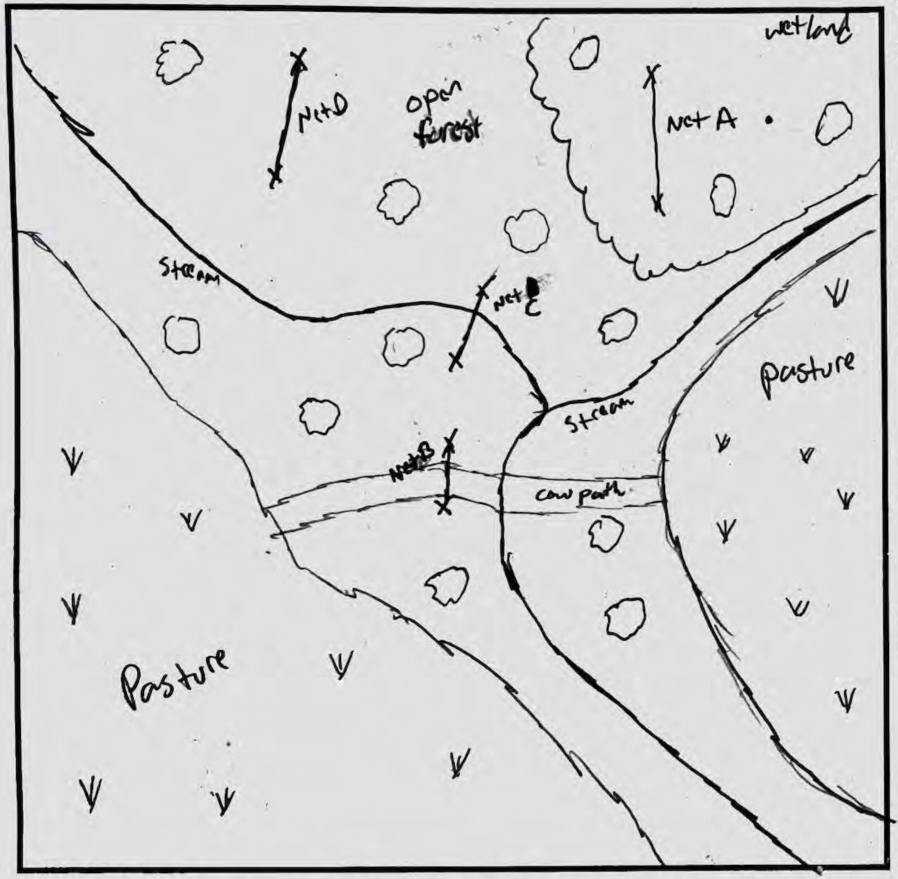

[1] Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Project Name/No.: Summer Shade **Date:** June 12, 2024

Site ID: MS-01 **Est. Distance to Water (ft):** 0 - Small Stream

VEGETATION

Primary Habitat Type[1]: Creek Riparian / Bottomland Forest

Potential Roost: Large Trees | Snags | [✓ Both] | Other (e.g., structure)

Roost Tree Potential: High | [✓ Moderate] | Low

Dominant Canopy Species **Avg. Canopy DBH range (in):** 10-18"

1. Tuliptree 2. Red Maple 3. Am. Beech 4. Sycamore

Canopy Closure: Closed (80% +) | [✓ Moderate (40 – 80%)] | Open (0 – 40%)

Dominant Subcanopy Species **Avg. Subcanopy DBH range (in):** 3-8"

1. Sweetgum 2. Boxelder 3. Green Ash 4. Pin Oak

Sub-Canopy Clutter: High (60% +) | [✓ Moderate (30 – 60%)] | Low (0 – 30%)

Dominant Shrub/Understory Species

1. Spicebush 2. Redbud 3. Pawpaw 4. Rosa multiflor

Shrub/ Understory Clutter: High (60% +) | [✓ Moderate (30 – 60%)] | Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft): 1-2ft **Channel Width:** 12 ft **Stream Width:** 3-6 ft.

Riparian Width right bank: 150+ left bank: 0-5ft **Avg. Water Depth:** 2-18" (6")

Other Wildlife Observed: Am. Crow (Vo), N. Cardinal (Vo), N. Mockingbird (Vo), Great-blue Heron (Vo), Barred Owl (Vo) Field Sparrow (1 in Net), Yellow-billed Cuckoo (Vo), Bufo fowleri (Vo), Hyla chrysoscelis (Vo), Rana clamitans (Vo)

Additional Comments: Rana catesbeiana (Vo), Acris crepitans (Vo), Great horned Owl (Vo),

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172658275

Bat Capture Datasheet

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Project Name/No.: Summer Shade Solar
Date: June 13, 2024
Biologist(s): James Kiser, Lucas Downs
Site ID: MS-02 / Simpson Ridgetop Rd.
County/State: Metcalfe Co, KY
Moon Phase: Waxing Crescent
Sunset: 20:02
Map Kilometer No./Quad: Summer Shade
Latitude: 36.887317
Longitude: -85.694025
Moonrise: 12:10pm
Moonset: 12:41am
General Site Description: Located over unimproved gravel/dirt ridgetop Road off of Joe Bowles Rd. It is directly south of headwaters of Glover Branch on the Simpson Property.
Nets Open: 1950h
Nets Closed: 01:10h

Time	Temp (F)	Wind¹	% Cloud Cover
20:00	80.4	0	0
21:00	76.7	0	0
22:00	76.5	0	0
23:00	73.2	2	0
00:00	72.8	0	0
01:00	72.2	0	0

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	18	7.5	135m²	36.887919	-85.694226	X				
B	9	5.0	45m²	36.887443	-85.694033	X				
C	6	7.5	45m²	36.887153	-85.693742	X				
D	12	7.5	90m²	36.887806	-85.693068	X				

* One net at full extension ~ 2.5m high

Weather Comments: Hot and humid with high temp in mid 80's clear sky and No Wind or Rain.

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.²	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
1	Lasiurus borealis	20:10	A	M	NR	40.5	10.75	0	C	0.5	—	
2	Lasiurus borealis	↓	A	F	L	41.0	12.0	0	D	3	—	
3	Lasiurus borealis	22:30	A	F	L	39.8	13.0	0	B	4		Photos; DSC_9765-9770
4	Nycticeius humeralis	22:45	A	M	NR	34.7	8.75	0	B	1.5		Photos: DSC_9775-9783
5	Lasiurus borealis	23:15	A	M	NR	41.2	11.75	0	C	6		
6	Eptesicus fuscus	23:30	A	M	NR	47.1	19.25	0	A	0.5		Photos: DSC_9786-9805- Ant attached to mouth,
7	Eptesicus fuscus	23:45	U	U	U	—	—	—	B	3		Escaped from Hand.
8	Nycticeius humeralis	00:55	A	M	NR	36.0	8.40	0	D	2		
	Glaucomys volans	01:30	—	—	—	—	—	—	C	6		

¹ **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

² For **females:** L = lactating, PL = post-lactating, NR = non-reproductive; for **males:** TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

*Note: U (unknown) only to be used for **escaped** bats*

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Net Site Description

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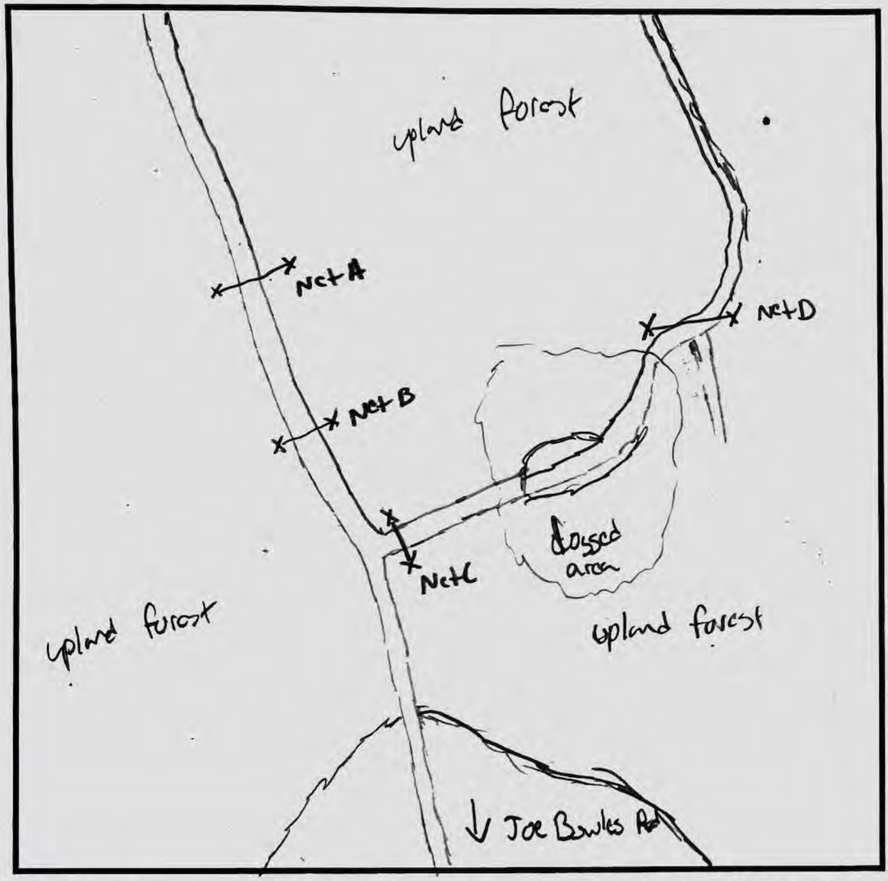

Project Name/No.: Summer Shade Solar **Date:** June 13, 2024

Site ID: MS-02 **Est. Distance to Water (ft):** Unknown

VEGETATION

Primary Habitat Type¹: Upland Forest

Potential Roost: Large Trees | Snags | [✓ Both] | Other (e.g., structure)

Roost Tree Potential: High | [✓ Moderate] | Low

Dominant Canopy Species **Avg. Canopy DBH range (in):** 10-16"

1. Cary ovata 2. Sugar Maple 3. White Ash 4. Carya cordiformis

Canopy Closure: Closed (80% +) | [✓ Moderate (40 – 80%)] | [✓ Open (0 – 40%)]

Dominant Subcanopy Species **Avg. Subcanopy DBH range (in):** 4-8"

1. Sugar Maple 2. Black Locust 3. Quercus muhlenbergii 4. KY Coffee Tree

Sub-Canopy Clutter: High (60% +) | [✓ Moderate (30 – 60%)] | Low (0 – 30%)

Dominant Shrub/Understory Species

1. Saplings of Overstory Trees 2. Redbud 3. Coral Berry 4. Rhamnus Caroliniana

Shrub/ Understory Clutter: [✓ High (60% +)] | Moderate (30 – 60%) | Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft): NA **Channel Width:** NA **Stream Width:** NA

Riparian Width right bank: NA left bank: NA **Avg. Water Depth:** NA

¹ Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Other Wildlife Observed: Barred Owl (VO), Rana catesbeiana (VO) Wood Thrush (VO), Eastern Wood Peewee (VO), E. Towhee (VO), N. Cardinal (VO), Scarlet Tanager (VO) Mourning Dove (VO), Bobwhite (VO - distant), N. Mockingbird (VO), Acris crepitans (VO), Hyla chrysoscelis (VO), Rana clamitans (VO)

Additional Comments: The site has been recently selectively logged. It is excellent bat foraging woods

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Bat Capture Datasheet

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Project Name/No.: SummerShadeSolar/172658275 **Date:** 14 June 2024 **Biologist(s):** James Kiser, Lucas Downs

Site ID: MS-03; Hope Property Woods **County/State:** Metcalfe/KY **Moon Phase:** First Quarter **Sunset:** 20:03h

Map Kilometer No./Quad: Sulpher Lick **Latitude:** 36.863376 **Longitude:** -85.678834° **Moonrise:** 13:07h **Moonset:** 01:03h

General Site Description: Located in Upland Woods on Hope's Property along old County Road. **Nets Open:** 19:50 **Nets Closed:** 01:05h

Time	Temp (F)	Wind¹	% Cloud Cover
20:00	78.3	0	0
21:00	76.6	1	30
22:00	75.6	1	0
23:00	75.1	1	0
00:00	74.2	1	0
01:00	73.0	0	0

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	6	5	30m²	36.863163	-85.698983	✓-rut				
B	15	5	75m²	36.863174	-85.699036					
C	6	5	30m²	36.863537	-85.698862	✓				

* One net at full extension ~ 2.5m high

Weather Comments: Hot and humid with high Temps reaching upper 80°s, No rainfall or wind.

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.²	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
	No BATS											

¹ **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

² For **females:** L = lactating, PL = post-lactating, NR = non-reproductive; for **males:** TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

Note: U (unknown) only to be used for ***escaped*** *bats*

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Net Site Description

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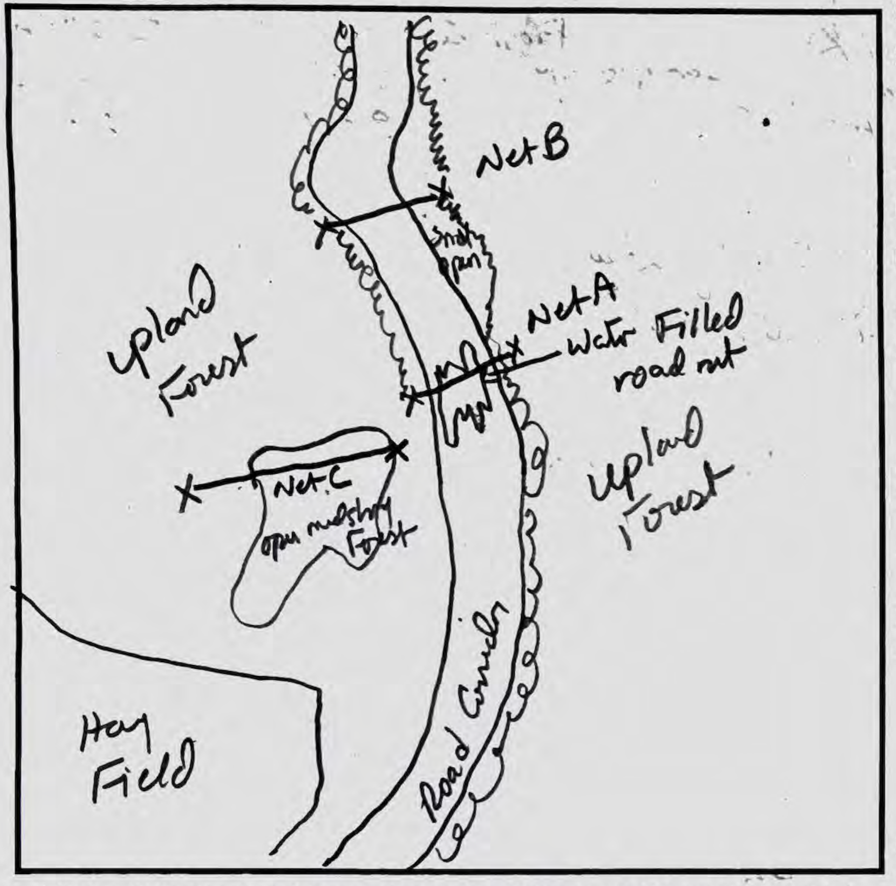

Project Name/No.: SummerShadeSolar/172658275 **Date:** 14 June 2024

Site ID: MS-03; Hope Property Woods **Est. Distance to Water (ft):** 0 Road-rut

VEGETATION

Primary Habitat Type[1]: Upland Forest

Potential Roost: Large Trees [✓ Snags] Both Other (e.g., structure)

Roost Tree Potential: High Moderate [✓ Low]

Dominant Canopy Species **Avg. Canopy DBH range (in):** 8-16"

1. Tuliptree 2. Southern Red Oak 3. Shagbark Hickory 4. White Oak

Canopy Closure: [✓ Closed (80% +)] Moderate (40 – 80%) Open (0 – 40%)

Dominant Subcanopy Species **Avg. Subcanopy DBH range (in):** 3-7"

1. Sweet Gum 2. Red Maple 3. Am, Elm 4. Tuliptree

Sub-Canopy Clutter: High (60% +) [✓ Moderate (30 – 60%)] Low (0 – 30%)

Dominant Shrub/Understory Species

1. Sapling Overstory 2. Redbud 3. Rosa multiflora 4. Cornus Florida

Shrub/Understory Clutter: [✓ High (60% +)] Moderate (30 – 60%) Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft): NA **Channel Width:** NA **Stream Width:** NA

Riparian Width right bank: NA left bank: NA **Avg. Water Depth:** NA

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[1] Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Other Wildlife Observed: Hairy-tailed Mole (Runway), Barred Owl (VO), Peromyscus leucopus (1), Am. Crow (VO), Wood Thrush (VO) Indigo Bunting (VO), Red-eyed Vireo (VO) E. Towhee (VO), N. Cardinal (VO) Scarlet Tanager (VO), Mourning Dove (VO)

Additional Comments: Yellow-billed Cuckoo (VO), Acadian Flycatcher (VO) E. Wood Peewee (VO), Hyla chryscocelus (VO), Rana clamitans (1), Rana sphenocephla (tadpoles), Ambystoma maculatum (larva) Ambystoma jeffersonianum (larva),

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Bat Capture Datasheet

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Project Name/No.: Summer Shade Solar/172658275 **Date:** 6/15/24 **Biologist(s):** James Kiser, Lucas Downs

Site ID: MS-04 / Nobob Creek **County/State:** Metcalfe/ KY **Moon Phase:** Waxing Gibbous **Sunset:** 20:03

Map Kilometer No./Quad: Sulphur Lick **Latitude:** 36.866543 **Longitude:** -85.688105 **Moonrise:** 2:04pm **Moonset:** 1:24am

General Site Description: Site is locatD over Nobob Creek on the Tudor and Humes property boundary. Creek contains pools of water and is not flowing. **Nets Open:** 19:55 **Nets Closed:** 01:10h

Time	Temp (F)	Wind[1]	% Cloud Cover
20:00	73.2	0	20
21:00	70.1	1	90
22:00	68.5	1	10
23:00	67.7	2	10
00:00	66.5	2	30
01:00	65.9	1	50

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	9.0	7.5	67.5m²	36.866555	-85.688174		✓			
B	9.0	5.0	45m²	36.866567	-85.687994	✓				
C	6.0	5.0	30m²	36.866492	-85.687522		✓			
D	12.0	7.5	90m²	36.866227	-85.686829		✓			

* One net at full extension ~ 2.5m high

Weather Comments: Hot and humid today with high temperature reaching low 90's, No rain and no wind

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.[2]	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
1	Eptesicus fuscus	20:15	A	F	L	47.0	16.25	0	A	2.0	—	—
2	Eptesicus fuscus		A	F	L	46.9	18.25	0	A	3.0	—	—
3	Eptesicus fuscus		A	F	L	49.4	21.0	0	A	3.5	—	—
4	Eptesicus fuscus		A	F	L	49.8	19.75	0	A			
5	Eptesicus fuscus	↓	A	F	L	47.7	19.25	0	A	5.0		
6	Eptesicus fuscus	20:20	A	F	L	46.2	16.5	0	C	2.0		
7	Lasiurus borealis	20:20	—	—	—	—	—	—	A	0.5		Escaped from Net
8	Lasiurus borealis	20:20	A	F	L	42.4	11.5	0	B	1.5		
9	Nycticeius humeralis	20:20	A	M	NR	36.6	8.0	0	B	1.5		
10	Eptecuocus fuscus	20:36	A	F	L	47.9	19.75	0	C	2		
11	Eptesicus fuscus	20:48	A	F	L	47.6	16.75	0	B	1.5		
12	Nycticeius humeralis	↓	A	M	NR	37.5	8.5	0	A	2.5		

[1] **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

[2] For **females**: L = lactating, PL = post-lactating, NR = non-reproductive; for **males**: TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

Note: U (unknown) only to be used for *escaped* bats

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Net Site Description

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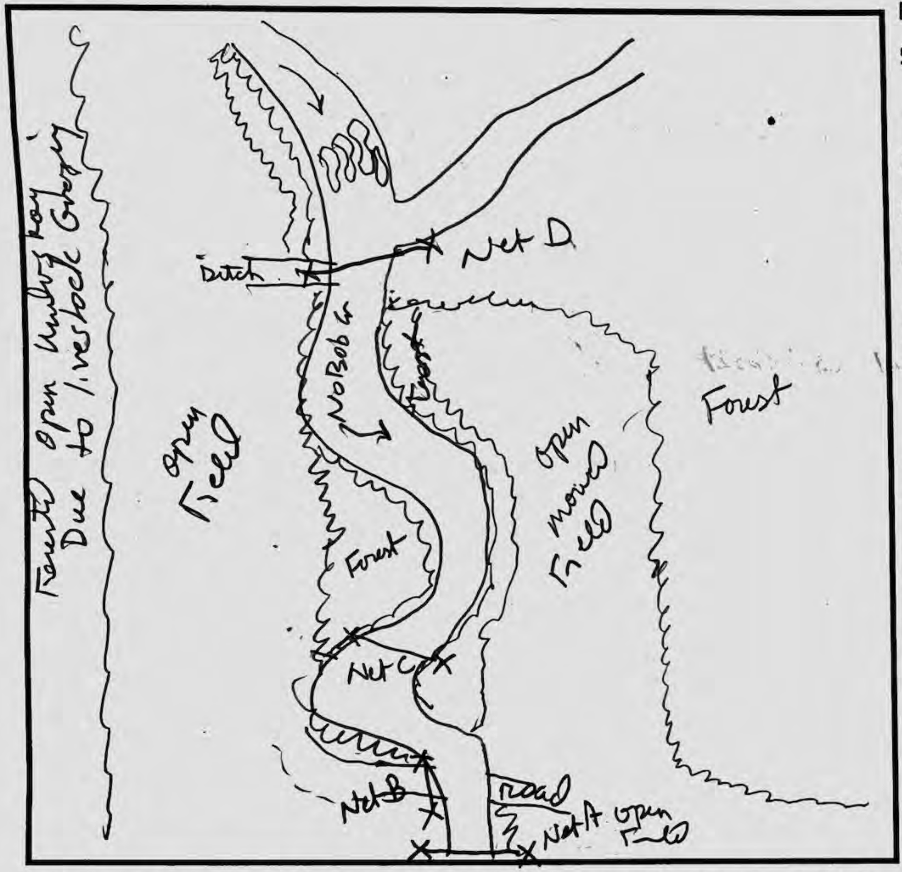

[1] Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Project Name/No.: Summer Slade/172658275 **Date:** 15 June 2024

Site ID: MS-04/Nobob Creek **Est. Distance to Water (ft):** At Site

VEGETATION

Primary Habitat Type[1]: Creek/Riparian

Potential Roost: Large Trees | Snags | [✓ Both] | Other (e.g., structure)

Roost Tree Potential: High | [✓ Moderate] | Low

Dominant Canopy Species **Avg. Canopy DBH range (in):** 14-20"

1. Sycamore 2. Sweetgum 3. Sugar Maple

Canopy Closure: Closed (80% +) | [✓ Moderate (40 – 80%)] | Open (0 – 40%)

Dominant Subcanopy Species **Avg. Subcanopy DBH range (in):** 4-8"

1. Sugar Maple 2. Am. Elm 3. Black Walnut 4. Tuliptree

Sub-Canopy Clutter: High (60% +) | [✓ Moderate (30 – 60%)] | Low (0 – 30%)

Dominant Shrub/Understory Species

1. Sapling Overstory Species 2. Spicebush 3. Rosa multiflora 4. Pawpaw

Shrub/ Understory Clutter: High (60% +) | [✓ Moderate (30 – 60%)] | Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft): 2-5 ft **Channel Width:** 16-25 ft **Stream Width:** 0-10 ft

Riparian Width right bank: 10 ft left bank: 30 ft **Avg. Water Depth:** 6"

Other Wildlife Observed: Louisiana Waterthrush (2 in Net), N. Cardinal (Vo), Wood Thrush (Vo), E. Wood Peewee (Vo), Gray Catbird (Vo) Ovenbird (Vo), Indigo Bunting (Vo), Carolina Wren (2 in Net), Eurycea longicauda (1), Rana clamitans (1), Coyote (Vo)

Additional Comments: Rana catesbeiana (VO), N. Watersnake (1Juv),

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Bat Capture Datasheet Pt. II

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Project Name/No.: Summer Shade Solar | 172658275 **Date:** 15 June 2024 **Biologist(s):** James Kiser, Lucas Downs

Site ID: MS-04 / Nobob Creek **County/State:** Metcalfe / KY

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.²	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (samples taken, transmitter #, if recap, disposition)
13	Nycticeius humeralis	21:00	A	M	NR	35.8	9.75	0	D	5.0		
14	Eptesicus fuscus		A	F	L	49.3	19.5	0	A	5.0		
15	Nycticeius humerals		A	M	NR	33.9	8.75	0	B	4.5		Photos: DSC_9865-9868
16	Nycticeius humerals	↓	A	M	NR	35.3	9.5	0	A	4.0		Ant-head Attachd - Photos: DSC_9870-9881
17	Eptesicus fuscus	21:20	A	M	NR	48.2	22.1	0	A	1.5		
18	Nycticeius humeralis	↓	A	F	L	35.8	12.75	0	A	2.0		
19	Nycticeius humeralis	21:30	A	F	L	34.8	11.25	0	D	3.0		
20	Lasiurus borealis	21:35	A	F	L	40.8	11.25	0	A	1.5		
21	Nycticeius humeralis	22:05	A	F	L	36.8	11.75	0	B	1.5		
22	Lasiurus borealis	22:30	A	M	NR	38.1	8.5	0	B	1.0		
23	Eptesicus fuscus	↓	A	M	NR	42.9	17.25	0	A	1.5		
24	Nycteceius humeralis	23:00	A	M	NR	35.5	9.0	0	B	2.5		Photos. DSC_9882-9886
25	Eptesicus fuscus	↓	A	F	L	47.5	21.0	0	A	0.5		Photos: DSC_9888-9890
26	Eptesicus fuscus	23:18	A	F	L	48.1	24.25	0	A	1.0		Photos: DSC_9892
27	Myotis grisescens	↓	A	F	L	44.2	11.3	0	D	1.0	KYFWD 828114	Photos: DSC_9893-9904
28	Eptesicus fuscus	23:35	A	M	NR	45.8	22.0	0	A	3.5		Photos: DSC_9905-9922
29	Eptesicus fuscus	23:47	A	M	NR	48.7	20.75	0	B	3.5		
30	Lasiurus borealis	00:28	A	F	L	41.3	14.25	0	B	4.5		
31	Nycticeius humeralis	↓	A	M	NR	35.8	9.1	0	A	5.		
32	Eptesicus fuscus	00:30	A	F	L	49.0	22.75	0	A	4		
33	Nycticeius humeralis	00:45	A	F	L	38.2	12.0	0	A	0.5		Photos: DSC_9923-9926
34	Eptesicus fuscus	01:05	A	F	L	—	—	—	A	1.5		Escaped from Hand

² For **females**: L = lactating, PL = post-lactating, NR = non-reproductive; for **males**: TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

*Note: U (unknown) only to be used for **escaped** bats*

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Bat Capture Datasheet

Page 1 of 2

Project Name/No.: Summer Shade Solar/ 172658275
Date: 6/16/24
Biologist(s): James Kiser, Lucas Downs

Site ID: MS-05 / Tudor Form Ridge
County/State: Metcalfe / KY
Moon Phase: Waxing Gibbous
Sunset: 20:03 h

Map Kilometer No./Quad: Sulphur Lick
Latitude: 36.871804
Longitude: -85.683165
Moonrise: 15:02h
Moonset: 01:46 h

General Site Description: Site is located on ridgetop along edge of overhead Utility Line Corridor in head of Nobob Creek between it and SR-90.
Nets Open: 19:55h
Nets Closed: 01:05h

Time	Temp (F)	Wind[1]	% Cloud Cover
20:00	79.7	2	75
21:00	77.4	2	90
22:00	74.6	0	90
23:00	73.8	1	75
00:00	73.9	1	80
01:00	76.3	2	75

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	12	7.5	90m²	36.870753	-85.683250	X				
B	18	5.0	90m²	36.871310	-85.683030	X				
C	15	7.5	112.5m²	36.872125	-85.682932	X				

* One net at full extension ~ 2.5m high

Weather Comments: Weather today was hot and humid with high temp of 95°F, heat Index 103°F, No Rain.

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.[2]	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
1	Lasiurus borealis	21:27	A	F	L	40.8	14.0	0	C	6	—	Photos: DSC_9927-9932
2	Nycticeius humeralis	↓	A	M	NR	36.1	8.25	0	C	6.5	—	Photos: DSC_9933-9959
3	Lasiurus borealis	23:20	A	M	U	—	—	—	C	3		Escaped from Net

[1] **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

[2] For **females:** L = lactating, PL = post-lactating, NR = non-reproductive; for **males:** TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

*Note: U (unknown) only to be used for **escaped** bats*

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Net Site Description

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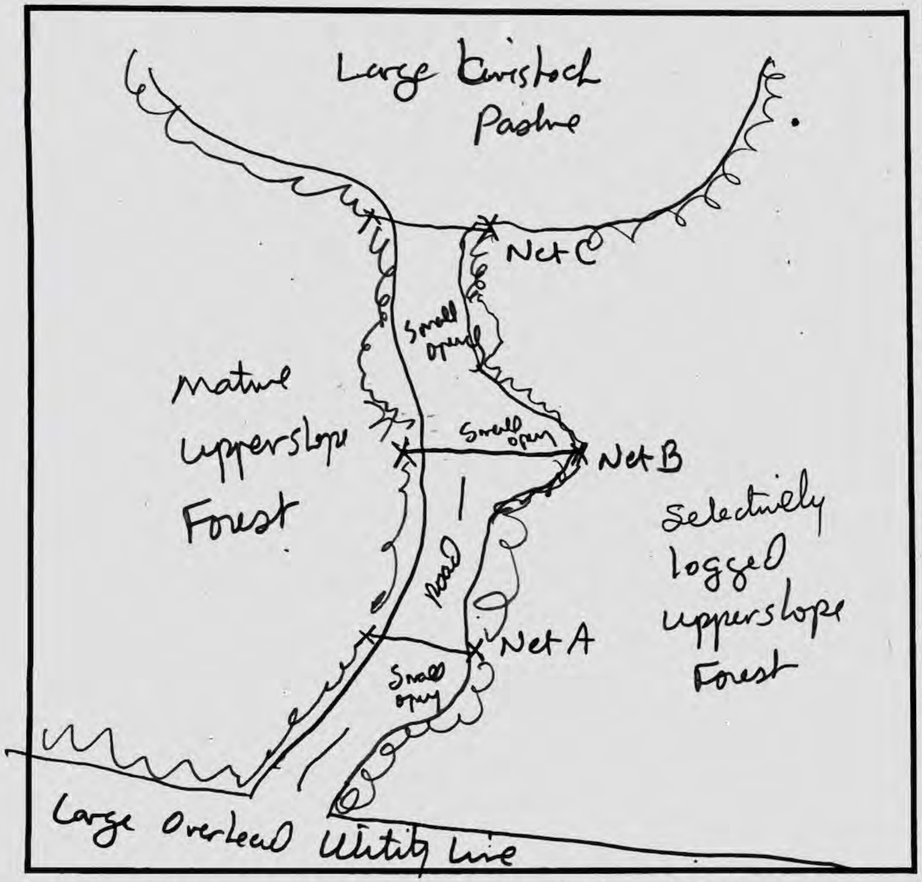

Project Name/No.: Summer Shade Solar | 172658275 **Date:** 16 June 2024

Site ID: MS-05; Tudor Farm Ridge **Est. Distance to Water (ft):** Unknown

VEGETATION

Primary Habitat Type[1]**:** Upland Forest

Potential Roost: Large Trees | Snags | [✓ Both] | Other (e.g., structure)

Roost Tree Potential: High | [✓ Moderate] | Low

Dominant Canopy Species **Avg. Canopy DBH range** (in): 10-16"

1. Black Locust 2. Red Cedar 3. Shagbark Hickory

Canopy Closure: Closed (80% +) | [✓ Moderate (40 – 80%)] | Open (0 – 40%)

Dominant Subcanopy Species **Avg. Subcanopy DBH range** (in): 3-8"

1. Hackberry 2. Red Cedar 3. Ostrya virginiana

Sub-Canopy Clutter: High (60% +) | [✓ Moderate (30 – 60%)] | Low (0 – 30%)

Dominant Shrub/Understory Species

1. Rosa multiflora 2. Black Locust (Sap.) 3. Tree of Heaven (Sap)

Shrub/ Understory Clutter: High (60% +) | [✓ Moderate (30 – 60%)] | Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft): NA **Channel Width:** NA **Stream Width:** NA

Riparian Width right bank: NA left bank: NA **Avg. Water Depth:** NA

---

[1] Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Other Wildlife Observed: Glaucomys volans (1 in Net) Eastern Towhee (Vo), wood Thrush (Vo), Am. Robin (Vo), E. Wood Pewee (Vo), Indigo Bunting (Vo), N. mockingbird (Vo) N. Cardinal (Vo), Carolina Wren (1 in Net), Hyla chryscocelis (Vo), Rana catesbiana (Vo), Rana clamitans (1), Acris crepitans (Vo)

Additional Comments: The ridgetop road corridor conects several small woodland openings with the utility line corridor and large open live stock pasture. The forest has open shrub layer due to historic live stock grazing. The numerous large live Shagbark Hickory and Black Locust with Cavities provide moderate roosting habitat.

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Bat Capture Datasheet

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Project Name/No.: Summit Shade Solar 172658275

Date: 6/17/24

Biologist(s): James Kiser, Lucas Downs

Site ID: MS-06 / Branstetter Woods

County/State: Metcalfe Co, KY

Moon Phase: Waxing Gibbous

Sunset: 20:04

Map Kilometer No./Quad: Sulphur Lick

Latitude: 36.843644

Longitude: -85.691595

Moonrise: 4:03pm

Moonset: 2:09am

General Site Description: Woodlot on ridge between Skaggs Cr. and Nobob Cr. near Cyclone, KY. Site can be accessed by traveling south through farm field from Apple Grove Rd.

Nets Open: 19:50

Nets Closed: 01:10

Time	Temp (F)	Wind[1]	% Cloud Cover
20:00	80.3	0	40
21:00	78.6	1	40
22:00	76.4	1	60
23:00	76.4	1	30
00:00	74.9	1	20
01:00	74.8	2	50

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	18	7.5	135m²	36.843436	-85.691573	X				
B	18	7.5	135m²	36.843718	-85.691189	X				
C	18	7.5	135m²	36.843566	-85.691140	X				
D	15	5.0	75m²	36.843686	-85.690471	X				

* One net at full extension ~ 2.5m high

Weather Comments: Hot and humid today with high Temp of 91°F, No Rain and Calm

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.[2]	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
1	Nycticeius humeralis	21:00	A	F	L	36.4	11.75	0	B	6	—	Photos; DSC_9961-9984
2	Eptesicus fuscus	21:28	J	M	NR	44.5	12.0	0	C	7	—	Photos: DSC_9985-9998 → Bat; [illegible] in lane of the [illegible].
3	Eptesicus fuscus	21:45	J	F	NR	46.5	12.8	0	B	5	—	Photos of bare skin on back; DSC_9999-0003
4	Eptesicus fuscus	21:58	J	M	NR	42.2	10.75	0	A	1	—	Photos: DSC-0006-0009
5	Eptesicus fuscus	↓	J	M	NR	44.7	11.0	0	A	3	—	Photos: DSC_0010
6	Nycticeius humeralis	22:35	A	F	L	37.3	10.75	0	B	5	—	Photos: DSC-0012-0014
7	Nycticeius humeralis	↓	A	F	L	36.6	11.0	0	B	5	—	Photos: DSC_0016
8	Eptesicus fuscus	22:50	J	M	NR	44.5	11.75	0	A	5	—	Photos: DSC_0017-0019
9	Eptesicus fuscus	23:05	J	M	NR	44.3	12.0	0	C	7	—	Photos; DSC_0021-0024
10	Eptesicus fuscus	23:44	J	M	NR	43.6	12.5	0	A	3.5		Photos: DSC_0025-0028
11	Eptesicus fuscus	23:55	J	M	NR	44.0	12.0	0	C	7	—	—
12	Eptesicus fuscus	23:55	A	M	NR	47.6	20.75	0	C	7	—	—

[1] **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

[2] For **females:** L = lactating, PL = post-lactating, NR = non-reproductive; for **males:** TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

*Note: U (unknown) only to be used for **escaped** bats*

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Net Site Description

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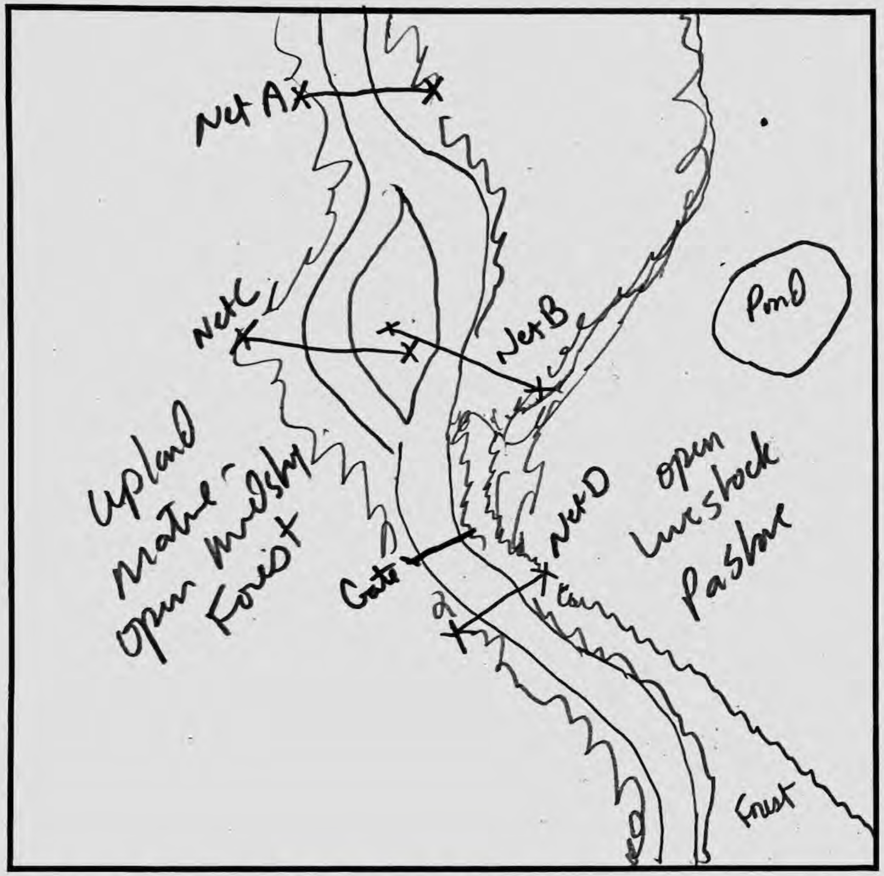

Project Name/No. Summer Shade Solar/172658275 **Date:** 17 June 2024

Site ID: MS-06; Branstetter Woods **Est. Distance to Water (ft):** 300 ft to Farm Pond

VEGETATION

Primary Habitat Type¹: Upland Forest

Potential Roost: Large Trees | Snags | [✓ Both] | Other (e.g., structure)

Roost Tree Potential: [✓ High] | [✓ Moderate] | Low

Dominant Canopy Species **Avg. Canopy DBH range (in):** 16-24"

1. White Ash 2. Carya ovata 3. Am Beech 4. Carya cordiformis

Canopy Closure: Closed (80% +) | [✓ Moderate (40 – 80%)] | [✓ Open (0 – 40%)]

Dominant Subcanopy Species **Avg. Subcanopy DBH range (in):** 4-12"

1. Sugar Maple 2. Am. Beech 3. Tulip tree 4. Sassafras

Sub-Canopy Clutter: High (60% +) | [✓ Moderate (30 – 60%)] | Low (0 – 30%)

Dominant Shrub/Understory Species

1. Spicebush 2. Leatherwood 3. Rosa multiflora 4. Pawpaw

Shrub/ Understory Clutter: High (60% +) | [✓ Moderate (30 – 60%)] | Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft): NA **Channel Width:** NA **Stream Width:** NA

Riparian Width right bank: NA left bank: NA **Avg. Water Depth:** NA

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¹ Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Other Wildlife Observed: Wood Thrush (Vo), Ovenbird (Vo), E. Wood Peewee (Vo), N. Cardinal (Vo), Indigo Bunting (Vo) Yellow-billed Cuckoo (Vo) Rana clamitans (Vo), Carolina Wren (Vo), Killdeer (Vo), Acris crepitans (Vo), Bufo fowleri (Vo), Gastrophryne carolinensis (Vo), Hyla chrysoscelis (Vo)

Additional Comments: This 150 acre woodlot contains mature forest and the open understory is good bat foraging habitat. The numerous large live Shagbark hickory and scattered dead snags provide bats with roosting habitat. Best forest on the project.

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Bat Capture Datasheet Pt. II

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Project Name/No.: Summer Shade Solar | 178658275 **Date:** 17 June 2024 **Biologist(s):** James Kiser, Lucas Downs

Site ID: MS-06 / Branstetter Woods **County/State:** Metcalfe / KY

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.²	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (samples taken, transmitter #, if recap, disposition)
13	Nyctecius humeralis	23:55	A	M	NR	35.5	9.5g	0	D	2	—	—
14	Eptesicus fuscus	00:00	J	M	NR	44.4	11.75g	0	B	5	—	—
15	Eptesicus fuscus	00:15	A	F	L	47.8	23.0g	0	C	7	—	—
16	Eptesicus fuscus	↓	A	F	L	48.6	22.75	0	A	5	—	—
17	Eptesicus fuscus	01:05	J	F	NR	49.1	14.75	0	A	3.5	—	—
18	Eptesicus fuscus	01:10	A	F	L	48.4	20.5	0	A	0.5	—	—
19	Eptesicus fuscus	01:15	J	M	NR	46.5	13.75	0	B	6.5	—	—
20	Eptesicus fuscus	01:15	A	F	L	46.7	21.0	0	B	6	—	—
21	Nyctecius humeralis	01:50	A	M	NR	35.7	8.5	0	A	5	—	—

² For **females**: L = lactating, PL = post-lactating, NR = non-reproductive; for **males**: TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

Note: U (unknown) only to be used for ***escaped*** *bats*

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Appendix D Photographic Log

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Photographic Log

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 1

Photo ID:
1-A

Species:
Lasiurus borealis

Capture Location:
36.887317, -85.694025

Site/Net ID:
MS-2-B

Sex:
Female

Reproductive Status:
Lactating

RFA (mm):
39.8

Weight (g):
13

Photograph ID: 2

Photo ID:
1-B

Species:
Lasiurus borealis

Capture Location:
36.850198, -85.701992

Site/Net ID:
MS-1-B

Sex:
Male

Reproductive Status:
Non-reproductive

RFA (mm):
38.6

Weight (g):
10.75

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 3	
Photo ID: 2-A	
Species: Eptesicus fuscus	
Capture Location: 36.850198, -85.701992	
Site/Net ID: MS-1-C	
Sex: Male	
Reproductive Status: Non-reproductive	
RFA (mm): 46.8	
Weight (g): 17.5	

Photograph ID: 4	
Photo ID: 2-B	
Species: Eptesicus fuscus	
Capture Location: 36.866543, -85.688105	
Site/Net ID: MS-4-A	
Sex: Male	
Reproductive Status: Non-reproductive	
RFA (mm): 45.8	
Weight (g): 22.0	

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 5	
Photo ID: 3-A	
Species: Nycticeius humeralis	
Capture Location: 36.850198, -85.701992	
Site/Net ID: MS-1-A	
Sex: Female	
Reproductive Status: Pregnant	
RFA (mm): 37.5	
Weight (g): 13.25	
Photograph ID: 6	
Photo ID: 3-B	
Species: Nycticeius humeralis	
Capture Location: 36.887317, -85.694025	
Site/Net ID: MS-2-B	
Sex: Male	
Reproductive Status: Non-reproductive	
RFA (mm): 34.7	
Weight (g): 8.75	

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 7	
Photo ID: 4-A	
Species: Myotis grisescens	
Capture Location: 36.850198, -85.701992	
Site/Net ID: MS-1-C	
Sex: Female	
Reproductive Status: Lactating	
RFA (mm): 42.6	
Weight (g): 11.5	
Photograph ID: 8	
Photo ID: 4-B	
Species: Myotis grisescens	
Capture Location: 36.850198, -85.701992	
Site/Net ID: MS-1-B	
Sex: Female	
Reproductive Status: Lactating	
RFA (mm): 41.4	
Weight (g): 11.0	

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 1

Photo ID:
MS-1_A_1

Mist Net Site:
MS-1

Net:
A

Net View:
1

Location:
36.850809, -85.701663

Type:
Forested/wetland

Photograph ID: 2

Photo ID:
MS-1_A_2

Mist Net Site:
MS-1

Net:
A

Net View:
2

Location:
36.850809, -85.701663

Type:
Forested/wetland

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 3

Photo ID:
MS-1_B_1

Mist Net Site:
MS-1

Net:
B

Net View:
1

Location:
36.850377, -85.702210

Type:
Corridtor to stream

Photograph ID: 4

Photo ID:
MS-1_B_2

Mist Net Site:
MS-1

Net:
B

Net View:
2

Location:
36.850377, -85.702210

Type:
Corridor to stream

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 5 **Photo ID:** MS-1_C_1 **Mist Net Site:** MS-1 **Net:** C **Net View:** 1 **Location:** 36.850530, -85.702169 **Type:** Over stream	
Photograph ID: 6 **Photo ID:** MS-1_C_2 **Mist Net Site:** MS-1 **Net:** C **Net View:** 2 **Location:** 36.850530, -85.702169 **Type:** Over stream	

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 7

Photo ID:
MS-1_C_3

Mist Net Site:
MS-1

Net:
C

Net View:
3

Location:
36.850530, -85.702169

Type:
Over stream

Photograph ID: 8

Photo ID:
MS-1_D_1

Mist Net Site:
MS-1

Net:
D

Net View:
1

Location:
36.850875, -85.702365

Type:
Wooded clearing

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 9 **Photo ID:** MS-1_D_2 **Mist Net Site:** MS-1 **Net:** D **Net View:** 2 **Location:** 36.850875, -85.702365 **Type:** Wooded clearing	
Photograph ID: 10 **Photo ID:** MS-2_A_1 **Mist Net Site:** MS-2 **Net:** A **Net View:** 1 **Location:** 36.887912, -85.694222 **Type:** Forested road corridor	

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 11

Photo ID:
MS-2_A_2

Mist Net Site:
MS-2

Net:
A

Net View:
2

Location:
36.887912, -85.694222

Type:
Forested road corridor

Photograph ID: 12

Photo ID:
MS-2_B_1

Mist Net Site:
MS-2

Net:
B

Net View:
1

Location:
36.887436, -85.694029

Type:
Forested road corridor

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 13

Photo ID:
MS-2_B_2

Mist Net Site:
MS-2

Net:
B

Net View:
2

Location:
36.887436, -85.694029

Type:
Forested road corridor

Photograph ID: 14

Photo ID:
MS-2_C_1

Mist Net Site:
MS-2

Net:
C

Net View:
1

Location:
36.887146, -85.693737

Type:
Forested road corridor

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 15

Photo ID:
MS-2_C_2

Mist Net Site:
MS-2

Net:
C

Net View:
2

Location:
36.887146, -85.693737

Type:
Forested road corridor

Photograph ID: 16

Photo ID:
MS-2_D_1

Mist Net Site:
MS-2

Net:
D

Net View:
1

Location:
36.887799, -85.693063

Type:
Forested road corridor

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 17

Photo ID:
MS-2_D_2

Mist Net Site:
MS-2

Net:
D

Net View:
2

Location:
36.887799, -85.693063

Type:
Forested road corridor

Photograph ID: 18

Photo ID:
MS-3_A_1

Mist Net Site:
MS-3

Net:
A

Net View:
1

Location:
36.863160, -85.698978

Type:
Road rut

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 19

Photo ID:
MS-3_A_2

Mist Net Site:
MS-3

Net:
A

Net View:
2

Location:
36.863160, -85.698978

Type:
Road rut

Photograph ID: 20

Photo ID:
MS-3_B_1

Mist Net Site:
MS-3

Net:
B

Net View:
1

Location:
36.863167, -85.699031

Type:
Forested

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 21

Photo ID:
MS-3_B_2

Mist Net Site:
MS-3

Net:
B

Net View:
2

Location:
36.863167, -85.699031

Type:
Forested

Photograph ID: 22

Photo ID:
MS-3_C_1

Mist Net Site:
MS-3

Net:
C

Net View:
1

Location:
36.863530, -85.698857

Type:
Forested road

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 23

Photo ID:
MS-3_C_2

Mist Net Site:
MS-3

Net:
C

Net View:
2

Location:
36.863530, -85.698857

Type:
Forested road

Photograph ID: 24

Photo ID:
MS-4_A_1

Mist Net Site:
MS-4

Net:
A

Net View:
1

Location:
36.866548, -85.688169

Type:
Stream

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 25

Photo ID:
MS-4_A_2

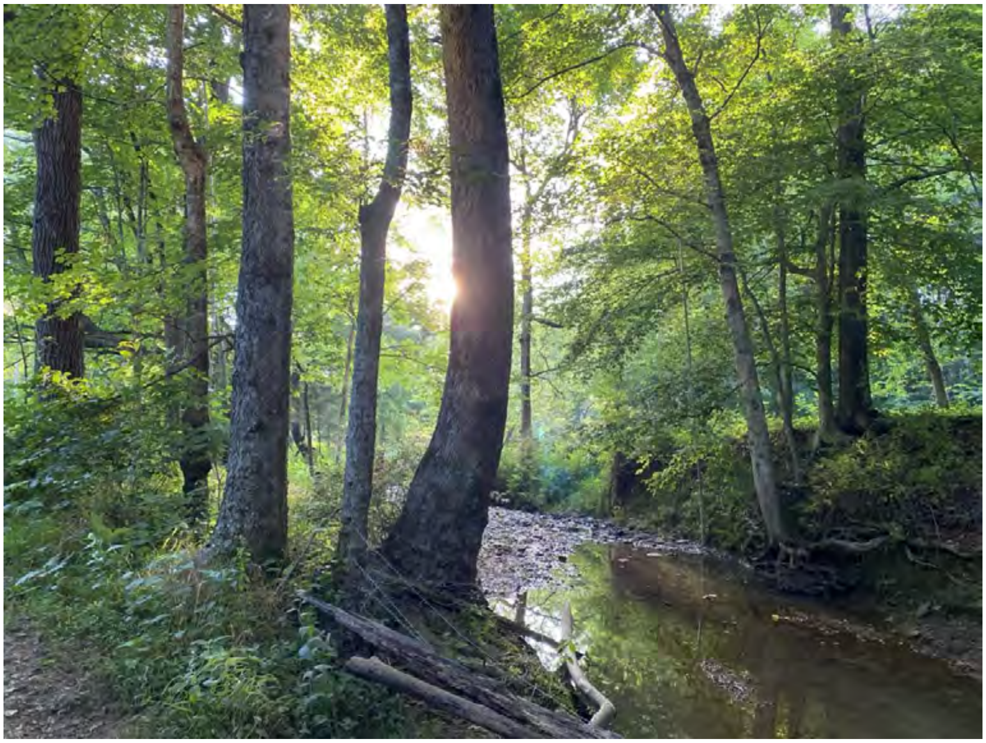
Mist Net Site:
MS-4

Net:
A

Net View:
2

Location:
36.866548, -85.688169

Type:
Stream



Photograph ID: 26

Photo ID:
MS-4_B_1

Mist Net Site:
MS-4

Net:
B

Net View:
1

Location:
36.866560, -85.687989

Type:
Forested road edge

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 27

Photo ID:
MS-4_B_2

Mist Net Site:
MS-4

Net:
B

Net View:
2

Location:
36.866560, -85.687989

Type:
Forested road edge

Photograph ID: 28

Photo ID:
MS-4_C_1

Mist Net Site:
MS-4

Net:
C

Net View:
1

Location:
36.866485, -85.687517

Type:
Stream

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 29	
Photo ID: MS-4_C_2	
Mist Net Site: MS-4	
Net: C	
Net View: 2	
Location: 36.866485, -85.687517	
Type: Stream	

Photograph ID: 30	
Photo ID: MS-4_D_1	
Mist Net Site: MS-4	
Net: D	
Net View: 1	
Location: 36.866220, -85.686825	
Type: Stream	

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 31

Photo ID:
MS-4_D_2

Mist Net Site:
MS-4

Net:
D

Net View:
2

Location:
36.866220, -85.686825

Type:
Stream

Photograph ID: 32

Photo ID:
MS-5_A_1

Mist Net Site:
MS-5

Net:
A

Net View:
1

Location:
36.870746, -85.683245

Type:
Road

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 33

Photo ID:
MS-5_A_2

Mist Net Site:
MS-5

Net:
A

Net View:
2

Location:
36.870746, -85.683245

Type:
Road

Photograph ID: 34

Photo ID:
MS-5_B_1

Mist Net Site:
MS-5

Net:
B

Net View:
1

Location:
36.871303, -85.683025

Type:
Road

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 35

Photo ID:
MS-5_B_2

Mist Net Site:
MS-5

Net:
B

Net View:
2

Location:
36.871303, -85.683025

Type:
Road

Photograph ID: 36

Photo ID:
MS-5_C_1

Mist Net Site:
MS-5

Net:
C

Net View:
1

Location:
36.872118, -85.682927

Type:
Road

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 37

Photo ID:
MS-5_C_2

Mist Net Site:
MS-5

Net:
C

Net View:
2

Location:
36.872118, -85.682927

Type:
Road

Photograph ID: 38

Photo ID:
MS-6_A_1

Mist Net Site:
MS-6

Net:
A

Net View:
1

Location:
36.843429, -85.691568

Type:
Road

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 39

Photo ID:
MS-6_A_2

Mist Net Site:
MS-6

Net:
A

Net View:
2

Location:
36.843429, -85.691568

Type:
Road

Photograph ID: 40

Photo ID:
MS-6_B_1

Mist Net Site:
MS-6

Net:
B

Net View:
1

Location:
36.843711, -85.691184

Type:
Road

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 41

Photo ID:
MS-6_B_2

Mist Net Site:
MS-6

Net:
B

Net View:
2

Location:
36.843711, -85.691184

Type:
Road

Photograph ID: 42

Photo ID:
MS-6_C_1

Mist Net Site:
MS-6

Net:
C

Net View:
1

Location:
36.843559, -85.691136

Type:
Road

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 43

Photo ID:
MS-6_C_2

Mist Net Site:
MS-6

Net:
C

Net View:
2

Location:
36.843559, -85.691136

Type:
Road

Photograph ID: 44

Photo ID:
MS-6_D_1

Mist Net Site:
MS-6

Net:
D

Net View:
1

Location:
36.843679, -85.690466

Type:
Road

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar**
Site Name:	**Summer Shade**	**Site Location:**	**Metcalfe County**

Photograph ID: 45

Photo ID:
MS-6_D_2

Mist Net Site:
MS-6

Net:
D

Net View:
2

Location:
36.843679, -85.690466

Type:
Road

2024 Fall Swarming Survey for the Summer Shade Solar Project

Metcalfe and Monroe Counties, Kentucky
IPaC Project Code: 2025-0021330

November 20, 2024

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1 Introduction

Summer Shade Solar, LLC (the “Client”) is proposing to develop a photovoltaic energy project known as the Summer Shade Solar Project (the “Project”) within Metcalfe and Monroe Counties, Kentucky (**Appendix A, Figure 1**). The Project may impact potential habitat within the range of multiple bat species either currently listed or under consideration for listing under the Endangered Species Act of 1973, which prohibits take of listed threatened and endangered species. Stantec Consulting Services Inc. (Stantec) was retained by the Client to conduct fall swarming surveys for listed bat species as part of the Project’s regulatory due diligence. The purpose of this assessment was to determine presence or probable absence of listed bats using suitable hibernacula within the Project area.

The Project area is within the ranges of the federally endangered gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), and northern long-eared bat (*Myotis septentrionalis*), as well as the proposed federally endangered tricolored bat (*Perimyotis subflavus*) according to the USFWS Information for Planning and Consultation (IPaC) environmental review tool (Project Code: 2025-0021330). Stantec biologists performed Phase I Habitat Assessment field surveys for these species from October 4-10, 2021, April 18-27, 2022, and February 26-29, 2024. The Phase I Habitat Assessment identified two cave features (C-01 and C-02) (**Appendix A, Figure 3**) that could serve as potential hibernacula for listed bat species. The forested habitat was also considered potential habitat for listed bat species, so a mist net survey was conducted from, June 12 to June 17, 2024, during the summer maternity season. Three gray bats were captured within the Project area during the 2024 summer mist net survey.

1.1 Project Area Description

The Project area is 1,526.21 acres in size and primarily composed of agricultural fields, forested riparian areas, upland forest tracts, and tree lines along field edges. The Project is located between the towns of Summer Shade and Beaumont, with Summer Shade to the west and north of the Project and Beaumont to the east. The Project is approximately 13 miles southeast of the city of Glasgow, Kentucky within Metcalfe and Monroe counties. KY HWY 163 borders the Project’s eastern boundary, KY HWY 678 borders the Project’s southern boundary, KY HWY 839 lies along the western boundary, and KY HWY 90 is straddled by the Project as a northern boundary. (**Appendix A, Figure 1 and Figure 2**). The Project can be found on the Summer Shade and Sulfur Lick, Kentucky United States Geological Survey (USGS) 7.5-Minute Quadrangle.

2 Methods

USFWS has standardized fall swarming survey practices for endangered bats, which are outlined in the *2024 Range-wide Indiana Bat & Northern Long-Eared Bat Survey Guidelines* (the "Guidelines"; USFWS 2024). Stantec submitted a Project-specific Study Plan Form for Bat Survey and Monitoring (**Appendix B**) on September 6, 2024, outlining this proposed level of effort in accordance with the Guidelines. Conditional authorization from the USFWS Kentucky Field Office was received on September 12, 2024, confirming that the proposed level of effort was sufficient to assess the usage of portals in the Project area by federally listed bats.

Specific provisions included:

1) Only band gray bats (if captured).
2) No transmitters should be attached to bats.

Surveys were conducted for six consecutive weeks between September 16, 2024, and October 29, 2024. One survey night per week was required to achieve the required 30 hours of survey effort for each cave entrance. Surveys were conducted under federal permit numbers ESPER0036267 and ES38821A-5, and Kentucky Department of Fish and Wildlife Resources (KDFWR) scientific wildlife collecting permit numbers SC2411182, SC2411184, and SC2411185.

The identified cave entrances were approximately 1.8 mi (2.9km) apart and were determined to not be connected since C-02 had a clear terminus, so they were not required to be surveyed on the same calendar night. Survey equipment and materials used to cover gaps around the entrances were removed each night after completion of the survey. The sampling period began at sunset and continued for five hours each night. Harp traps were the preferred method of bat capture and were prioritized for surveys; however, a mist net was used to sample C-02, as proposed in the approved study plan.

While conducting surveys any noise, use of lights, and other potential disturbances were kept to a minimum within 300 ft (91.4 m) of the sampling sites. Harp traps were monitored at 30-minute intervals to reduce the number of bats that escape and reduce the chance of white-nose syndrome (WNS) spread (WNS Disease Management Group 2024). Mist nets were monitored at 10-minute intervals to reduce bat escapes and reduce entanglement.

2.1 Bat Capture

Protocols for bat capture, handling, and equipment decontamination for WNS (WNS Disease Management Group 2024) were followed during the survey. All bats captured were removed and placed individually in disposable brown paper bags. Biologists wore disposable gloves when handling individual bats and periodically disinfected gloves with hand sanitizer. All measuring equipment and surfaces used to process bats were decontaminated after each bat.

Morphological characteristics (e.g., ear and tragus length, presence or absence of calcar, pelage color, mass, right forearm length) were used to identify bats to species. The species, sex, reproductive condition, age, mass, right forearm length, capture/release time, and capture site were recorded for all bats. Age (adult or juvenile) was determined by examining epiphyseal-diaphyseal fusion (calcification) of long bones in the wing. Weight was measured to 0.1 gram using a spring scale. Length of the right forearm of each bat was measured in millimeters using a field ruler or calipers. The reproductive condition of captured bats was classified as non-descended male, descended male, non-reproductive female, pregnant female (based on abdominal palpation), lactating female, or post-lactating female. Bat processing and data collection was completed within 30 minutes of removing bats from the mist net or harp trap.

2.2 Weather

Biologists monitored nightly weather conditions and recorded hourly temperature, wind speed, cloud cover, and any precipitation events. If any of the following weather conditions existed during the survey, then the time and duration of such conditions were noted on the datasheets and the survey effort for that night were concluded:

- winds sufficiently strong and variable enough to move equipment (i.e., traps or nets) more than 50 percent of the time;
- precipitation, including rain and/or fog lasting more than 30 minutes or continuing intermittently during the survey period; or
- a temperature drop below 50°F during the first two hours of the survey.

Cloud cover was visually estimated. Sunset time, moon rise and setting times, and moon phase were obtained from online resources such as Weather Underground.

2.3 Acoustic Data Collection and Analysis

To assess general levels of bat activity at each portal, acoustic detectors (Song Meter 4 [SM4], Wildlife Acoustics, Maynard, Massachusetts) were deployed at each portal for the duration of surveys. Directional and omnidirectional microphones were positioned parallel to portal entrances. Data collection began at sunset and continued for five hours or until survey activities concluded. The detectors digitally recorded echolocation pulses from bats that passed near the microphones, storing acoustic data on removable SD cards.

All data files were downloaded from detectors deployed at each portal after the survey was complete. All files were converted to a zero-crossing format and processed using Kaleidoscope Pro software (Kaleidoscope; version 5.6.8).

A biologist experienced in the analysis of acoustic bat signatures visually inspected all files identified as a bat pass by Kaleidoscope to check accuracy of differentiation of bat activity from ultrasonic “static/noise” or interference by the program. Files found to contain only static were removed from analysis. The biologist also reviewed files classified by the program as noise; any files which were labeled as noise by the program but contained bat passes were re-identified as a bat pass to be included in the analysis. The summary .txt files produced by the acoustic detectors were reviewed to determine the number of hours surveyed at each portal, and the overall bat passes per survey hour for each portal surveyed were calculated. Due to the inability to identify bat species near hibernacula from their calls, and because the Guidelines state “analysis of recorded bat calls to attempt species identification should not be completed as these calls are not expected to be foraging calls”, the biologist did not identify species of bats from collected acoustic data.

3 Results

3.1 Site Descriptions

Two caves were identified in the Phase I Habitat Assessment and were surveyed during the fall swarming season between September 16, 2024 and October 29, 2024 (**Appendix A, Figure 3**).

C-01 was located in a steep drainage approximately 425 ft (129.5 m) from the boundary of the western portion of the Project area at 36.862525°, -85.698292°. The cave entrance was approximately 5 ft (1.5 m) tall and 2.5 ft (0.8 m) wide and was situated approximately 2.5 ft (0.8 m) off the ground within a limestone rock shelf. A stream flowed continuously from the cave entrance and down a steep, rocky channel before meeting with a larger stream at the toe of the slope. There was significant cold airflow coming from the entrance of the cave and when investigated after the conclusion of the surveys, biologists noted that the cave continued back at least 200 ft (60.9 m) and may connect to a larger cave system. C-01 was surveyed on September 17, September 24, October 1, October 7, October 13, and October 29, 2024. A large harp trap was deployed at the cave's entrance parallel to the cliff line and exclusion netting was used to enclose the opening.

C-02 was located in the northern portion of the Project area at 36.862453°, -85.698440°. C-02 was a rockshelter type cave primarily composed of sandstone with a large opening approximately 76 ft (22 m) wide and up to 20 ft (6.1 m) tall. At the back of the rockshelter, a smaller cave-like opening approximately 20 ft (6.9 m) wide and 2 ft (0.6 m) tall extended back another 25 ft (7.6 m); however, no dark zones were present and small mammal scat was abundant. No cold air was noted flowing from the cave. The rockshelter was located at the head of a dry, rocky stream channel originating from a spring outside of the cave. Due to the large dimensions of the opening to C-02, a 59 ft (18 m) mist net was used in lieu of a harp trap, as proposed in the approved study plan. Exclusion netting was used to enclose the remaining open areas. C-02 was surveyed on September 16, September 24, October 1, October 7, October 13, and October 25, 2024.

Site sketches can be found on the Bat Capture Data Sheets in **Appendix C** and photos of each entrance with survey equipment in place can be found in **Appendix D**.

3.2 Bat Capture

Survey efforts for the Project were conducted between September 16, 2024 and October 29, 2024. Five bats representing two species were captured during survey efforts including two tricolored bats and three big brown bats (*Eptesicus fuscus*) (**Table 2).** In addition, a single big brown was observed roosting inC-02 outside of the excluded area throughout the survey period on October 1, 2024 and was also observed using C-02 on October 25, 2024 but was not captured on either date. Data Sheets can be found in **Appendix C** and representative photos of each species can be found in **Appendix D.**

Table 1. Capture Summary for the Fall Swarming Survey for Summer Shade Solar Project, September-October 2024

Feature Name	Survey Start Date	Time of Capture (24 hr)	Species	Sex[1]	Reproductive Condition[2]	Age[3]	Mass (g)	RFA (mm)	Wing Score[4]
C-02	09/16/2024	2145	*Eptesicus fuscus*	M	TD	A	20.0	47.1	0
C-01	09/24/2024	2145	*Perimyotis subflavus*	F	NR	A	4.75	37.75	0
C-01	09/24/2024	2300	*Perimyotis subflavus*	M	TD	A	5.5	33.5	0
C-02	09/24/2024	1928	*Eptesicus fuscus*	M	NR	A	22.5	45.8	0
C-02	10/07/2024	2115	*Eptesicus fuscus*	F	NR	A	26.5	47.7	0

[1] F = Female, M = Male, U = Unknown (escaped)
[2] NR = Non-Reproductive, TD = Testes Descended, P = Pregnant, L = Lactating, PL = Post-Lactating
[3] A = Adult, J = Juvenile, U = Unknown (escaped)
[4] Reichard's wing damage index is a scale from 0-3 measuring scarring and/or blotching that may indicate damage from WNS

3.3 Weather

Weather during the survey period was consistent for this time of year in Metcalfe and Monroe counties, Kentucky, with nightly temperatures ranging from 52.4ºF to 72.0ºF. Cloud cover ranged from 0 percent to 100 percent during the survey period. Wind ranged from calm to a moderate breeze, which is 0 – 4 on the Beaufort wind scale. None of the weather conditions outlined in Section 2.2 that would require survey efforts to cease for the day occurred during the survey period. **Table 3** contains a summary of onsite weather data collected during survey efforts.

***Table 2**. Weather Recordings During the Fall Swarming Survey for Summer Shade Solar Project, September-October 2024*

Feature Name	Survey Start Date	Temp °F			Wind Speed[1]			Cloud Cover %		
		2000h	2200h	2300h	2000h	2200h	2300h	2000h	2200h	2300h
C-01	09/17/2024	67.8	56.5	66.0	0	0	0	50	20	10
C-02	09/16/2024	72.0	64.0	61.0	0	0	1	0	0	0
C-01	09/24/2024	67.3	6637	66.5	0	0	0	100	80	100
C-02	09/24/2024	71.0	68.0	67.0	0	0	1	85	80	90
C-01	10/01/2024	65.3	64.8	65.0	2	2	1	50	100	50
C-02	10/01/2024	67.8	68.0	68.0	1	1	1	10	0	10
C-01	10/07/2024	56.1	53.0	52.4	0	1	1	0	0	0
C-02	10/07/2024	59.1	57.1	56.0	0	0	0	0	0	0
C-01	10/13/2024	72.0	66.7	65.8	0	0	2	0	0	0
C-02	10/13/2024	70.0	65.0	62.0	3	1	4	10	10	10
C-01	10/29/2024	63.1	62.8	62.4	1	2	2	0	0	0
C-02	10/25/2024	68.0	68.0	68.0	0	0	0	0	0	0

---

[1] Based on the Beaufort wind speed indicators

3.4 Acoustic Data Collection and Analysis

The rate of bat passes recorded per survey hour ranged from 5.40 to 434.40 passes. In general, bat activity was particularly high at cave C-01 during week 5. After manually vetting the collected data for bat passes, it is concluded that using omnidirectional microphones have recorded additional tree dwelling bats (hoary bat [*Lasiurus cinereus*], silver haired bat [*Lasionycteris noctivagans]*), eastern red bat [*Lasiurus borealis*]) in the vicinity of the cave entrances. These species are included within **Table 4.**

***Table 4**. Summary of Acoustic Data Collected During the Fall Swarming Survey for Summer Shade Solar Project, October 2024*

Feature Name	Survey Start Date	Total Hours Surveyed	Total Recorded Bat Passes	Bat Passes Per Hour
		Week 1		
C-01	9/17/2024	5.00	48	9.60
C-02	9/16/2024	5.00	32	6.40
		Week 2		
C-01	9/24/2024	5.00	827	165.40
C-02 *	9/24/2024	5.00	N/A	N/A
		Week 3		
C-01	10/1/2024	5.00	187	37.40
C-02	10/1/2024	5.00	161	32.20
		Week 4		
C-01	10/7/2024	5.00	548	109.60
C-02	10/7/2024	5.00	27	5.40
		Week 5		
C-01	10/13/2024	5.00	2,172	434.40
C-02	10/13/2024	5.00	55	11.00
		Week 6		
C-01	10/29/2024	5.00	450	90.00
C-02	10/25/2024	5.00	70	14.00

*SD card was not formatted and no data was recorded

4 Discussion

Fall swarming surveys were conducted from September 16 to October 29, 2024 at two cave features (C-01 and C-02) within the Project area in Metcalfe and Monroe counties, Kentucky. The primary objective was to determine usage of caves by federally listed bat species within the Project area for fall swarming and potential hibernation. Gray bats, Indiana bats, and northern-long eared bats are winter cave obligate species. Gray bats occupy caves year-round and use deep, vertical caves with cold air sinks (USFWS 2007b). Indiana bats select caves and abandoned mines with cold, stable temperatures in large rooms with extensive or vertical passages (King 2019; USFWS 2007a). Northern long-eared bats occupy caves and mines with rooms of various sizes with stable internal temperatures, high humidity, and no air currents (USFWS 2022a). Tricolored bats are known to select for a variety of winter habitats including bridges, caves, culverts, mines, and trees near roadways. Caves and mines are selected based on habitat connectivity and open space for migration between habitats (USFWS 2022b). No federally endangered gray bats, Indiana bats, or northern long-eared bats were captured. Two proposed federally endangered tricolored bats were captured at C-01.

The secondary objective was to record baseline data for non-listed bat species. Three big brown bats were captured at C-02 during the survey. In winter, big brown bats hibernate in caves, usually in the coldest sections near the entrance. (KDFWR n.d.).

The data collected during the USFWS-approved fall swarming survey indicate that gray, Indiana, and northern long-eared bats likely do not use the caves within the Project area as potential hibernacula. Concurrence with a May Affect, Not Likely to Adversely Affect determination is anticipated from the USFWS Kentucky Field Office for these three species regarding proposed impacts to caves.

Tricolored bats were captured during the fall swarming season using C-01, which is approximately 425 ft (129.5 m) outside the Project area boundary; therefore, impacts to this cave, or in close vicinity to the entrance, by Project construction May Affect the tricolored bat and further consultation with the USFWS is recommended.

5 References

King, R. 2019. Indiana Bat (*Myotis sodalis*) 5-Year Review: Summary and Evaluation.

Kentucky Department of Fish & Wildlife Resources. (n.d.). Big Brown bat. Retrieved November, 2024, from https://fw.ky.gov/Wildlife/Pages/Big-Brown-Bat.aspx

USFWS. 2007a. Gray bat (*Myotis grisescens*) 5-Year Review: Summary and Evaluation. In U.S. Fish & Wildlife Service (No. 07–1866). U.S. Fish and Wildlife Service. Retrieved November, 2024, from https://ecos.fws.gov/docs/five_year_review/doc2625.pdf

USFWS. 2007b. Indiana Bat (*Myotis sodalis*) Draft Recovery Plan: First Revision. 2007. U.S. Fish and Wildlife Service, Fort Snelling, MN.

USFWS. 2022. Endangered and threatened wildlife and plants; Endangered species status for Northern Long-Eared Bat. In U.S. Fish & Wildlife Service. Retrieved November, 2024, from https://www.govinfo.gov/content/pkg/FR-2022-11-30/pdf/2022-25998.pdf#page=1

USFWS. 2022b. Endangered and threatened wildlife and plants; Endangered species status for tricolored bat. In U.S. Fish & Wildlife Service (No. 2022–18852). Retrieved November 2024, from https://www.federalregister.gov/documents/2022/09/14/2022-18852/endangered-and-threatened-wildlife-and-plants-endangered-species-status-for-tricolored-bat

USFWS. 2024. Range-wide Indiana Bat and Northern Long-eared Bat Survey Guidelines. U.S. Fish and Wildlife Service, Region 3, Bloomington, MN.

White-nose Syndrome Disease Management Group. 2024. National White-Nose Syndrome Decontamination Protocol – March 2024. www.WhiteNoseSyndrome.org

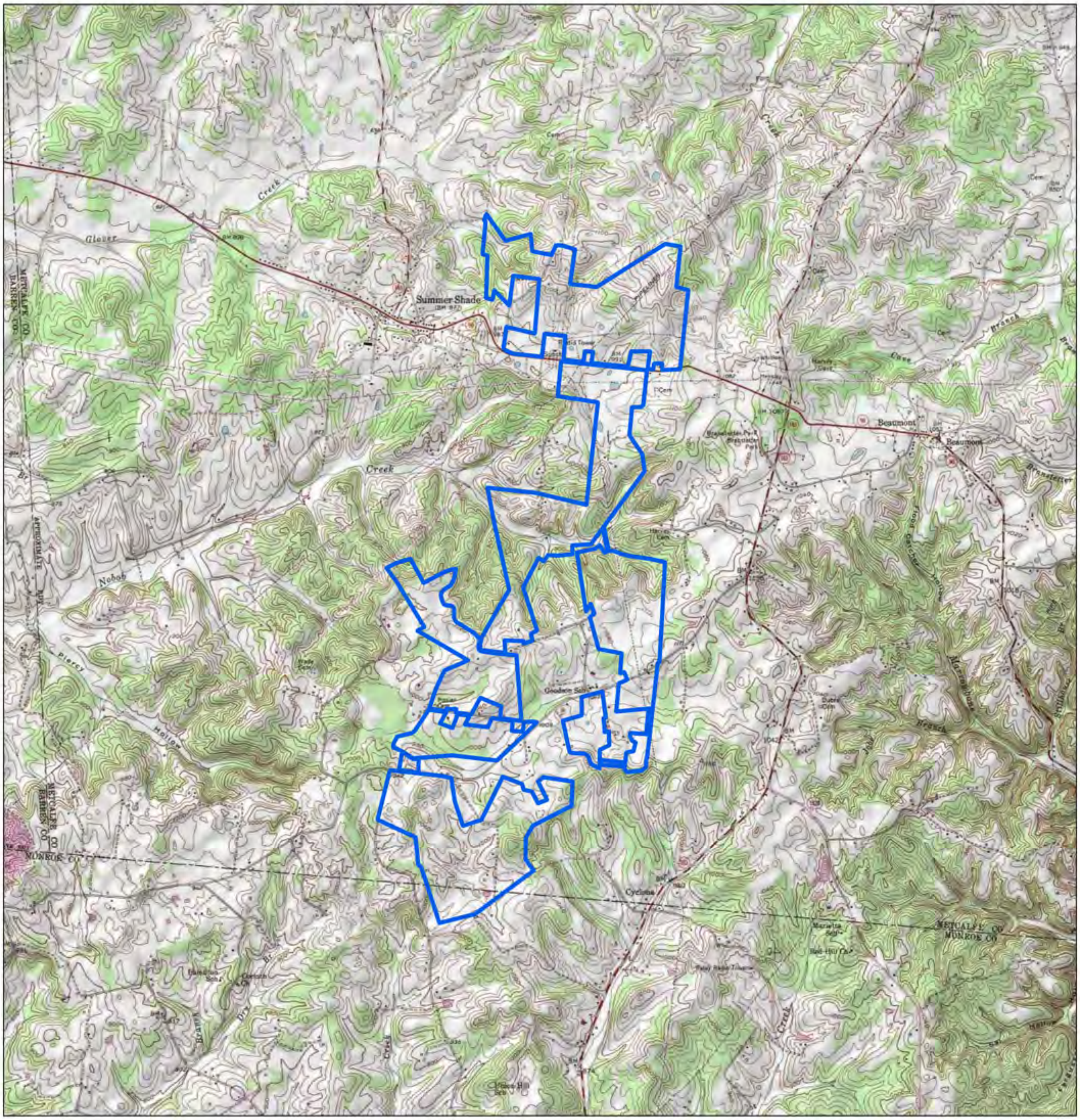
Appendices

Appendix A Project Maps

Figure 1: *Project Topographic Overview Map*

Figure 2: *Project Aerial Overview Map*

Figure 3: *Bat Harp Trap Survey Map*



Legend

□ Project Boundary

(At original document size of 8.5x11)
1 inch = 4,500 feet

Stantec

Project Location
Metcalfe and Monroe Counties,
Kentucky

Prepared by MNA on 2024-10-23
TR by KC on 2024-10-25
IR by SPK on 2024-10-25

172658275

Client/Project
Summer Shade Solar, LLC
Summer Shade Solar Project
Harp Trap Survey Report

Figure No.
1

Title
Project Topographic Overview Map

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: USGS, Stantec, Summer Shade Solar LLC
3. Background: USGS 7.5" Quadrangle Basemap

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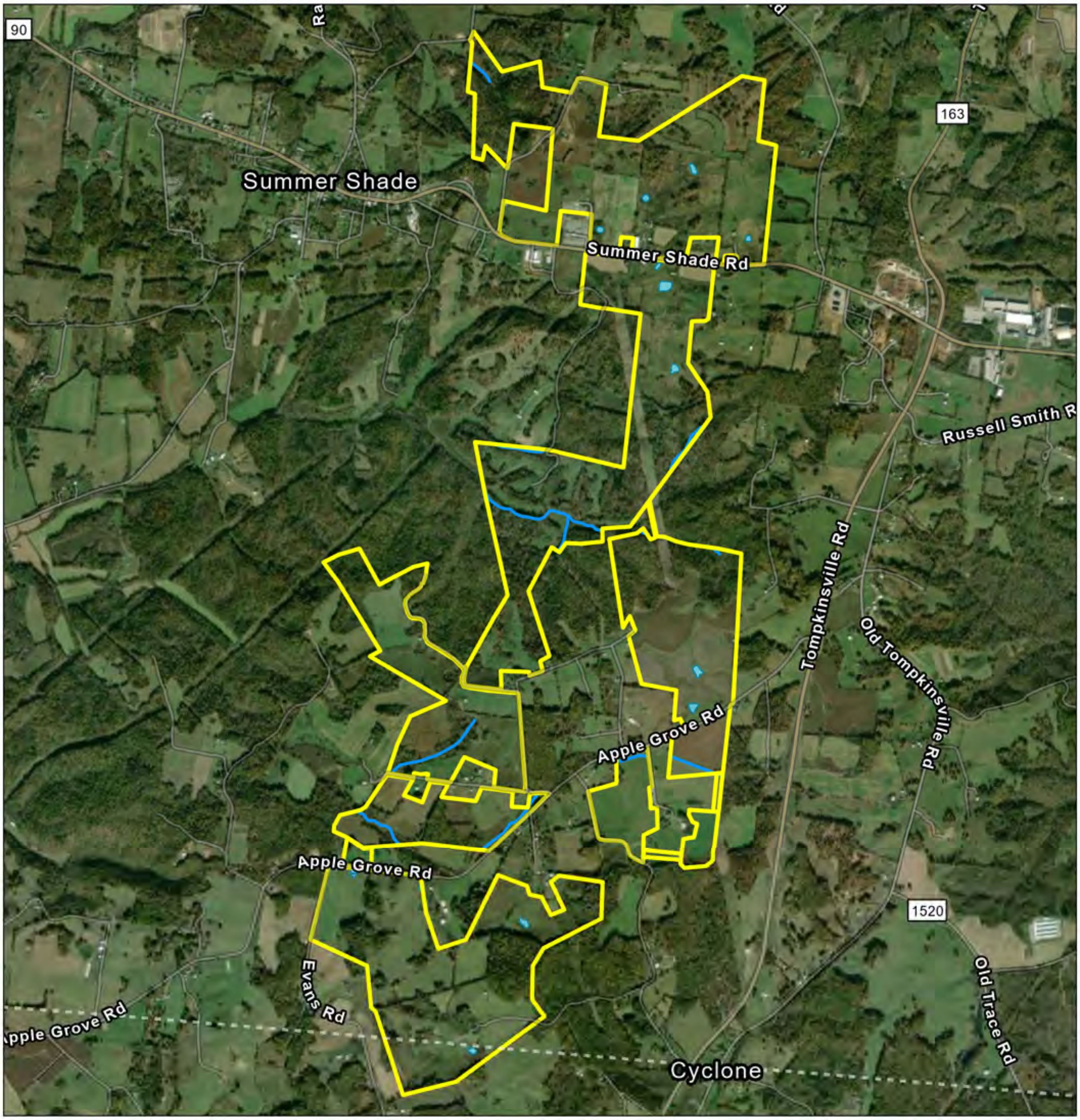

Legend
- 🟨 Project Boundary
- — NHD Streams
- 🟦 NHD Waterbodies

0 1,500 3,000 Feet
(At original document size of 8.5x11)
1 inch = 3,000 feet

N

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: NHD, Stantec, Summer Shade Solar LLC
3. Background: Esri Aerial Imagery Hybrid Basemap

Stantec

Project Location
Metcalfe and Monroe Counties, Kentucky

Prepared by MNA on 2024-10-23
TR by KC on 2024-10-25
IR by SPK on 2024-10-25

Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
Harp Trap Survey Report

Figure No.
2

Title
Project Overview Map

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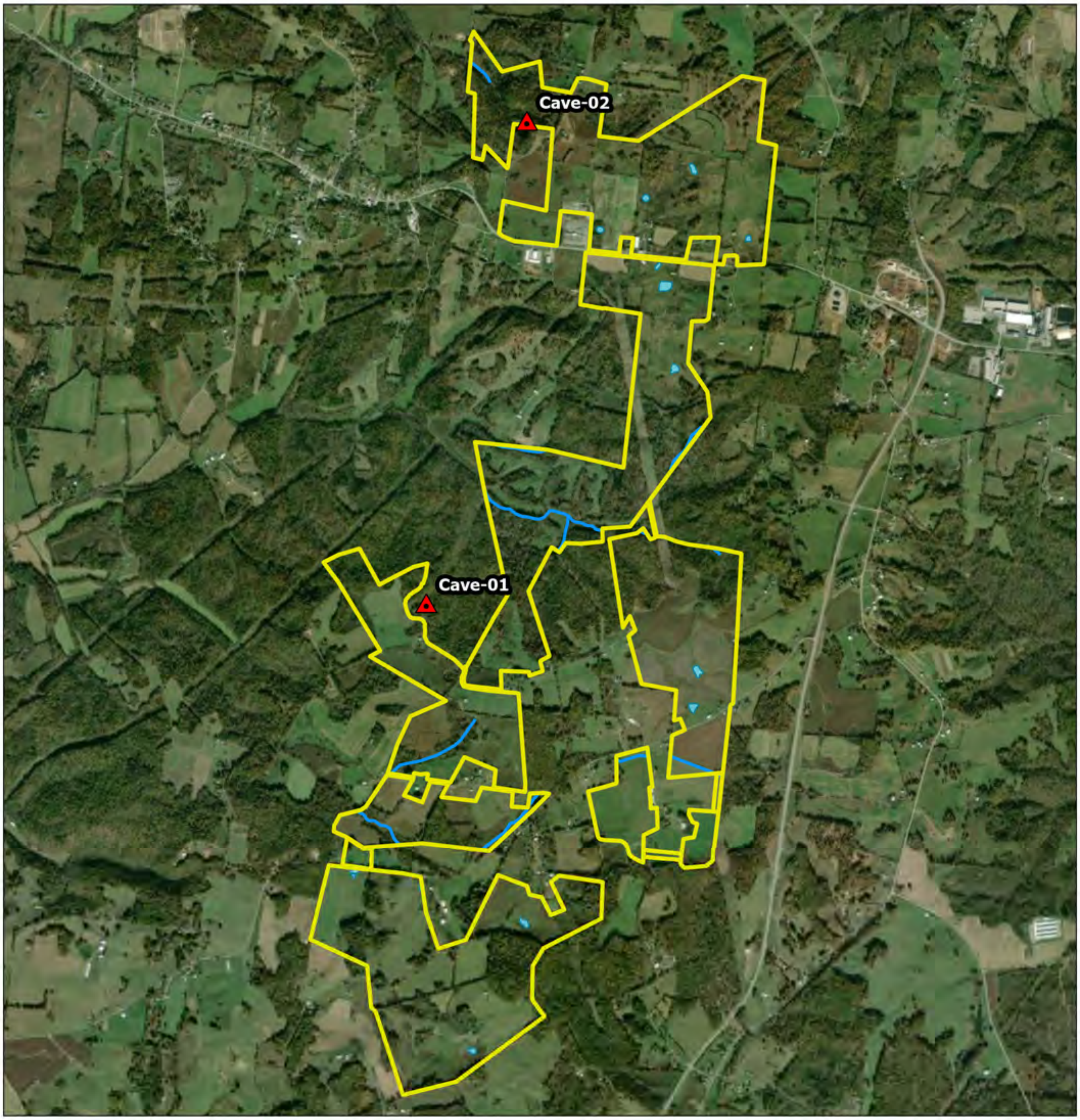

Legend
- ▲ Caves (Bats Captured)
- 🟨 Project Boundary
- — NHD Streams
- 🟦 NHD Waterbodies

(At original document size of 8.5x11)
1 inch = 3,000 feet

Stantec

Project Location
Metcalfe and Monroe Counties,
Kentucky

Prepared by MNA on 2024-10-23
TR by KC on 2024-10-25
IR by SPK on 2024-10-25

172658275

Client/Project
Summer Shade Solar, LLC
Summer Shade Solar Project
Harp Trap Survey Report

Figure No.
3

Title
Bat Harp Trap Survey Map

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: NHD, Stantec, Summer Shade Solar LLC
3. Background: Aerial Imagery Basemap

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Appendix B USFWS Study Plan Form for Bat Surveys and Monitoring

U.S. Fish and Wildlife Service

Study Plan Form for Bat Surveys and Monitoring (v. 2.2)[1]

PROJECT & SURVEY INFORMATION

Project Name: Summer Shade Solar

Proposed Survey Start Date: 6/12/2024

Project Proponent's Name (e.g., client/company/institution): Summer Shade Solar LLC

Project Location: State(s): Kentucky

County(s): Metcalfe & Monroe

Latitude: 36.859904

Longitude: -85.692516

REQUIRED: Attach or provide links to Google Earth® KMZ files (preferred) and/or shapefiles (mapping must show project boundaries, impacted forest habitat (if known) and all proposed survey sites)

Files are attached: Yes ☑ No ☑

File Links:

Project Summary. In the space provided below, please provide a description of the proposed action, including any activities that will permanently or temporarily alter the current environment and existing habitat features.

The Project consists of a proposed photovoltaic (PV) electrical generating facility comprised of approximately 1,468 acres. The facility is proposed to be sited east and south of the town of Summer Shade, Kentucky. Proposed Project activities include the panel array installation, ancillary equipment, transmission interconnection, and equipment staging.

Due to the presence of approximately 448 acres of forested potential summer habitat for the Indiana bat (Myotis sodalis), northern long-eared bat (M. septentrionalis), and tricolored bat (Perimyotis subflavus) within the Project, Stantec was retained by Summer Shade in order to complete a mist net survey for these three bat species. It is expected that between 123 acres and 246 acres of potential bat habitat tree clearing will occur for the Project.

CONTACT INFORMATION

Project Manager/Primary Point of Contact (POC): Shane Kelley

Phone: (502) 269-8994

Field Survey Crew Leader (if different from POC): James Kiser

Cell Phone: 502-396-3199

Institution/Company Name: Stantec Consulting

Mailing Address: 9200 Shelbyville Road Suite 800, Louisville, KY 40222

POC Email Address: Shane.Kelley@stantec.com, James.Kiser@stantec.com

USFWS Sec. 10(a)(1)(A) Permit No.(s) (if applicable): ES38821A-5

State Permit No.(s) (if applicable): SC2411181

---

[1] Unless otherwise directed by the Service, surveyors may complete this fillable form, in lieu of a traditional narrative format, and submit it (and supporting files) to the Ecological Services Field Office in the state(s) where the work is to be completed (https://www.fws.gov/our-facilities). Use of this form is not a requirement at this time. Our goal is to improve pre-survey coordination and to expedite the Field Office review and approval process. Please submit your study plan at least 15 working days in advance of your proposed survey start date. Suggestions for improving this document may be sent to R4_Bat_Survey_Guidance@fws.gov.

Have project proponents been informed that abiding by protective time-of-year restrictions (where available) may be sufficient to avoid take of federally listed bats and (in some cases) may negate the need for a bat survey? Yes☑ No☐

Have project proponents been informed that the Service does not require presence/probable absence surveys for federally listed species and that presence can be assumed in a project area containing suitable habitat? Yes☑ No☐

Will this survey be conducted on private or public lands? *(Check both if applicable)*: Private☑ Public☐

Has permission of all necessary landowners/managing agencies been obtained? Yes☑ No☐

If no, explain: ____________________

Does this project have a federal nexus[2]? Yes☑ No☐ Unsure☐

If yes, explain: An IP or nationwide permit may be needed (USACE)

IPaC[3] Consultation Code (if applicable): ____________________

Purpose of Survey: Official P/A Survey ☑ Research ☐ Monitoring ☐
Educational Outreach/Training Other: ____________________

Survey Target Species: Indiana bat (IBAT) ☑ Northern long-eared bat (NLEB) ☑
Tricolored bat (TCB) ☑ Other: ____________________

Has a Phase-1 Habitat Assessment* of the project area been conducted? Yes☑ No☐
If yes, how was the habitat assessment conducted? Field☐ Desktop☐ Combo☑
*(*if available, attach a written report)*

Is suitable habitat[4] present (or assumed present) for all "target" species? Yes☑ No☐

If no, explain: ____________________

Does this project fall within the outer-tier[5] of any "target" species known home range? Yes☐ No☐ Unsure☐

If yes, which species: ____________________

Project Configuration

Is this project **linear** (>1 km in total length)? Yes☐ No☑ Combo☐ Unsure☐

If yes, how many 1-km sections containing suitable IBAT/NLEB habitat will be impacted? ________

Is this project **non-linear**? Yes☐ No☑ Combo☐ Unsure☐

If yes, how many acres of suitable IBAT/NLEB habitat is in the overall project area? 360

If yes, how many acres of suitable IBAT/NLEB habitat will be directly impacted/cleared? 123 to 246

PROPOSED METHODS & SURVEY LEVEL OF EFFORT[6]

ACOUSTICS

Total number of detector sites proposed to be surveyed: _______ Number of detector nights/site: _________

---

[2] A project or action that is carried out, authorized, funded, and/or permitted by a federal agency.
[3] https://ipac.ecosphere.fws.gov/
[4] See Appendix A of the Guidelines regarding suitable habitat definitions.
[5] See Appendix G of the Guidelines if you are unclear what the out-tier of a known range includes.
[6] Survey level of effort (acoustic or netting) must be spread over at least two calendar nights/survey site.

Total number of detector nights for entire survey: __________

Total proposed number of calendar nights to complete the entire survey: __________________

Detector(s) (Brand, Model): ____________________ Microphone(s): directional ☐ omnidirectional ☐

Recording Format: Full Spectrum ☐ Zero-Crossing ☐

FWS-Approved[7] Acoustic Bat ID Software: KPro vers.____ KPro Classifier, NA vers. ____ BCID vers.____
Other Candidate Programs (e.g., Sonobat) vers.: _______________

Species to be included for automatic software ID classification analysis:

EPFU☐ CORA☐ COTO☐ LABO☐ LACI☐ LANO☐ LASE☐ TABR☐ MYCI☐ MYEV☐ MYGR☐ MYLU☑
MYLE☐ MYSE☐ MYSO☐ MYTH☐ MYVO☐ NYHU☐ PESU☑ Others:__________________________

Will qualitative analysis (i.e., manual vetting) be used? Yes☐ No☐ Unsure☐

Name(s) of qualified biologist(s) conducting qualitative/manual identifications (attach resume or link with qualifications):

____

MIST-NETTING

Total number of net sites to be surveyed: 6-7 Total number of net nights/site: 3-4

Total number of net nights for entire survey (No. of sites X No. of net nights/site): 20

Total proposed number of calendar nights to complete the entire survey: 7

A) Maximum number of net set-ups that will be operated/checked (10-min interval) on a given calendar night at a given survey site: 4
B) Minimum Number of personnel present to operate/check X (see A) net set-ups on a given site: 2
C) Proposed Staffing Rate (A divided by B): 2:1

Staffing Rate

Number of Section 10-permitted biologists per net site (or state-permitted in USFWS R5): 1

Do you propose to band bats? Yes☑ No☐

If yes, please answer the following:

What species will be banded? COTO☑ MYGR☑ MYLU☑ MYSE☐ MYSO☑ PESU☑
Others:____________________ All captured bats:
If banding *Myotis* sp. or PESU, specify band size: 2.9 for MYSO, MYSE, MYLU, 2.4 for PESU
Describe your proposed bands (color and letter-numbers) and banding scheme: KDFWR-provided metal lipped bands
Will banding pliers be used? Yes☑ No☐

Will any biological samples be collected from captured bats (e.g., guano, hair, swab, wing punch)? Yes☐ No☑

If yes, explain: guano, for a hormone study.

Name of institution or facility to conduct DNA analysis: NA

RADIO-TRACKING

Will any bats be radio-tagged and tracked? Yes☐ No☑

---

[7] https://www.fws.gov/media/automated-acoustic-bat-id-software-programs

If yes, please answer following:

Which species will be radio-tagged? MYSO, MYSE, PESU
Name of USFWS Section 10 permitted biologist(s) who will apply transmitter(s): James Kiser
Make/model and approximate weight of transmitter(s) to be used: Holohill LB-2
Manufacturer date and estimated life-span of transmitters to be used: 7-10 days
Frequency range (MHz) of transmitters (e.g., 150.xxx or 172.xxx): 150.xxx
If radio-tracking multiple targeted bats/species, what criteria will be used in selecting which bats will be tracked? MYSO and MYSE will be targeted first, but we will track all transmittered bats concurrently
Will all radio-tagged bats be tracked (min. of 4-hrs. search effort/day) to their diurnal roosts for the minimum recommended period of 7 days? Yes☐ No☐
If no, explain: __________
Will night-time foraging data/telemetry be collected? Yes☐ No☐
Glue used for attaching transmitters: Type: Silicone-based Surgical Adhesive Name: Uro-Bond III 5000
Manufacturer: 3M Other: __________

EMERGENCE SURVEYS

After diurnal roost sites of radio-tagged bats are identified, will emergence surveys be conducted at each identified roost (assuming landowner permission is obtained)? Yes☐ No☐

If yes, how many emergence surveys/roost? 2

Have you identified a small number (e.g., ≤10) of potentially suitable roost trees* that you propose to conduct emergence surveys for? Yes☐ No☐

*(*If yes, provide photographs of each tree documenting that all of the tree can be observed by the surveyor along with coordinates (lat/long and/or KML/shapefile) of all trees to be surveyed.)*

POTENTIAL HIBERNACULA SURVEYS

Are you aware of any known hibernacula used by the target species within the project area itself or nearby?

Yes☐ No☑ Unknown☐

If yes or unknown, list sites or explain: __________

Has your desktop analysis identified any natural or man-made features that could be used as a hibernaculum by any of the target bat species? Yes☑ No☐ Unknown☐

If yes, underground features (e.g., caves, mines, tunnels, bunkers, cisterns) present: Yes☑ No☐
If yes, above-ground features* (e.g., crawl spaces) present: Yes☐ No☑
If unknown, explain: __________

Are you requesting approval of a field survey for potential hibernacula at this time? Yes*☑ No☐
*(*If yes, attach a separate narrative explaining how the project area(s) will be surveyed for potential hibernacula.)*

Are you submitting the results of a Phase 1 Habitat Assessment of potentially suitable hibernacula identified from field surveys? Yes*☐ No☑
*(*If yes, provide a Phase 1 Habitat Assessment Data Sheet for each potential hibernaculum/portal(s)*[8] *identified to be surveyed.)*

BRIDGE & CULVERT ASSESSMENTS

Will any bridges or culverts be surveyed for bat presence? Yes☐ No☑

If yes, please answer the following:

---

[8] If multiple cave entrances/portals, please list all locations.

Structure type(s) (check all that apply): Bridge ☐ Culvert ☐ Other ☐

If "other", explain: ______________________________

Survey methodology for structure(s) (check all that apply):

Visual inspection ☐ Guano collection ☐ Emergence survey ☐ Acoustics* ☐

Mist-net* ☐ Harp-trap* ☐ Other ______________________________

*(*Due to site-specific conditions of structures, coordination with the local USFWS Field Office and appropriate state agency(ies) is necessary before proceeding with these survey methodologies)*

Will guano be collected and analyzed to confirm species ID? Yes ☐ No ☐

If "yes", name of institution/entity performing analysis: ______________________________

ADDITIONAL SURVEY INFORMATION[9]

Will the proposed bat survey deviate from the current version of the USFWS Survey Guidelines?[10] Yes ☐ No ☑

If yes, provide justification for <u>any departures or modifications</u> to the guidelines (if applicable) below:

I hereby acknowledge that the information being provided to the Service is accurate and complete as of today's date.

Signature: ______________________________ Date: 6/5/2024

---

[9] Attach additional pages to this form, if needed.

[10] Proposed surveys deviating from the current Range-wide IBAT & NLEB Survey Guidelines will only be accepted with a thoroughly described justification. Coordinate with your local USFWS Field Office (https://www.fws.gov/our-facilities) for acceptable modifications.

*******FOR U.S. FISH AND WILDLIFE SERVICE USE ONLY**********

United States Department of the Interior
Fish and Wildlife Service

Kentucky ES Field Office

330 W. Broadway, Suite 265, Frankfort, KY 40601

Office Phone: (502) 695-0468

SITE-SPECIFIC AUTHORIZATION - BAT WORK

Our Field Office has reviewed your study plan and found it to contain sufficient information for our approval. When signed, this statement serves as your site-specific authorization to conduct the proposed activities at the specified locations included in the attached Study Plan Form and supporting files and must be carried with your federal permit when conducting work for this project. All activities must be carried out with strict adherence to permit conditions and authorizations specified in your federal permit as well as your state permit(s) (if needed). The section 10(a)(1)(A) permit authorizing the activities must remain with the surveyor at all times. This authorization is not valid if you have not obtained permission from the owner of the lands where activities will occur.

For federal permit reporting purposes, please use the appropriate USFWS bat survey data spreadsheet, available on the IBAT and NLEB Summer Survey Guidance website[1]. To mitigate the risk of humans transmitting viruses (e.g., SARS-CoV-2) to bats or viral transmission from bats to humans, the U.S. Fish and Wildlife Service requests anyone directly handling or working in close proximity to bats follow current guidelines prepared by the CDC[2] and IUCN Bat Specialist Group[3] in addition to the following the standard WNS decontamination protocols[4].

If the work expands beyond the scope of your original study plan or if there are adverse effects to bats that were not anticipated, cease all survey and/or research activities, and contact this office prior to continuing. Additionally, if a federally listed bat is captured, this USFWS Field Office must be notified within 48 hours with information regarding species, sex, age, and whether or not the bat has a transmitter attached.

Field Office POC: Mike Armstrong; Karah Jaffe

email: Mike_Armstrong@fws.gov; Karah_Jaffe@fws.gov phone: (502) 229-4632; (859) 797-9523

☐ **Authorized as Proposed**

☑ **Authorized with Conditions** (see below)

You are authorized to proceed provided that the following adjustment(s) and/or conditions are met.

(1) Do not band MYSE if captured. Also band any MYGR captured with appropriate sized KDFWR bands using banding pliers. (2) Ensure net set placements reflect variation of habitats present on site and preferred by MYSO, MYSE, and PESU. (3) Ensure transmitters are thoroughly tested for proper functioning prior to the study (see Appendix D of Survey Guidance). (4) attach

☐ **Not Authorized.**

Comments:

Signature & Date:

NOTE: Please check the appropriate box above before signing/locking the document.

---

[1] https://www.fws.gov/library/collections/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines
[2] https://www.cdc.gov/healthypets/covid-19/wildlife.html
[3] https://www.iucnbsg.org/uploads/6/5/0/9/6509077/amp_recommendations_for_researchers_final.pdf
[4] https://www.whitenosesyndrome.org/mmedia-education/national-wns-decontamination-protocol-u-s

Appendix C Bat Capture Data Sheets

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Bat Capture Data Sheet

Page 1 of 1

Project Name/No.: Summer Shade Solar **Date:** 9/17/24 **Biologist(s):** Kristen Clemens / Lynda Mills

Site Name/No.: Cave # 1 **State/County:** Metcalfe / KY **Lat/Long:** 36.881147 -85.683371

Quadrangle: ______ **Nets Open:** 1800 **Nets Close:** 2350 **Sun Rise/Set:** 0627 / 1846 **Moon Rise/Set:** 1844 / 0542 **Moon Phase:** Full 100%

Site Information: Small cave entrance w/ water flowing out - harp trap

Time	Temp	Wind	Wind Direction	% Cloud Cover	Beaufort Wind Scale		Net	Length	Height	Road	Stream	Pond	Cave/ Portal	Other
					Scale	Wind speed Indicators								
1800	73.3	3		80%	0	Calm (0 mph)	harp	- large trap					X	
2000	66.8	0		50%	1	Light Wind (1-3 mph)								
2230	56.5	0		20	2	Light Breeze (4-7 mph)								
2330	66	0		10	3	Gentle Breeze (8-12 mph)								
					4	Moderate Breeze (13-18 mph)								
						Acoustic Detector ID:								

No.	Species	Time	Net/Ht.	Age	Sex	Repro.*	RFA (mm)	Mass (g)	WNS Score	Notes: Band#, Guano/Hair
	NO BATS									

***Reproduction: P – pregnant; L – lactating; PL – Post Lactating; DESC. - testes descended ; NON - testes not descended for male and not Preg, Lac, or PLac for female**

9

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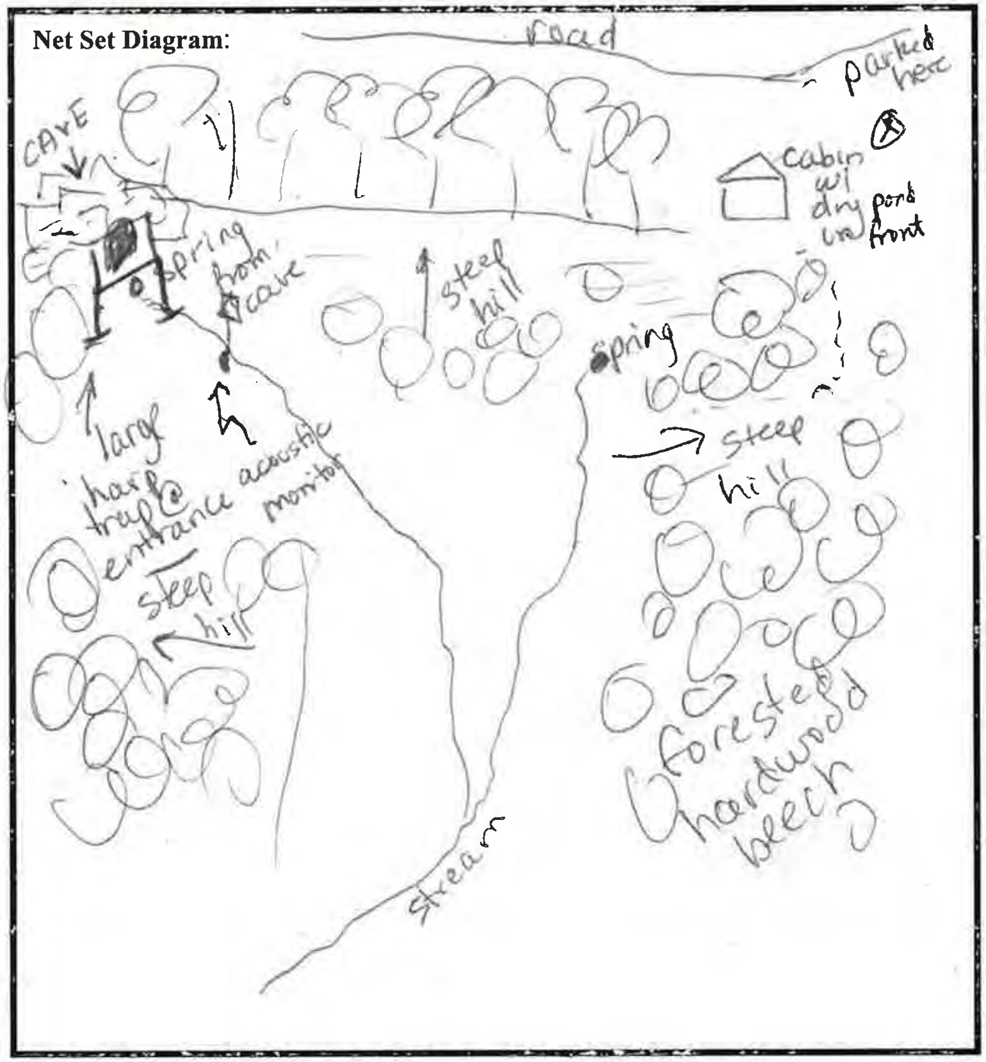
Net Site Habitat Description

Page 1 of 1

Net Set Diagram:



Project: Summer Shade Solar

Date: 9/17/24 **Site Name:** Cave 1

Other Wildlife Observations slimy Salamander

STREAM CHARACTERISTICS 5-8' NA ☐

Bank Height: 1 ft **Channel Width:** ~~4-5 ft~~

Stream Width: ~~6-8 ft~~ 4-5' **Riparian Width: (rt bank)** 10' **(lt bank)** ______

Avg. Water Depth: < 6" **% Canopy Cover** 100%

% Substrate type: Bedrock 80, **Boulder** 10, **Cobble** 5, **Gravel** 5,

Sand _____, **Fines** _____.

VEGETATION

Estimated Distance to Water Source: 0'

Estimated Canopy Closure: [✓ closed] moderate open

Dominant Sized Canopy Species (>16") **Avg. DBH range** 15-20" Beech

1. Beech 2. Hickory 3. ______

Subdominant Sized Canopy Species (<16") **Avg. DBH range** ______

1. Maple 2. Beech 3. ______

Roost Tree Potential consists of: Large Trees Snags [✓ Both]

Roost Tree Potential for Area: High [✓ Moderate] Low

Subcanopy Clutter: closed moderate [✓ open]

Travel Corridor Present: [✓ Yes] No stream

Overall Habitat: Great [✓ Good] Fair Poor No habitat present

Comments: Obsered slimy salamander, cave salamander, ~~green~~ pickerel frog (I think) heard green frog (I think); many aquatic snails, wt deer, gray squirrels great amphibian habitat

rev. 6-2016

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Bat Capture Datasheet

Page 1 of 1

Project Name/No.: Summer Shade Solar **Date:** 9/16/24 **Biologist(s):** [illegible] Lynda Mills / Kristen Clemens

Site ID: Cave #2 **County/State:** Metcalfe / KY **Moon Phase:** Waxing Gibbous 98% **Sunset:** 1848

Map Kilometer No./Quad: **Latitude:** 36.~~88117~~ 962453 **Longitude:** -85.~~688374~~ 698440 **Moonrise:** 1815 **Moonset:** 0426

General Site Description: Sandstone Rockshelter with small opening in back **Nets Open:** [illegible] [illegible] 1830 **Nets Closed:** [illegible] 2350 [illegible]

Time	Temp (F)	Wind¹	% Cloud Cover
20:00	72	0	0%
21:00	68	0	0
22:00	64	0	0
23:00	61	1	0
00:00			
01:00			

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	18	2.5m		36.888227	-85.691861				X	Rockshelter

** One net at full extension ~ 2.5m high*

Weather Comments:

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.²	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
1	Eptesicus fuscus	2145	A	M	TD	47.1	20.0	0	A	1/2	N/A	caught going into shelter; photos

¹ **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

² For **females**: L = lactating, PL = post-lactating, NR = non-reproductive; for **males**: TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

*Note: U (unknown) only to be used for **escaped** bats*

Confidential Data. If found, please return to:
Stantec Consulting Services, 9200 Shelbyville Road Suite 800, Louisville Kentucky 40222 US

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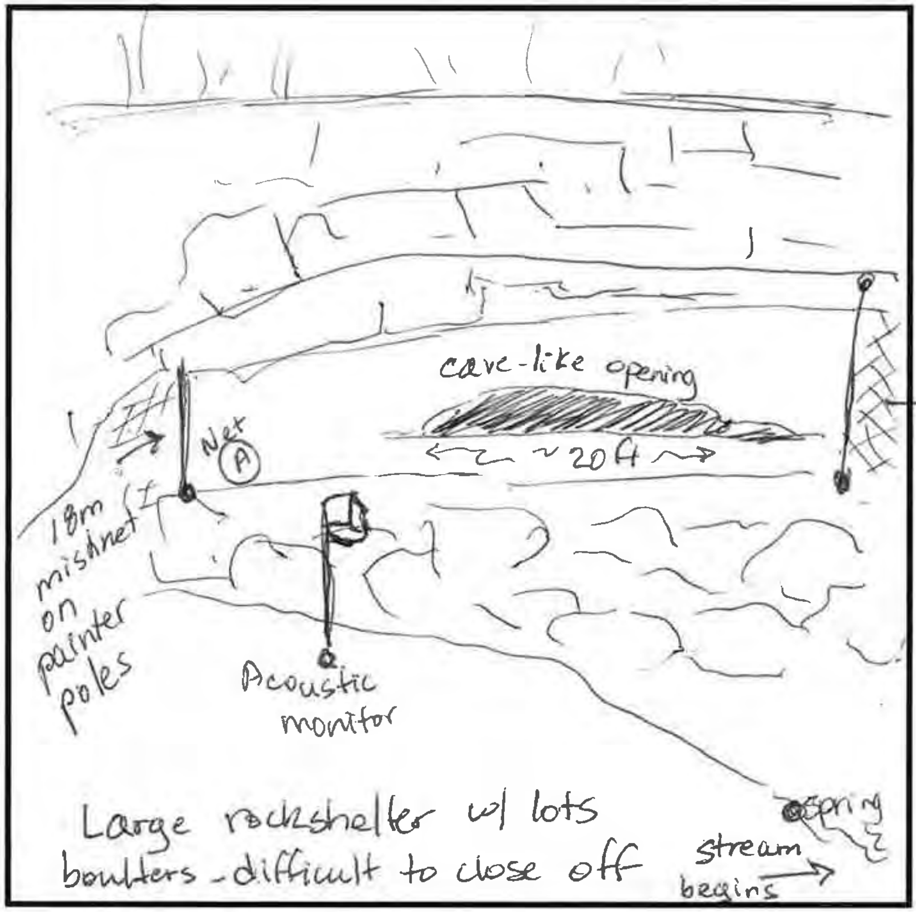
Net Site Description

Page 1 of 1



Large rockshelter w/ lots boulders - difficult to close off

[1] Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Project Name/No.: Summer Shade Solar **Date:** 9/16/24

Site ID: Cave 2 **Est. Distance to Water (ft):** 100 ft

VEGETATION

Primary Habitat Type[1]: Hardwood Forest

Potential Roost: Large Trees | Snags | [✓ Both] | Other (e.g., structure)

Roost Tree Potential: [✓ High] | Moderate | Low

Dominant Canopy Species **Avg. Canopy DBH range (in):** ________

1. Hickory 2. Maple 3. ________

Canopy Closure: [✓ Closed (80% +)] | Moderate (40 – 80%) | Open (0 – 40%)

Dominant Subcanopy Species **Avg. Subcanopy DBH range (in):** ______

1. Pawpaw 2. ________ 3. ________

Sub-Canopy Clutter: High (60% +) | Moderate (30 – 60%) | Low (0 – 30%)

Dominant Shrub/Understory Species

1. Nettle 2. ________ 3. ________

Shrub/ Understory Clutter: High (60% +) | Moderate (30 – 60%) | Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft): ________ **Channel Width:** ________ **Stream Width:** ________

Riparian Width right bank: ______ left bank: ______ **Avg. Water Depth:** _____

Other Wildlife Observed: Pickerel frog, Great Horned Owl, ~~Barre~~ Barred Owls, Coyotes

Additional Comments: Difficult set-up - covered about 80-90% of opening - rockshelter very large and open, used painter poles and 18 m net Native American artifact fragments (bone, stone tools) observed under heavily-looted shelter. Hammock + primitive campsite below.

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Bat Capture Datasheet

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Project Name/No.: SummerShade **Date:** 9/24/24 **Biologist(s):** Doug Stephens, Kristen Clemens

Site ID: Cave 01 **County/State:** Metcalfe/KY **Moon Phase:** Last quarter 53% **Sunset:** 18:38

Map Kilometer No./Quad: **Latitude:** 36.862525 **Longitude:** -85.698292 **Moonrise:** 23:25 **Moonset:** 14:17

General Site Description: Cave opening with stream **Nets Open:** 18:10 **Nets Closed:** 23:40

Time	Temp (F)	Wind[1]	% Cloud Cover
18:30 ~~20:00~~	73.5	0	100
19:30 ~~21:00~~	72.2	1	80
20:30 ~~22:00~~	67.3	0	100
21:30 ~~23:00~~	67.4	0	80
22:30 ~~00:00~~	66.7	0	80
23:30 ~~01:00~~	66.5	0	100

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	Harp trap			36.302525	-85.698292				X	Harp trap (large) at cave entrance

** One net at full extension ~ 2.5m high*

Weather Comments: Rainy/Stormy all day. Humid & damp during setup

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.[2]	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
1	PESU	21:45	A	F	NR	37.75	4.75	0	A		C21640	
2	PESU	23:00	A	M	TD	33.5	5.5	0	A		C21639	

[1] **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

[2] For **females:** L = lactating, PL = post-lactating, NR = non-reproductive; for **males:** TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

*Note: U (unknown) only to be used for **escaped** bats*

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Net Site Description

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See previous site diagram from 9/17

Project Name/No.: Summer Shade **Date:** 9/24/24
Site ID: Cave-02 **Est. Distance to Water (ft):** 0

VEGETATION

Primary Habitat Type¹: creek/riparian (cave)
Potential Roost: Large Trees | Snags | [✓ Both] | Other (e.g., structure)
Roost Tree Potential: High | [✓ Moderate] | Low

Dominant Canopy Species **Avg. Canopy DBH range** (in): 15-25
1. F. grandifolia 2. L. tulipifera 3. A. saccharum
Canopy Closure: Closed (80% +) | Moderate (40 – 80%) | Open (0 – 40%)

Dominant Subcanopy Species **Avg. Subcanopy DBH range** (in): 9-10
1. L. tulipifera 2. F. grandifolia 3. A. saccarum
Sub-Canopy Clutter: High (60% +) | Moderate (30 – 60%) | Low (0 – 30%)

Dominant Shrub/Understory Species
1. F. grandifolia 2. A. saccharum 3. Asiminia triloba
Shrub/ Understory Clutter: High (60% +) | Moderate (30 – 60%) | Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft): 40 **Channel Width:** 12 **Stream Width:** 9
Riparian Width right bank: 100m+ left bank: 100m+ **Avg. Water Depth:** <0.5m

Stream flows from cave before connecting with larger stream ~60 ft away

---

¹ Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Other Wildlife Observed: VO - BAOW, SCOW
Salamanders - cave, dusky, slimy

Additional Comments:
*check acoustics - bat v. nearly flew into harp trap from outside at 20:30

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Bat Capture Datasheet

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172658275
Project Name/No.: SUMMER SHADE SOLAR
Date: 24 SEPTEMBER 2024
Biologist(s): L. MILLS M. ANGEL
Site ID: CAVE - 02
County/State: METCALFE / KY
Moon Phase: LAST QUARTER
Sunset: 18:37
Map Kilometer No./Quad:
Latitude: 36.862453
Longitude: -85.698440
Moonrise: 23:19
Moonset: 14:13
General Site Description: LARGE ROCKSHELTER ATOP HILLSIDE W/ STREAM BELOW
Nets Open: 18:37
Nets Closed: 23:37

Time	Temp (F)	Wind¹	% Cloud Cover
18:30 ~~20~~:00	78	0	95
19:30 ~~21~~:00	73	0	90
20:30 ~~22~~:00	71	1	80
21:30 ~~23~~:00	69	0	95
22:30 ~~00~~:00	68	0	80
23:30 ~~01~~:00	67	1	90

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	18	2.5	45	36.888227	-85.691861				X	ROCKSHELTER ENTRANCE

* One net at full extension ~ 2.5m high

Weather Comments: HUMID, MILD TEMPS BUT FEELS WARM & MUGGY

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.²	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
1	Eptesicus fuscus	1929	A	M	NR	45.8	22.5	0	A	0.5	N/A	Bat+bag: 29.5g - 7 5g: 22.5g

[1] **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

[2] For **females**: L = lactating, PL = post-lactating, NR = non-reproductive; for **males**: TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

Note: U (unknown) only to be used for ***escaped*** *bats*

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Net Site Description

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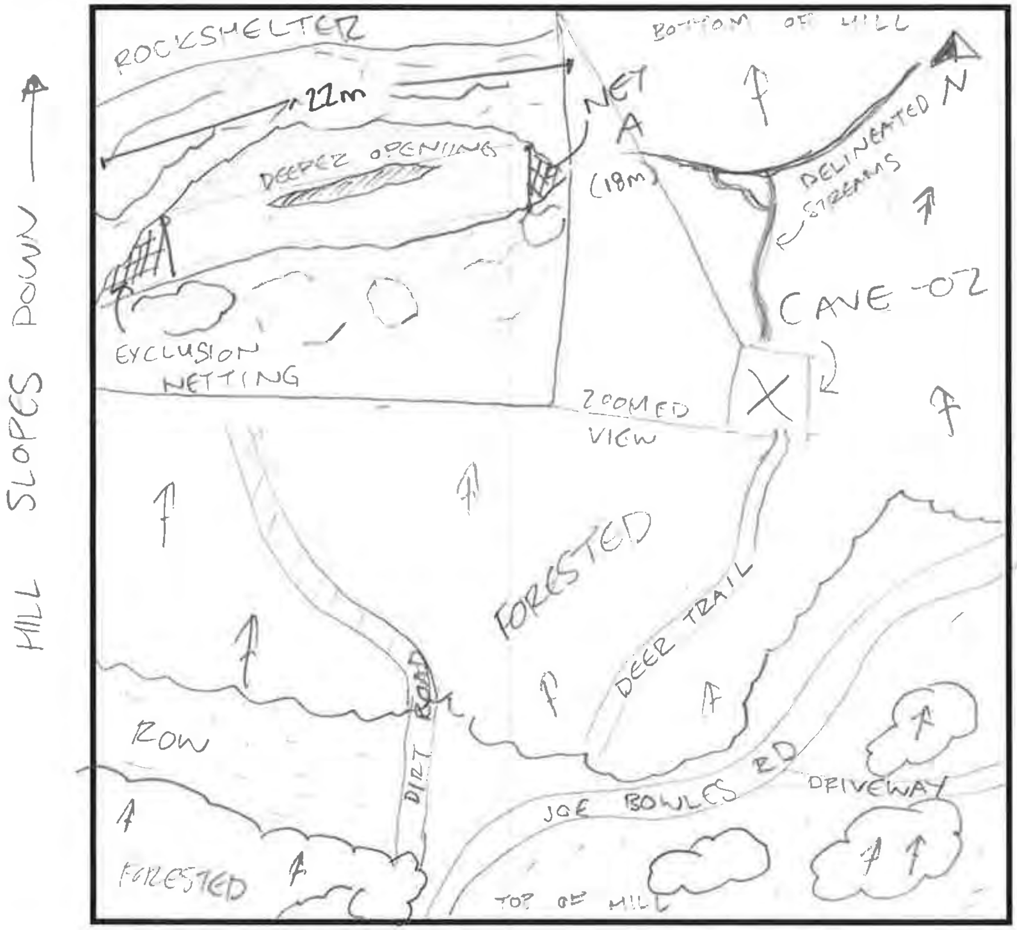

[1] Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Project Name/No.: 172658275 SUMMER SHADE SOLAR

Date: 24 SEPT 2024

Site ID: CAVE-02

Est. Distance to Water (ft): 160 FT

VEGETATION

Primary Habitat Type[1]: BOTTOMLAND FOREST

Potential Roost: Large Trees | Snags | [✓ Both] | Other (e.g., structure)

Roost Tree Potential: [✓ High] | Moderate | Low

Dominant Canopy Species **Avg. Canopy DBH range** (in): 10 - 20"

1. ACER SACCHARUM 2. JUGLANS NIGRA 3. CARYA OVATA

Canopy Closure: Closed (80% +) | [✓ Moderate (40 – 80%)] | Open (0 – 40%)

Dominant Subcanopy Species **Avg. Subcanopy DBH range** (in): 3-8"

1. ASIMINA TRILOBA 2. ACER SACCHARUM 3. CELTIS OCCIDENTALIS

Sub-Canopy Clutter: High (60% +) | [✓ Moderate (30 – 60%)] | Low (0 – 30%)

Dominant Shrub/Understory Species

1. ASIMINA TRILOBA 2. LINDERA BENZOIN 3.

↗ 90% PAWPAW

Shrub/ Understory Clutter: High (60% +) | [✓ Moderate (30 – 60%)] | Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft): 0.5' **Channel Width:** 6' **Stream Width:** DRY

Riparian Width right bank: 3' left bank: 3' **Avg. Water Depth:** 0

FLOWING STREAM FAR BELOW NET SITE ON HILL BOTTOM

Other Wildlife Observed: CHIPMUNKS, COYOTES

Additional Comments:

Lg. Harp Trap

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Bat Capture Datasheet

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Project Name/No.: 172658275 Summer Shade

Date: 10/1/2024

Biologist(s): Doug Stephens / Chris Knabel

Site ID: Cave 1

County/State: Metcalfe, KY

Moon Phase: New Moon (0.6%)

Sunset: 18:25

Map Kilometer No./Quad:

Latitude: 36.862525

Longitude: -85.698292

Moonrise: 05:30

Moonset: 18:01

General Site Description:

Nets Open: 18:00

Nets Closed: 23:30

	Time	Temp (F)	Wind[1]	% Cloud Cover
1800	20:00	70.7	2	80
1900	21:00	67.0	1	80
2000	22:00	65.3	2	50
21:00	23:00	64.3	1	40
22:00	00:00	64.8	2	100
23:00	01:00	65.0	1	50

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A										

** One net at full extension ~ 2.5m high*

Weather Comments: Cloudy (mostly)

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.[2]	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
	No Bats											

[1] **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

[2] For **females**: L = lactating, PL = post-lactating, NR = non-reproductive; for **males**: TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

*Note: U (unknown) only to be used for **escaped** bats*

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Net Site Description

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SEE NIGHT OF

24 SEPTEMBER 2024

Project Name/No.: SUMMER SHADE **Date:** 1 OCTOBER 2024

Site ID: CAVE-01 **Est. Distance to Water (ft):**______

VEGETATION

Primary Habitat Type[1]: ____________________

Potential Roost:	Large Trees	Snags	Both	Other (e.g., structure)
Roost Tree Potential:	High	Moderate	Low	

Dominant Canopy Species **Avg. Canopy DBH range** (in): ________

1.________ 2.________ 3.________

Canopy Closure:	Closed (80% +)	Moderate (40 – 80%)	Open (0 – 40%)

Dominant Subcanopy Species **Avg. Subcanopy DBH range** (in): ______

1.________ 2.________ 3.________

Sub-Canopy Clutter:	High (60% +)	Moderate (30 – 60%)	Low (0 – 30%)

Dominant Shrub/Understory Species

1.________ 2.________ 3.________

Shrub/ Understory Clutter:	High (60% +)	Moderate (30 – 60%)	Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft):________ **Channel Width:**______ **Stream Width:**________

Riparian Width right bank:______ left bank:_______ **Avg. Water Depth:**_____

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[1] Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Other Wildlife Observed: ____________________

Additional Comments: ____________________

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Bat Capture Datasheet

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Project Name/No.: 172658275 SUMMER SHADE SOLAR

Date: 1 OCTOBER 2024

Biologist(s): L. MILLS, M. ANGEL

Site ID: CAVE-02

County/State: METCALFE / KY

Moon Phase: NEW MOON

Sunset: 18:26

Map Kilometer No./Quad:

Latitude: 36.862453

Longitude: -85.698440

Moonrise: 05:30

Moonset: 18:01

General Site Description: LARGE ROCKSHELTER ATOP HILLSIDE W/ STREAM BELOW

Nets Open: 18:26

Nets Closed: 23:26

Time	Temp (F)	Wind[1]	% Cloud Cover
18:30 ~~20:00~~	71.2	1	50
19:30 ~~21:00~~	68.8	0	45
20:30 ~~22:00~~	67.8	1	10
21:30 ~~23:00~~	68.2	2	0
22:30 ~~00:00~~	68.0	1	0
23:30 ~~01:00~~	68.0	1	10

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	18	2.5	45	36.888227	-85.691861				X	ROCKSHELTER ENTRANCE

* One net at full extension ~ 2.5m high

Weather Comments: MILD, MODERATE HUMIDITY; CAVE WET FROM HURRICANE HELENE RAINFALL

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.[2]	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
	NO BATS											
	(EPFU SEEN ROOSTING											
	AT FAR END OF											
	CAVE ENTRANCE @											
	20:58 & 22:57)											

[1] **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

[2] For **females:** L = lactating, PL = post-lactating, NR = non-reproductive; for **males:** TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

Note: U (unknown) only to be used for ***escaped*** *bats*

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Net Site Description

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SEE NIGHT OF

24 SEPTEMBER 2024

Project Name/No.: 172658275 SUMMER SHADE **Date:** 1 OCT 2024

Site ID: CAVE-02 **Est. Distance to Water (ft):** 160 FT

VEGETATION

Primary Habitat Type[1]: ____

Potential Roost:	Large Trees	Snags	Both	Other (e.g., structure)
Roost Tree Potential:	High	Moderate	Low	

Dominant Canopy Species **Avg. Canopy DBH range** (in): ____

1.____ 2.____ 3.____

Canopy Closure:	Closed (80% +)	Moderate (40 – 80%)	Open (0 – 40%)

Dominant Subcanopy Species **Avg. Subcanopy DBH range** (in): ____

1.____ 2.____ 3.____

Sub-Canopy Clutter:	High (60% +)	Moderate (30 – 60%)	Low (0 – 30%)

Dominant Shrub/Understory Species

1.____ 2.____ 3.____

Shrub/ Understory Clutter:	High (60% +)	Moderate (30 – 60%)	Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft):____ **Channel Width:**____ **Stream Width:**____

Riparian Width right bank:____ left bank:____ **Avg. Water Depth:**____

[1] Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Other Wildlife Observed: RED SPOTTED NEWT

Additional Comments: ____

X-Large Harp Trap

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Bat Capture Datasheet

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Project Name/No.: Summer Shade Solar **Date:** 10/7/2024 **Biologist(s):** Doug Stephens / Matt Denzler

Site ID: Cave 01 **County/State:** Metcalfe / KY **Moon Phase:** Waxing Crescent (22.7%) **Sunset:** 18:17 CT

Map Kilometer No./Quad: ____ **Latitude:** 36.86253 **Longitude:** -85.69850 **Moonrise:** 11:29 **Moonset:** 20:51

General Site Description: ____ **Nets Open:** 18:15 **Nets Closed:** 23:20

Time	Temp (F)	Wind¹	% Cloud Cover
18:00	65.7	1	40
19:00	58.7	0	20
20:00	56.1	0	0
21:00	55.3	0	0
22:00	53.0	1	0
23:00	52.4	1	0

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes

** One net at full extension ~ 2.5m high*

Weather Comments: Mostly sunny. High ~73°F. Expected low in 40's tonight.

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.²	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
	No Bats											

---

[1] **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

[2] For **females**: L = lactating, PL = post-lactating, NR = non-reproductive; for **males**: TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

*Note: U (unknown) only to be used for **escaped** bats*

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Bat Capture Datasheet

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Project Name/No.: SUMMER SHADE SOLAR **Date:** 7 OCTOBER 2024 **Biologist(s):** L. MILLS, M ANGEL

Site ID: CAVE-02 **County/State:** METCALFE / KY **Moon Phase:** WAXING CRESCENT **Sunset:** 18:16

Map Kilometer No./Quad: **Latitude:** 36.888227 **Longitude:** -85.691861 **Moonrise:** 23:30 **Moonset:** 20:50

General Site Description: UPLAND FORESTED SLOPE **Nets Open:** 18:16 **Nets Closed:** 23:16

Time	Temp (F)	Wind¹	% Cloud Cover
18.00	64.2	0	0
19.00	60.0	0	0
20.00	59.1	0	0
21:00	57.8	0	0
22:00	57.1	0	0
23:00	56.0	0	0

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	18	2.5	45	36.888227	-85.69186				X	ROCKSHELTER

* One net at full extension ~ 2.5m high

Weather Comments: COOL, CLEAR SKIES TODAY

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.²	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
1	Eptesicus fuscus	2115	A	F	NR	47.7	26.5	0	A	1.0	—	

[1] **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

[2] For **females**: L = lactating, PL = post-lactating, NR = non-reproductive; for **males**: TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

*Note: U (unknown) only to be used for **escaped** bats*

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Net Site Description

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SEE

NIGHT OF 24 SEPT 2024

Project Name/No.: SUMMER SHADE **Date:** 7 OCTOBER 2024

Site ID: CAVE-02 **Est. Distance to Water (ft):**______

VEGETATION

Primary Habitat Type[1]: ______________________

Potential Roost:	Large Trees	Snags	Both	Other (e.g., structure)
Roost Tree Potential:	High	Moderate	Low	

Dominant Canopy Species **Avg. Canopy DBH range (in):** ________

1.____________ 2.____________ 3.____________

Canopy Closure:	Closed (80% +)	Moderate (40 – 80%)	Open (0 – 40%)

Dominant Subcanopy Species **Avg. Subcanopy DBH range (in):** ______

1.____________ 2.____________ 3.____________

Sub-Canopy Clutter:	High (60% +)	Moderate (30 – 60%)	Low (0 – 30%)

Dominant Shrub/Understory Species

1.____________ 2.____________ 3.____________

Shrub/ Understory Clutter:	High (60% +)	Moderate (30 – 60%)	Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft):________ **Channel Width:**_______ **Stream Width:**________

Riparian Width right bank:______ left bank:_______ **Avg. Water Depth:**_____

[1] Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Other Wildlife Observed: BOBCAT, WEASEL, BARRED OWL, COYOTE, MOUSE, CAVE SALAMANDER

Additional Comments: ______________________

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Bat Capture Datasheet

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Project Name/No.: Summer Shade | 172658275 **Date:** 10 | 13 | 24 **Biologist(s):** Shane Kelley, Matt Denzler

Site ID: C-01 **County/State:** Metcalfe | KY **Moon Phase:** Waxing gibbous (82.8%) **Sunset:** 1808

Map Kilometer No./Quad: N/A **Latitude:** 36.862355 **Longitude:** -85.695050 **Moonrise:** 1611 **Moonset:** 0315

General Site Description: Riparian & upland deciduous forest w/ a stream & cave **Nets Open:** 1800 **Nets Closed:** 2308

Time	Temp (F)	Wind¹	% Cloud Cover
20:00	72.0	0	0
21:00	67.5	0	0
22:00	66.7	0	0
23:00	65.8	0	0
00:00	63.5	0	0
01:00	62.8	2	0

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	—	—	—						X	Medium Harp trap

** One net at full extension ~ 2.5m high*

Weather Comments: Warm, Clear skies, Low 80°s to high 60s at night

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.²	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)
	No Bats											

¹ **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

² For **females:** L = lactating, PL = post-lactating, NR = non-reproductive; for **males**: TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

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Net Site Description

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Project Name/No.: Summer Shade
Date: 10/13/24
Site ID: C-01
Est. Distance to Water (ft): 0

See previous data sheet

VEGETATION

Primary Habitat Type[1]:

Potential Roost: Large Trees | Snags | Both | Other (e.g., structure)

Roost Tree Potential: High | Moderate | Low

Dominant Canopy Species
Avg. Canopy DBH range (in):
1.
2.
3.

Canopy Closure: Closed (80% +) | Moderate (40 – 80%) | Open (0 – 40%)

Dominant Subcanopy Species
Avg. Subcanopy DBH range (in):
1.
2.
3.

Sub-Canopy Clutter: High (60% +) | Moderate (30 – 60%) | Low (0 – 30%)

Dominant Shrub/Understory Species
1.
2.
3.

Shrub/ Understory Clutter: High (60% +) | Moderate (30 – 60%) | Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft):
Channel Width:
Stream Width:
Riparian Width right bank:
left bank:
Avg. Water Depth:

---

[1] Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Other Wildlife Observed: BADO, Coyote, cave salamander, Zig Zag salamander, green salamander?

Additional Comments:

Confidential Data. If found, please return to:
Stantec Consulting Services, 9200 Shelbyville Road Suite 800, Louisville Kentucky 40222 US

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Bat Capture Data Sheet

Page ____ of ____

Project Name/No.: Sunny Shade Solar Date: 10/13/24 Biologist(s): L Mills / T. Grabenstein

Site Name/No.: Cave 2 - Rock shelter State/County: Ky / Metcalfe Lat/Long:

Quadrangle: ____ Nets Open: 1730 Nets Close: 2310 Sun Rise/Set: 1806 Moon Rise/Set: 0315 Moon Phase: Waxing Gibbous 84%

Site Information: same site as previous trap night # 5

Time	Temp	Wind	Wind Direction	% Cloud Cover	Beaufort Wind Scale		Net	Length	Height	Road	Stream	Pond	Cave/ Portal	Other
					Scale	Wind speed Indicators								
900	79	0	0	<10%	0	Calm (0 mph)	18 m							
					1	Light Wind (1-3 mph)								
200	70	3	N?		2	Light Breeze (4-7 mph)								
					3	Gentle Breeze (8-12 mph)								
2200	65	1			4	Moderate Breeze (13-18 mph)								
240		4												
2300	62	4				Acoustic Detector ID:								

No.	Species	Time	Net/Ht.	Age	Sex	Repro.*	RFA (mm)	Mass (g)	WNS Score	Notes: Band#, Guano/Hair

No bats
high winds through
out the night

Reproduction: P – pregnant; L – lactating; PL – Post Lactating; DESC. - testes descended ; NON - testes not descended for male and not Preg, Lac, or PLac for female

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Net Site Habitat Description

Page 1 of 1

Net Set Diagram:

see previous data sheet

Project.: Sunny Shade Solar

Date: 10/13/24 **Site Name:** Cave 2

Other Wildlife Observations ____

STREAM CHARACTERISTICS

NA ☐

Bank Height: ____ **Channel Width:** ____

Stream Width: ____ **Riparian Width: (rt bank)** ____ **(lt bank)** ____

Avg. Water Depth: ____ **% Canopy Cover** ____

% Substrate type: Bedrock ____, **Boulder** ____, **Cobble** ____, **Gravel** ____,

Sand ____, **Fines** ____.

VEGETATION

Estimated Distance to Water Source: ____

Estimated Canopy Closure: closed moderate open

Dominant Sized Canopy Species (>16") **Avg. DBH range** ____

1.____ 2.____ 3.____

Subdominant Sized Canopy Species (<16") **Avg. DBH range** ____

1.____ 2.____ 3.____

Roost Tree Potential consists of: Large Trees Snags Both

Roost Tree Potential for Area: High Moderate Low

Subcanopy Clutter: closed moderate open

Travel Corridor Present: Yes No

Overall Habitat: Great Good Fair Poor No habitat present

Comments: gray squirrel, oppossum, red-backed salamander
coyotes

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Bat Capture Data Sheet

Page 1 of 1

Project Name/No.: Summer Shade Solar 2 **Date:** 10/25/24 **Biologist(s):** Lynda Mills / Matt Denzler

Site Name/No.: Cave 2 - Rock shelter **State/County:** KY / Metcalfe Co. **Lat/Long:**

Quadrangle: **Nets Open:** 1715 **Nets Close:** 2253 **Sun ~~Rise~~/Set:** 1853 **Moon Rise/Set:** 1225/1457 **Moon Phase:** Waning Cresce 34%

Site Information: 18 m net - 1 tier - across large rock shelter opening

Time	Temp	Wind	Wind Direction	% Cloud Cover	Beaufort Wind Scale	
					Scale	Wind speed Indicators
1730	76	0	0	10%	0	Calm (0 mph)
1900	70	0	0		1	Light Wind (1-3 mph)
2130	68	0	0	<10%	2	Light Breeze (4-7 mph)
2200	68	0	0		3	Gentle Breeze (8-12 mph)
2300	68				4	Moderate Breeze (13-18 mph)
						Acoustic Detector ID:

Net	Length	Height	Road	Stream	Pond	Cave/ Portal	Other
18m	18m						

No.	Species	Time	Net/Ht.	Age	Sex	Repro.*	RFA (mm)	Mass (g)	WNS Score	Notes: Band#, Guano/Hair
	observed Eptesicus fuscus									
	fly up to net but not									
	get caught									
	No bats									

*Reproduction: P – pregnant; L – lactating; PL – Post Lactating; DESC. - testes descended ; NON - testes not descended for male and not Preg, Lac, or PLac for female

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Net Site Habitat Description

Page 1 of 1

Net Set Diagram:

see previous data sheets

Campout / hammock of local guy located below rockshelter.

Project.: Summer Shade Solar Cave 2

Date: 10/25/24 Site Name: Cave

Other Wildlife Observations ~~Gnats~~

STREAM CHARACTERISTICS

NA ☐

Bank Height: ______ Channel Width: ______

Stream Width: ______ Riparian Width: (rt bank) ______ (lt bank) ______

Avg. Water Depth: ______ % Canopy Cover ______

% Substrate type: Bedrock ____, Boulder ____, Cobble ____, Gravel ____,

Sand ____, Fines ____.

VEGETATION

Estimated Distance to Water Source: ______

Estimated Canopy Closure: closed moderate open

Dominant Sized Canopy Species (>16") Avg. DBH range ______

1. ______ 2. ______ 3. ______

Subdominant Sized Canopy Species (<16") Avg. DBH range ______

1. ______ 2. ______ 3. ______

Roost Tree Potential consists of: Large Trees Snags Both

Roost Tree Potential for Area: High Moderate Low

Subcanopy Clutter: closed moderate open

Travel Corridor Present: Yes No

Overall Habitat: Great Good Fair Poor No habitat present

Comments: golden crown kinglets, red-bellied woodpecker, Carolina wren chipmunk WINTER WREN - caught in net @ Sunset

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arpTrap (Large)

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Bat Capture Datasheet

Page ___ of ___

Project Name/No.: Summer Shade Solar

Date: 10/29/24

Biologist(s): Doug Stephens / Matt Denzler

Site ID: Cave 01

County/State: Metcalfe / KY

Moon Phase: Waning Crescent

Sunset: 17:48

Map Kilometer No./Quad: ___

Latitude: 3686248

Longitude: -85.69850

Moonrise: 04:20

Moonset: 16:27

General Site Description: ___

Nets Open: 17:30

Nets Closed: 22:45

23:00 → 62.4° - 2 - 0

Time	Temp (F)	Wind[1]	% Cloud Cover
17:30	68.3	1	10
18:00	67.0	1	10
19:00	64.0	1	0
20:00	63.1	1	0
21:00	62.8	2	0
22:00	62.8	2	0

Net ID (A, B,.)	Length (m)	Height*	Net Area	Lat. (decimal degrees)	Long.	Road	Stream	Pond	Other (specify)	Photo ID, Notes
A	Harp Trap									

* *One net at full extension ~ 2.5m high*

Weather Comments: Mostly clear. High ~79° Wind through the evening was high in canopy of trees + not at ground

No.	Species	Time (24h)	Age (A, J, U)	Sex (M, F, U)	Repro.[2]	RFA (mm)	Mass (g)	WNS Score (0-3)	Net ID	Hgt in Net (m)	Band* #	Comments (e.g., samples taken, transmitter #, disposition)

[1] **Beaufort wind scale.** 0 = smoke rises vertically (<1 mph), 1 = wind direction shown by smoke (1-3 mph), 2 = wind felt on face; leaves rustle (4-7 mph), 3 = leaves, twigs in constant motion (8-12 mph), 4 = dust rises; small branches move (13-18 mph), 5 = small trees in leaf begin to sway (19-24 mph)

[2] For **females**: L = lactating, PL = post-lactating, NR = non-reproductive; for **males**: TD = testes descended, NR = non-reproductive

* Apply band to LEFT arm for females and RIGHT arm for males

*Note: U (unknown) only to be used for **escaped** bats*

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Net Site Description

Page ___ of ___

See Previous Habitat Assessment

Project Name/No.: Summer Shade Solar **Date:** 10/29/24

Site ID: Cave 01 **Est. Distance to Water (ft):** 0

VEGETATION

Primary Habitat Type[1]: ____________

Potential Roost:	Large Trees	Snags	Both	Other (e.g., structure)
Roost Tree Potential:	High	Moderate	Low	

Dominant Canopy Species **Avg. Canopy DBH range** (in): ______

1. ______ 2. ______ 3. ______

Canopy Closure:	Closed (80% +)	Moderate (40 – 80%)	Open (0 – 40%)

Dominant Subcanopy Species **Avg. Subcanopy DBH range** (in): ______

1. ______ 2. ______ 3. ______

Sub-Canopy Clutter:	High (60% +)	Moderate (30 – 60%)	Low (0 – 30%)

Dominant Shrub/Understory Species

1. ______ 2. ______ 3. ______

Shrub/ Understory Clutter:	High (60% +)	Moderate (30 – 60%)	Low (0 – 30%)

STREAM CHARACTERISTICS (if relevant)

Bank Height (ft): ______ **Channel Width:** ______ **Stream Width:** ______

Riparian Width right bank: ______ left bank: ______ **Avg. Water Depth:** ______

[1] Bridge, Bottomland Forest, Cave Entrance, Creek/Riparian, Field Edge, Mine Portal, Pond, Structure, Upland Forest, Other (describe)

Other Wildlife Observed: Many Plethodon dorsalis along rock ledges at cave entrance throughout the night. Desmognathus fuscus, white-footed mouse

Additional Comments: ______

Appendix D Photographic Log

Photographic Log

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar Project**
Site Name:	**Summer Shade Solar**	**Site Location:**	**Metcalfe and Monroe County, Kentucky**

Photograph ID: 1

Survey Date:
9/17/2024

Cave Location:
36.862323, -85.698609

Site:
Cave-01

Harp Trap Size:
Large

Comments:
Harp trap deployed at Cave-01 entrance

Photograph ID: 2

Survey Date:
9/17/2024

Cave Location:
36.862323, -85.698609

Site:
Cave-01

Harp Trap Size:
Large

Comments:
Acoustic detector deployed downstream of harp trap and Cave-01 entrance

Photographic Log

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar Project**
Site Name:	**Summer Shade Solar**	**Site Location:**	**Metcalfe and Monroe County, Kentucky**

Photograph ID: 3

Survey Date:
9/24/2024

Cave Location:
36.888227, -85.691861

Site:
Cave-02

Harp Trap Size:
18m Mist Net

Comments:
Mist net deployed across entrance of Cave-02; entrance too large to adequately deploy a harp trap, so a mist net deployment was approved by USFWS and used instead

Photograph ID: 4

Survey Date:
9/24/2024

Cave Location:
36.888227, -85.691861

Site:
Cave-02

Harp Trap Size:
18m Mist Net

Comments:
Acoustic detector deployed downstream of mist net and Cave-02 entrance

Photographic Log

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar Project**
Site Name:	**Summer Shade Solar**	**Site Location:**	**Metcalfe and Monroe County, Kentucky**

Photograph ID: 1	
Survey Date: 9/24/2024	
Species: Perimyotis subflavus	
Capture Location: 36.862323, -85.698609	
Site ID: Cave-01	
Age: Adult	
Sex: Female	
Reproductive Status: Non-Reproductive	
RFA (mm): 37.75	
Weight (g): 4.75	
Photograph ID: 2	
Survey Date: 9/24/2024	
Species: Perimyotis subflavus	
Capture Location: 36.862323, -85.698609	
Site ID: Cave-01	
Age: Adult	
Sex: Female	
Reproductive Status: Non-Reproductive	
RFA (mm): 37.75	
Weight (g): 4.75	

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar Project**
Site Name:	**Summer Shade Solar**	**Site Location:**	**Metcalfe and Monroe County, Kentucky**

Photograph ID: 3	
Survey Date: 9/24/2024	
Species: Perimyotis subflavus	
Capture Location: 36.862323, -85.698609	
Site ID: Cave-01	
Age: Adult	
Sex: Male	
Reproductive Status: Testes-Descended	
RFA (mm): 33.5	
Weight (g): 5.5	

Photograph ID: 4	
Survey Date: 9/24/2024	
Species: Perimyotis subflavus	
Capture Location: 36.862323, -85.698609	
Site ID: Cave-01	
Age: Adult	
Sex: Male	
Reproductive Status: Testes-Descended	
RFA (mm): 33.5	
Weight (g): 5.5	

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar Project**
Site Name:	**Summer Shade Solar**	**Site Location:**	**Metcalfe and Monroe County, Kentucky**

Photograph ID: 5 **Survey Date:** 9/24/2024 **Species:** Perimyotis subflavus **Capture Location:** 36.862323, -85.698609 **Site ID:** Cave-01 **Age:** Adult **Sex:** Male **Reproductive Status:** Testes-Descended **RFA (mm):** 33.5 **Weight (g):** 5.5	
Photograph ID: 6 **Survey Date:** 9/24/2024 **Species:** Eptesicus fuscus **Capture Location:** 36.888227, -85.691861 **Site ID:** Cave-02 **Age:** Adult **Sex:** Male **Reproductive Status:** Non-Reproductive **RFA (mm):** 45.8 **Weight (g):** 22.5	

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar Project**
Site Name:	**Summer Shade Solar**	**Site Location:**	**Metcalfe and Monroe County, Kentucky**

Photograph ID: 7 **Survey Date:** 9/24/2024 **Species:** Eptesicus fuscus **Capture Location:** 36.888227, -85.691861 **Site ID:** Cave-02 **Age:** Adult **Sex:** Male **Reproductive Status:** Non-Reproductive **RFA (mm):** 45.8 **Weight (g):** 22.5	
Photograph ID: 8 **Survey Date:** 9/24/2024 **Species:** Eptesicus fuscus **Capture Location:** 36.888227, -85.691861 **Site ID:** Cave-02 (roosting on ceiling of cave) **Age:** Adult **Sex:** Male **Reproductive Status:** Non-Reproductive **RFA (mm):** 45.8 **Weight (g):** 22.5	

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar Project**
Site Name:	**Summer Shade Solar**	**Site Location:**	**Metcalfe and Monroe County, Kentucky**

Photograph ID: 9

Survey Date:
10/7/2024

Species:
Eptesicus fuscus

Capture Location:
36.888227, -85.691861

Site ID:
Cave-02

Age:
Adult

Sex:
Female

Reproductive Status:
Non-Reproductive

RFA (mm):
49.7

Weight (g):
26.5

Photograph ID: 10

Survey Date:
10/7/2024

Species:
Eptesicus fuscus

Capture Location:
36.888227, -85.691861

Site ID:
Cave-02

Age:
Adult

Sex:
Female

Reproductive Status:
Non-Reproductive

RFA (mm):
49.7

Weight (g):
26.5

Client:	**Summer Shade Solar LLC**	**Project:**	**Summer Shade Solar Project**
Site Name:	**Summer Shade Solar**	**Site Location:**	**Metcalfe and Monroe County, Kentucky**

Photograph ID: 11	
Survey Date: 10/7/2024	
Species: Eptesicus fuscus	
Capture Location: 36.888227, -85.691861	
Site ID: Cave-02 (roosting on ceiling of cave)	
Age: Adult	
Sex: Female	
Reproductive Status: Non-Reproductive	
RFA (mm): 49.7	
Weight (g): 26.5	

Stantec is a global leader in sustainable architecture, engineering, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.

SITING BOARD 1-82:

Provide any communication with the Kentucky Transportation Cabinet District Engineer, or their representative, regarding permits or agreements necessary for the project. If no communication has been initiated, explain when that contact will occur.

Response: Coordination with the Kentucky Transportation Cabinet District Engineer or their representative will take place prior to construction. Summer Shade has already initiated conversation with a KYTC District 3 permit engineer regarding permits or agreements necessary for the Project.

Witness: Mark Carney

SITING BOARD 1-83:

Provide information on the specifications, model number, and cutsheets of the photovoltaic (PV) cell/solar panels to be used.

Response: Module supplier has not yet been selected; we will use appropriate module technology consistent with final design when the Project is closer to construction and ready to make this selection.

Witness: Alfonso Tovar

SITING BOARD 1-84:

Confirm whether the project will have a battery storage system. If a battery storage system is going to be utilized, provide the following:

a. Safety data sheets for the energy storage system.

b. The environmental impact of the battery storage system.

c. Expected life of the batteries.

d. Method to dispose of batteries at the end of the useful life.

e. Whether the battery storage system installation will comply with National Fire Protection Association Standard 855

Response:

a. Yes, we anticipate having a battery storage system. Final consideration for the Project's inclusion of and/or coupling of the BESS is subject to final PJM system impact and facilities study results. The BESS supplier has not yet been selected; we will use the best available technology available when the Project is closer to construction and ready to make this selection. Safety sheets will be available at that time, but any BESS system will comply with the latest safety standards.

b. The normal operation of the BESS is not expected to have negative environmental impacts.

c. The expected life of the batteries will be dependent on the selection as described in response 84(a).

d. The owner and manufacturer are expected to remove the batteries at the end of their useful life and ship them to a recycling facility.

e. Yes, the BESS will comply with the National Fire Protection Association Standard 855.

Witness: Alfonso Tovar / Aubree Muse

SITING BOARD 1-85:

Describe the hazard detection systems, such as smoke and heat detectors, as well as gas meters, that will be used within the BESS facility.

Response: The BESS containers are equipped with an automatic fire alarm, combustible gas detection and alarm system and an exhaust system. The BESS container is equipped with combustible gas detectors, smoke detectors, and temperature detectors. If any abnormality is detected, the battery management system (BMS) transmits an alarm to the energy management system (EMS) and, as necessary, activates the corresponding controls and even remote shutdown of the BESS.

Witness: Alfonso Tovar

SITING BOARD 1-86:

Describe alert systems that will be in place at the BESS facility and who will monitor and maintain those systems. Explain whether the systems provide remote alert and annunciation to offsite personnel and the fire department.

Response: Each BESS container includes sensors for every cell. The operating parameters of the cells are continuously monitored by an on board electronic system, the Battery Management System (BMS). The BMS monitors individual battery cells, tracking voltage, current, temperature, and estimating state of charge and health. The BMS not only monitors the status of the battery, but it also prevents overcharging, over-discharging, overheating, and short-circuiting based on the status of the cells, equalizes the voltage and state of charge (SOC) across all cells, and controls temperature to prevent overheating and potential thermal runaway.

The BMS communicates with the overall Energy Management System (EMS) and the Supervisory Control and Data Acquisition (SCADA) of the Project.

The overall systems are monitored locally at the Operations and Maintenance building and remotely 24/7. All systems are routinely supervised to ensure they are operating as expected. These systems provide remote alarms and alerts out of standard parameters. The remote monitoring system and/or plant operators will notify the fire department in case of a fire event.

Witness: Alfonso Tovar

SITING BOARD 1-87:

Describe how the BESS facility will be designed to prevent thermal runaway. Include ventilation and air conditioning (HVAC) systems that will be used.

Response: Thermal runaway is a situation that occurs due to faulty manufacturing and/or overheating during operation. The BESS containers to be installed at this Project will be procured from a manufacturer meeting all the industry standard safety and quality requirements. The BESS will utilize a cooling system to maintain the battery cells within its nominal operating range.

Witness: Alfonso Tovar

SITING BOARD 1-88:

Describe the fire suppression systems that will be installed at the BESS facility. Provide the standards those systems will have to meet. Who will monitor and maintain those systems.

Response: BESS approach to fire suppression can include mechanical containment and ventilation of gases. The different compartments will keep the fire from spreading to neighboring cells or neighboring containers. The BESS will be manufactured with all required industry standard fire prevention systems.

The status of BESS is continuously monitored and maintained with the remote management systems and also by the O&M staff.

Witness: Alfonso Tovar

SITING BOARD 1-89:

Explain how the BESS facility will comply with IEEE 1578 standards in relation to electrolyte spills.

Response: BESS for utility scale use solid or gel electrolytes, which reduces the risk of liquid spills. The scope of IEEE 1578 standard specifically lists VLA, VRLA and Ni-Cd batteries, suggesting limited direct applicability to Lithium Iron Phosphate (LFP) BESS for electrolyte spills. LFP BESS is anticipated to be the chosen BESS chemistry.

Witness: Alfonso Tovar

SITING BOARD 1-90:

Explain whether the BESS facility be designed to withstand environmental hazards that may arise within the area.

Response: The BESS facility will be designed in accordance with all applicable standards to withstand environmental hazards that may arise within the area.

Witness: Alfonso Tovar

SITING BOARD 1-91:

Explain whether Summer Shade will pursue an Industrial Revenue Bond and Payment In Lieu of Taxes agreement with Metcalfe County. If so, explain how that might change the cumulative tax revenues of the Project.

Response: Summer Shade will pursue an Industrial Revenue Bond and Payment In Lieu of Taxes ("PILOT") agreement with Metcalfe County. The Industrial Revenue Bond will provide the Project with savings on state and local property taxes. This provides the opportunity for Summer Shade to increase the net benefit and tax revenues paid to Metcalfe County via the PILOT.

Witness: Aubree Muse

SITING BOARD 1-92:

Explain whether an Engineering, Procurement, and Construction (EPC) firm has been selected for the project. Provide the request for proposal for the EPC contractor.

Response: An EPC contractor has not been selected for the Project at this time. No request for proposals have been issued.

Witness: Alfonso Tovar

SITING BOARD 1-93:

Explain whether Summer Shade intends to hire as many local workers for the construction and operations phases of the project as possible, all other qualifications for the positions being equal. If confirmed, explain how Summer Shade will ensure this occurs. If not confirmed, explain why not.

Response: Summer Shade intends to prioritize hiring as many local workers for construction and operations as possible, but this will be the responsibility of the EPC and O&M companies. Summer Shade will assert our preference for the labor to be hired locally across all phases of the project construction and operations during the EPC RFP stage.

Witness: Alfonso Tovar

SITING BOARD 1-94:

Refer to Application, Section 6, Public Notice Report indicates that Summer Shade has discussed agrivoltaics employment opportunities (e.g., sheep grazing) with a local resident. Refer also to Application, Attachment F Economic Analysis, a predominantly qualitative discussion of planned agrivoltaics at the proposed Summer Shade project site.

a. Provide a comprehensive overview of Summer Shade's current plan for agrivoltaics at the proposed project site.

b. Provide a comprehensive overview of the grazing employment discussion with the local resident, as referenced in the Public Notice Report.

c. Describe all site access and safety protocols during the project's operational phase regarding grazing access for herds and shepherds.

Response:

[redacted]

[redacted] [redacted]

c. Site access and safety protocols during the operational phase regarding grazing access for herds and shepherds will be coordinated with the operations and maintenance company. Protocols for herds and shepherds will be held to the same standard as other operations and maintenance workers.

<u>Witness</u>: Aubree Muse

SITING BOARD 1-95:

State the expected operational life of the Project.

Response: The expected operational life of the Project is 40 years.

Witness: Aubree Muse

SITING BOARD 1-96:

Explain any commitments regarding infrastructure removal or land restoration during decommissioning included in the landowner lease agreements.

Response: Summer Shade Solar will remove all above-grade facilities and return ground to a substantially similar condition to what existed prior to construction.

Witness: Matt Kiehlmeier

SITING BOARD 1-97:

Provide any mitigation measures Summer Shade has considered to dampen construction and operational noise.

Response: Summer Shade has proposed Mitigation Measure 15 in the Site Assessment Report in consideration of construction noise. Summer Shade will evaluate panel installation methods that do not include pile driving; however, if pile-driving activity occurs within 1,000 feet of a noise-sensitive receptor, Summer Shade shall implement a construction method that will suppress the noise generated during the pile-driving activity, such as semi-tractor and canvas method, sound blankets on fencing surrounding the site, or comparable methods. Per Summer Shade's noise study in Appendix D of the Application, most nearby receptors receive sound levels less than 35 dBA, which is comparable to a typical quiet suburban environment at night.

Witness: Shane Kelley

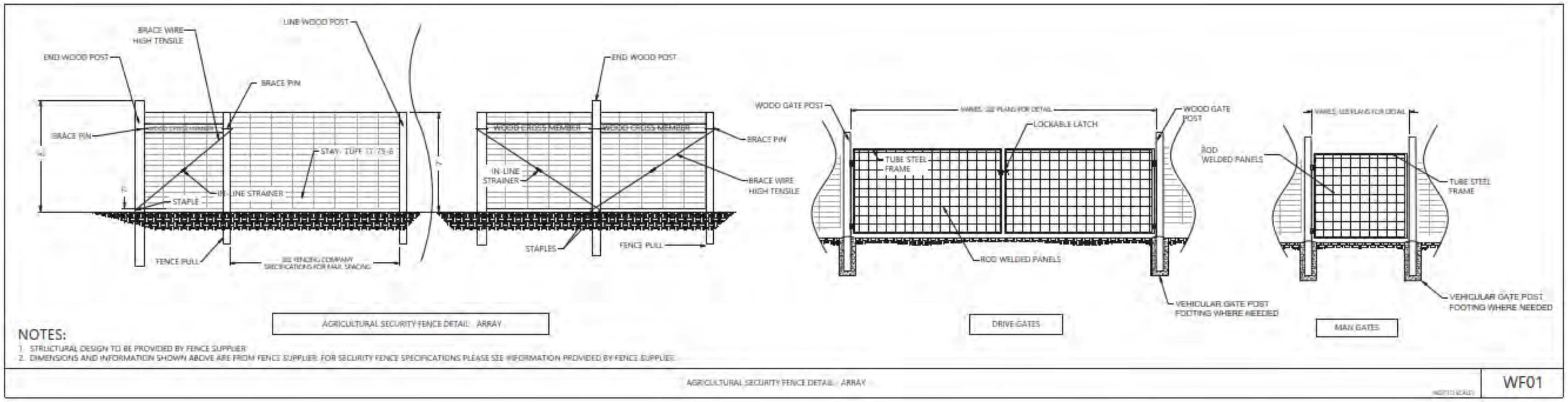
SITING BOARD 1-98:

Provide information on any fiber optic or communication network installed as a part of the project and any excavation that may be required for the installation.

Response: The communications provider has not been selected at this time. Considering the anticipated location of the O&M building and project's substation, it is anticipated that fiber optics communication can be brought directly to the substation and O&M building via overhead lines. Excavation that may be required will be determined by the fiber optic or communications network installer.

Witness: Alfonso Tovar

TYPICAL AGRICULTURAL SECURITY FENCE DETAIL - ARRAY



NOTES:

1. STRUCTURAL DESIGN TO BE PROVIDED BY FENCE SUPPLIER
2. DIMENSIONS AND INFORMATION SHOWN ABOVE ARE FROM FENCE SUPPLIER. FOR SECURITY FENCE SPECIFICATIONS PLEASE SEE INFORMATION PROVIDED BY FENCE SUPPLIER.

Candela
RENEWABLES

360 Pine Street, Suite 500
San Francisco, CA 94104

SITING BOARD 1-99:

Refer to the Site Assessment Report (SAR), page 2. Describe the proposed design of the six-foot 'wildlife' fence.

Response: See attachment below.

Witness: Aubree Muse

SITING BOARD 1-100:

Confirm whether all fencing, installed according to National Electric Safety Code standards, will be installed prior to the commencement of any electrical work.

Response: All fencing will be installed according to National Electric Safety Code standards and will be installed prior to the commencement of any electrical work.

Witness: Alfonso Tovar

SITING BOARD 1-101:

Provide information on all natural gas pipelines that intersect the project. Include in the response the owner, pipe diameter, status, and setback requirements.

Response: Columbia Gulf Transmission (TransCanada) is the owner of a right of way ("ROW") containing three separate gas lines. The ROW is defined as 175 feet wide. There is no setback requirement except to remain out of this 175-foot ROW. The EPC contractor will locate and avoid all pipelines. To the best of our knowledge, the ROW contains one 3-inch gas line and two 30-inch gas lines.

Witness: Matt Kiehlmeier

SITING BOARD 1-102:

Provide the distance between the existing Summer Shade substation and the proposed project substation.

Response: The existing EKPC substation is adjacent to the proposed Project substation. The straightline distance is approximately 50 feet.

Witness: Aubree Muse

SITING BOARD 1-103:

Provide the number of miles between the Summer Shade project and the Glover Creek Solar, LLC (Grover Creek) project in Case No. 2020-00043.

Response: The Glover Creek Project also features distributed array areas; measuring from the closest array area of the Glover Creek Project to the Summer Shade Project, the straightline distance is approximately 0.50 miles.

Witness: Aubree Muse

SITING BOARD 1-104:

Provide any overlaps in the projected construction schedules of both the Summer Shade project and the Glover Creek project in Case No. 2020-00043.

Response: The Glover Creek project has completed construction; therefore, there will be no overlaps in the construction schedules of the Summer Shade and Glover Creek projects.

Witness: Aubree Muse

SITING BOARD 1-105:

Provide any communication with representatives of Glover Creek regarding the proximity between the two projects. Include in the response any concerns that were raised.

Response: Summer Shade has not had communication with representatives of the Glover Creek project as it is already fully constructed. There are no concerns from Summer Shade regarding the proximity of the two projects.

Witness: Aubree Muse

SITING BOARD 1-106:

Refer to the SAR, Appendix D, Limited Noise Assessment. Explain why the Stantec sound study has been titled 'Limited' since multiple Stantec sound studies submitted to the Siting Board with previous solar facility applications have not had a "Limited" descriptor.

Response: Report has been updated with the removal of the "Limited" descriptor in the title. The content and methodologies of the report remains the same as the previous Stantec reports submitted to the Siting Board, with the exception of comments addressed below.

Witness: Shane Kelley

SITING BOARD 1-107:

Refer to the SAR, Appendix D, Limited Noise Assessment. The Construction Noise Modeling section states that the nearest home will be 185 feet from a solar panel. SAR, Appendix A (Property Value Impacts) states that the nearest home will be 155 feet from a solar panel. Explain this discrepancy.

Response: The discrepancy likely stems from mapping differences. Utilizing ARCGIS, the nearest home is located approximately 185 feet from the nearest solar panel.

Witness: Shane Kelley

SITING BOARD 1-108:

Refer to the SAR, Appendix D, Limited Noise Assessment. Update Appendix A of the noise assessment (Operational Noise Modeling Results) to list all distances to project components (i.e., fence, panel, inverter, substation, BESS) in feet rather than meters.

Response: The Noise Assessment has been updated to include an updated Appendix A to list distances in feet.

Witness: Shane Kelley

Stantec

Summer Shade Solar Project
Noise Assessment
Metcalfe County, KY

June 20, 2025

Prepared for:
Summer Shade Solar, LLC
500 Sansome Street
San Diego, California 94111-3211

Prepared by:
Stantec Consulting Services, Inc.

Project Number: 172658275

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Appendix A: Receptor Locations (UTM 16 Coordinates) and Operational Noise Modeling Results

Abbreviations

AC	Alternating current
BESS	Battery energy storage system
dB	Decibel (Unweighted)
dBA	Decibel (A-weighted)
DC	Direct current
Hz	Hertz
kV	Kilovolt
L_{eq}	Equivalent sound level
L_{max}	Maximum sound level
MVA	Megavolt ampere
MW	Megawatt
Project	Summer Shade Solar Project
PV	Photovoltaic
PWL (or L_w)	Sound Power Level
SPL (or L_p)	Sound Pressure Level

1.0 Introduction

Summer Shade Solar, LLC (Summer Shade Solar) is preparing an application to construct and place in utility service the Summer Shade Solar Project (Project). The Project will include an approximately 106 megawatt (MW) alternating current (AC) nameplate capacity solar energy facility and an approximately 424 MW AC battery energy storage system (BESS) facility.

Stantec Consulting Services Inc. (Stantec) completed an operational sound assessment. Operational noise modeling was completed to predict the expected sound generated from the proposed solar inverter stations, substation transformer, and BESS equipment at nearby noise-sensitive receptor locations. The estimated daytime and nighttime project operational sound levels were compared to applicable noise regulations. In addition, Project operational sound levels were compared to a Project noise goal. Construction noise was also analyzed and compared to applicable regulations. This report documents the methodology, results, and conclusions of the Project pre-construction sound assessment.

2.0 Terminology

Sound is caused by vibrations that generate waves of minute pressure fluctuations in the surrounding air. Sound levels are measured using a logarithmic decibel (dB) scale. Noise is typically defined as unwanted sound.

Human hearing ranges from 20 to 20,000 Hz. Human hearing varies in sensitivity for different sound frequencies, and the frequency sensitivity changes based on the overall sound level. The ear is most sensitive to middle frequency sounds between 800 and 8,000 Hertz (Hz) and is least sensitive to low and high frequency sounds below 400 Hz or above 12,500 Hz, respectively. Consequently, several different frequency weighting networks have been used to approximate the way the human ear responds various frequencies at different sound levels. Of most common use is the A-weighting network. A-weighting discriminates against frequency sounds similar to the response of the human ear at the low to moderate sound levels typical of environmental sources. A-weighted decibels, or dBA, is most widely used for regulatory requirements. Sound levels without a frequency weighting applied, referred to as unweighted or linear, are generally reported as dB.

Broadband (overall) sound levels, which are expressed as a single number in decibels, account for acoustical energy across the frequency spectrum, including energy at low, middle, and high frequencies. To assess how much acoustical energy is present in different ranges of the frequency spectrum, sound can be separated into spectral (frequency) components using octave band filters. For environmental noise assessments, octave band sound levels are often expressed in unweighted decibels (dB) at octave band center frequencies from 31.5 to 8,000 Hz.

Environmental sound is variable in time; therefore, it is appropriate to analyze sound levels statistically. Numerous metrics and indices have been developed to quantify the temporal characteristics (changes over time) of environmental noise. A common metric for assessing environmental noise is the equivalent sound level, or L_{eq}. The L_{eq} is a metric that corresponds to the average, or equivalent, sound level over a defined period of time. Other common metrics include the maximum and minimum sound levels, L_{max} and L_{min}, respectively. L_{max} is the highest sound level that occurred during a period of time, while L_{min} is the lowest sound level during a period of time. The L_{max} is particularly useful for evaluating high level, impulsive noise events; L_{min} is useful for understand low sound levels in an area.

The sound power level (PWL or L_w) of a noise source is related to the acoustic energy that the source emits regardless of the environment in which it is placed (i.e., similar to the wattage of a light bulb). Sound power is a property of the source and, therefore, is independent of distance. The radiating sound power then produces a sound pressure level (SPL or L_p) at a point of which human beings can perceive as audible sound. The sound pressure level is dependent on the acoustical environment (e.g., indoor, outdoor, absorption, reflections) and the distance from the noise source. Unless otherwise stated, sound levels in this report refer to sound pressure levels.

A change in sound levels of 3 decibels is generally considered to be the threshold of perception, whereas a change of 5 decibels is clearly perceptible, and a change of 10 decibels is perceived as a doubling or halving of loudness. Each time the number of noise sources is doubled or halved, logarithmic addition (or subtraction) of decibels results in a 3 decibel change in sound levels.

Typical sound levels generated by common sources are shown on **Figure 1**.

3.0 Project Description

The Project is a proposed 106 MW photovoltaic (PV) solar power energy generating facility located in Metcalfe County, Kentucky. The project site is located on approximately 1,535 acres west of the intersection of Kentucky Route 90 and Kentucky Route 163. The Project will be constructed primarily on agricultural and wooded land that is roughly split into three sections. The northern section is north of Kentucky Route 90. Note that an existing electrical substation borders the northern portion of the Project along Kentucky Highway 90. The center section spans from Kentucky Route 90 to Apple Grove Road, while the southern section is south of Apple Grove Road. The land use surrounding the Project Area is mixed between agricultural uses and residential uses. The location of the Project within the County and State are shown on **Figure 2**.

The Project will consist of inverters, a utility interconnection substation, and a BESS facility. Major components of the Project include solar arrays, solar inverter stations, a Project substation with an associated transformer, BESS inverters, and BESS containers. The Project layout, the surrounding area, and nearby noise-sensitive receptors are shown on **Figure 3.** Noise-sensitive receptors include nearby residences, schools, churches, hospitals, parks, and cemeteries. Arrays of photovoltaic modules will be mounted on fixed-tilt racking systems arranged in rows. Power conversion systems (also called inverter stations) will be distributed throughout the Project area, comprised of one distribution transformer and a series of power inverters. The proposed Project substation will be adjacent to the existing substation to the northwest. The power generated by the proposed solar facility will be connected to the existing power grid. The proposed BESS facility, which consist of BESS inverters and BESS containers, is located approximately 265 feet north of the proposed Project substation. The BESS facility has the ability to store power to distribute when needed on the existing power grid.

Solar panels produce direct current (DC) voltage which must be converted to AC voltage through a series of inverters. Solar energy facilities operate by converting solar radiation into electricity, meaning the solar generation portion of the Project will only produce electricity between sunrise and sunset. After sunset, the site no longer receives solar radiation, and the solar inverters will shift into stand-by mode and generate minimal noise. The Project will include a step-up power transformer located within the substation footprint. The substation transformer is generally expected to operate at full capacity during daylight hours when the solar array will be generating power and in standby mode during nighttime hours. The Project BESS facility is anticipated to operate at full capacity during some daytime and nighttime hours. However, BESS equipment is not expected to operate at full capacity continuously during those periods. To be conservative, the Project substation transformer and BESS equipment were assumed to operate during the nighttime hours for this sound assessment.

The main sources of operational sound levels from the Project will be the solar array inverter stations, the substation transformer, BESS inverters, and BESS containers. Project equipment assessed includes 25 solar inverter stations within the solar array areas, one power transformer within the Project substation area, and 24 BESS inverters with 96 BESS containers. Each BESS container will have four BESS enclosure units within it.

Construction activities will also produce noise that needs to be evaluated. Activities that will occur during the construction of the Project include impact pile driving and the use of heavy construction equipment. The loudest sound levels during construction activities are expected to be from impact pile driving. The impact pile driving equipment will be used to install the solar array posts, while other construction equipment will be used to install the remaining facility components. Construction activities are expected to be limited to daytime hours.

4.0 Regulatory Environment / Criteria

A review was conducted of noise regulations applicable to the Project at the federal, State, and County levels. There are no federal environmental noise requirements that are applicable to this Project.

Kentucky Revised Statutes (KRS) Section 278.708 requires a site assessment report be completed for proposed electric generation facilities that includes “evaluation of sound levels expected to be produced by the facility” (*KRS 278.708(3)(a)8*) and “evaluation of anticipated peak and average sound levels associated with the facility’s construction and operation at the property boundary" (*KRS 278.708(3)(d)*). Quantifiable noise limits are not provided in KRS 278.708. This sound assessment was completed to address the above requirements.

No Metcalfe County noise regulations or limits that are applicable to the Project were identified.

Since there are no quantitative noise limits identified in any jurisdiction, it is appropriate to recommend a Project goal to minimize the impact of noise on nearby noise-sensitive receptors. Due to the rural nature of the surrounding area, a Project noise goal of 55 dBA during the daytime and 50 dBA during the nighttime at residential structures is recommended for operational Project sound. These sound levels are similar to and consistent with noise regulation limits commonly found around the United States. Meeting these sound levels will reduce the impact of Project noise on nearby receptors.

5.0 Existing Noise Conditions

5.1 NOISE-SENSITIVE RECEPTORS

In this analysis, noise-sensitive receptors were considered to include residences, schools, churches, hospitals, parks, and cemeteries. Noise-sensitive receptor locations were identified within 2,000 feet of the Project boundaries by reviewing high resolution aerial imagery. The receptor locations, named with the prefix “R” and shown on **Figures 3 through 5**, include 100 residential dwellings and one church.

There are five sets of residential receptors located within 2,000 feet of the Project boundary that meet the definition of “residential neighborhood” according to KRS 278.700, which includes populated areas of five or more acres containing at least one residential structure per acre. The neighborhoods are listed in **Table 5.1** below.

Table 5.1: Residential Neighborhoods within 2,000 feet of Project

Residential Neighborhood name	Receptors	Approximate Distance from Project Fence (ft)
Summer Shade Road/Cemetery Road	R-56 through R-60	1,200
Summer Shade Road/Mount Moriah Road	R-36 through R-40	1,055
Clifton Smith Road	R-03 through R-07	250
Roy Lee Humes Road	R-27 through R-31	785
Old Goodson Church Road/Apple Grove Road	R-72 through R-77 R-93, R-94	80

Table 5.2 shows the nearest residential receptor locations to Project boundaries and equipment throughout the Project area.

Table 5.2: Nearest Receptors to the Project

Land use	Nearest Receptor to	Approx. Distance from Fence (ft)	Approx. Distance from Nearest Solar Panel (ft)	Approx. Distance from Nearest Inverter (ft)	Approx. Distance to Substation (ft)	Approx. Distance to BESS equipment (ft)
Residence (R-66)	Substation	1,755	1,805	2,100	1,260	1,685
Residence (R-61)	BESS Equipment	705	760	1,080	1,525	1,525
Residence (R-05)	Solar Inverter	260	320	360	11,515	11,980
Residence (R-42)	Solar Array	140	185	1,695	3,325	3,365

5.2 EXISTING NOISE FROM ADJACENT PROPERTIES

The primary sources of noise from the surrounding area are likely to be vehicle traffic on rural roads and adjacent agricultural activities including, but not limited to, ATVs, farm machinery, irrigation, tractors, and trucks. Kentucky Route 90 and Kentucky Route 163 also contribute to noise in the vicinity of the Project area. Additionally, wildlife (e.g., birds, cattle, insects, and frogs) contribute to the existing acoustical environment.

5.3 EXISTING NOISE ON THE PROJECT SITE

Existing sound sources on the Project site are likely typical of agricultural activities. These sources include ATVs, tractors, and trucks. Rural wildlife noises also contribute to the existing acoustical environment. Typical sound levels in a variety of outdoor environments are shown in **Figure 1**.

6.0 Construction Sound Assessment

6.1 SOUND SOURCES AND ASSESSMENT METHODOLOGY

Construction activities related to the development of the Project will occur over a period of approximately 12 to 18 months. Construction will occur in phases, starting with site preparation activities such as vegetation clearing, installation of stormwater controls, and access road construction. Construction of the Project substation along with the trenching and installation of the underground electrical collection system will likely be occurring concurrently with the solar array installation activities. The construction process is progressive in nature; therefore, several locations may see activity during the same time period, with installation activities then progressing to other array sites.

Construction activities are expected to be limited to daytime hours. Heavy construction equipment, including, but not limited to, backhoes, bulldozers, excavators, and haul trucks, may be present and operational at different points during the first phase of the construction period. The second phase of construction at each array site will include impact pile drivers to install posts for the solar array system. This analysis assumes that up to three pile drivers may be operating simultaneously within a solar array field.

Major components of the Project that require assembly include solar modules, inverters, a Project substation, and a BESS facility. Assembly will occur within the Project site several hundred to thousands of feet from the nearest receptors. Assembly will take place during construction hours and will be of limited duration at any given location within the Project.

Traffic noise is expected to increase temporarily during construction due to the mobilization of labor and materials, equipment and staff moving between sections of the Project, and construction and equipment vehicles entering and leaving the site.

Sound levels from construction equipment will vary by type, age of equipment, and overall condition. Typical construction equipment sound emission levels from the Federal Highway Administration (FHWA) Roadway Construction Noise Model (RCNM) database[1] are presented in **Table 6.1**. These sound levels are representative of typical infrastructure construction equipment and were used for this assessment. Pile driving was modeled assuming an L_{max} sound level of 101 dBA at 50 feet. Other than pile drivers, sound levels associated with the types of equipment expected to be used will vary from approximately 74 to 85 dBA at 50 feet. For comparison, typical sound levels generated by common sources are shown in **Figure 1**.

Table 6.1: Typical Construction Equipment Sound Emission Levels

Equipment Description	Acoustical Use Factor, %	Sound Level at 50 feet, dBA	
		L_{max}	L_{eq}
Backhoe	40	78	74
Compactor (ground)	20	83	76
Compressor (air)	40	78	74
Crane	16	81	73
Dozer	40	82	78
Dump Truck	40	76	72
Excavator	40	81	77
Flat Bed Truck	40	74	70
Front End Loader	40	79	75
Generator	50	81	78
Impact Pile Driver	20	101	94
Paver	50	77	74

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[1] FHWA 2006. Roadway Construction Noise Model User's Guide. U.S. Department of Transportation. U.S. Department of Transportation, Federal Highway Administration, FHWA-HEP-05-054, DOT-VNTSCFHWA-05-01. January 2006. https://www.fhwa.dot.gov/environment/noise/construction_noise/rcnm/rcnm.pdf

Equipment Description	Acoustical Use Factor, %	Sound Level at 50 feet, dBA	
		L_{max}	L_{eq}
Pickup Truck	40	75	71
Pneumatic Tools	50	85	82
Pumps	50	81	78
Roller	20	80	73
Tractor	40	84	80
Vibratory Pile Driver	20	101	94
Welder/Torch	40	74	70

Source: FHWA Roadway Construction Noise Model User's Guide.

The FHWA RCNM model was used to assess sound levels during construction at the nearest receptor to solar panel arrays (R-42) where pile driving would occur. RCNM accounts for the attenuation of sound with distance from equipment and estimates both L_{max} and L_{eq} sound levels. Equipment included in the RCNM model predictions included three pile drivers, one crane, one pickup truck, and one front end loader.

6.2 CONSTRUCTION SOUND ASSESSMENT RESULTS

Table 6.2 shows the results of the construction sound modeling at the nearest receptor to Project construction activities (R-42). The table shows the expected loudest instantaneous sound level (L_{max}) as well as the average sound level (L_{eq}) due to multiple pieces of equipment operating simultaneously in a solar field. Because pile drivers will only be used during solar panel post installations, results have been presented both with and without pile drivers in use.

Table 6.2: Estimated Sound Levels at Nearest Receptor (R-42) Due to Construction (Sunrise to Sunset)

Condition	Distance to Solar Array (ft)	Estimated L_{max} Sound Level (dBA)	Estimated L_{eq} Sound Level (dBA)
With pile driver	185	90	88
Without pile driver		69	67

The estimated sound levels of 67 to 90 dBA during construction are received at the nearest noise-sensitive receptor, while construction sound levels are expected to be lower at other identified receptors that are farther away. Note that these sound levels will be produced for a short duration and during only daytime hours.

7.0 Operational Sound Assessment

7.1 SOUND SOURCES AND ASSESSMENT METHODOLOGY

The Project, as currently proposed, includes 25 solar inverter stations within the solar generation arrays, one power transformer within the Project substation area, and 24 BESS inverters with 96 BESS containers as shown in **Figures 3 and 4**. Each BESS container will have four BESS enclosure units within it. These are the primary operational sound sources associated with the Project. The solar arrays associated with the Project include fixed-tilt tracking panels, which does not produce any noise.

The solar inverter stations and BESS inverters were assumed to be a Sungrow SG44000UD inverter station with a PWL of 91 dBA for each inverter station based on manufacturer's sound test data. The Project substation is expected to have a power transformer with a capacity of 106 megavolt amperes (MVA) with an audible sound level of the substation transformer (i.e., NEMA noise rating) of 82 dB. The NEMA TR-1[2] standard and methods in addition to the Edison Electric Institute Electric Power Plant Environmental Noise Guide[3] were then used to estimate the overall and octave band sound power levels. The Project is expected to include 96 Powin Stack 750 battery containers. The manufacturer sound testing data provided octave band sound level data for a single enclosure unit; however, each battery container will include four enclosures. Therefore, four noise sources were modeled for each battery container with the sound level data provided by the manufacturer. Octave band sound power level data for the Project noise sources are shown in **Table 7.1**.

Table 7.1: Equipment Sound Power Levels

Equipment Type	Octave Band Sound Power Level (dB)									Total Sound Power Level (dBA)
	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz	8,000 Hz	
Solar array and BESS inverter stations	90	89	87	83	86	84	87	77	55	91
Substation transformer	102	108	110	105	105	99	94	89	82	106
BESS enclosure unit	64	74	80	79	77	73	68	64	57	78

Sound attenuates between a source and receptor location due to a variety of factors, including but not limited to, distance between source and receptor, atmospheric absorption, ground type, topography, shielding from solid structures, vegetation, and meteorological conditions. Operational sound levels from the proposed Project equipment were estimated using the Datakustik CadnaA noise prediction software (the "model"), which utilizes the ISO 9613-2 standard[4] algorithms for outdoor sound propagation. CadnaA is a widely used modeling tool to estimate outdoor sound propagation.

The model was developed by importing the proposed Project layout, topographic data from the U.S. Geological Survey National Elevation Dataset, and aerial imagery. The solar inverter stations, BESS equipment, and substation transformer noise sources were modeled as point sources within the model based on the current Project layout provided by Summer Shade Solar. The solar and BESS inverter stations

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[2] National Electrical Manufacturers Association (NEMA) Standards Publication TR 1-2013 (R2019). Transformers, Step Voltage Regulators and Reactors.

[3] Edison Electric Institute. Electric Power Plant Environmental Noise Guide. Volume 1 2nd Edition.

[4] ISO 9613-2: 1996. Acoustics – Attenuation of sound during propagation outdoors. Part 2: General method of calculation.

were modeled at a height of 2.9 m (9.5 ft) above grade. The substation transformer was modeled at 3.0 m (9.8 ft) above grade. BESS containers were modeled at a height of 3.4 m (11.3 ft) above grade. Receptor points were added for the identified sensitive receptor locations within 2,000 feet of the Project Area at a height of 1.5 m (5 ft) above grade. A ground attenuation factor of 0.5 was used to represent the agricultural land of the Project parcels and surrounding area.

Additional assumptions that were used to conservatively estimate operational sound levels included the following:

- No sound attenuation from vegetation (foliage) to simulate a worst-case condition when leaves are not present on trees.
- Sound attenuation from existing buildings is not accounted for in the model. Land uses with intervening buildings between the receptor location and the Project noise sources will receive additional sound attenuation from buildings.
- Meteorological conditions conducive to sound propagation with all receptors located downwind of all noise sources.

The model produces estimated sound levels at the specified receptor locations as well as sound level contours as outputs. These outputs of the model are used to compare model results to the Project noise goal, as discussed in the next section.

This analysis was carried out in octave frequency bands, and results are displayed as the A-weighted sound level. Octave frequency band results for receptors are available upon request. The octave band results are consistent with the A-weighted sound level findings presented in this report.

The estimated daytime sound levels include all equipment operating simultaneously at full load. During the night, solar array inverters will be energized but operating in stand-by mode, generating minimal noise. Although the solar arrays will only generate power during daylight hours, the Project substation and BESS facility have been assumed to operate during daytime and nighttime hours. Although it is anticipated that Project substation power transformer operation during nighttime hours will be in the quieter standby mode, the estimated nighttime sound level analysis assumes operation at full load to conservatively estimate sound levels.

7.2 OPERATIONAL SOUND ASSESSMENT RESULTS

Operational sound levels estimated using the model for the 101 noise-sensitive receptors identified in the vicinity of the Project area are provided in tabular format in **Appendix A**. The estimated sound levels represent daytime and nighttime sound levels from the Project noise sources. **Appendix A** also shows the nearest distance from each receptor to the fence line, solar arrays, solar inverters, the substation, and BESS equipment.

Sound level contours for daytime operation with all Project noise sources operating at full load are displayed on **Figure 4**. The figure displays the overall project-generated sound levels from solar equipment, the substation, and the BESS equipment in the vicinity of the Project area and illustrates how sound is expected to propagate in the area. **Figure 5** shows the nighttime operational sound level contours produced by the substation transformer and BESS equipment. **Table 7.2** provides a summary of the expected sound levels at receptors within 2,000 feet of the Project boundaries.

Table 7.2: Summary of Estimated Operational Sound Levels at Sensitive Receptors

Estimated Sound Level	Number of Receptors	
	Daytime	Nighttime
25 dBA or less	37	76
26 dBA to 30 dBA	29	8
31 dBA to 35 dBA	23	10
36 dBA to 40 dBA	6	1
41 dBA to 45 dBA	6	6
46 dBA to 50 dBA	0	0
Greater than 50 dBA	0	0

The results of the operational sound modeling demonstrate that the highest expected daytime sound level at nearby sensitive receptors is 43 dBA at receptor R-66; this receptor is closest to the Project substation. This meets the daytime Project noise goal of 55 dBA by 12 dB. During the nighttime period, a maximum sound level of 43 dBA is also received at R-66. This meets the nighttime Project noise goal of 50 dBA by 7 dB. All other identified receptors receive sound levels lower than those received at R-66. Most nearby receptors receive sound levels less than 35 dBA, which is comparable to a typical quiet suburban environment at night. Overall, Project operational noise is expected to meet the Project noise goal.

8.0 Summary

An operational sound analysis was completed for the Summer Shade Solar Project to evaluate the impact of Project-generated sound on nearby noise-sensitive receptors. Quantitative noise regulations applicable to the Project were not identified. Therefore, an operational Project noise goal of 55 dBA during the day and 50 dBA at night was recommended. An operational noise model was developed and utilized to estimate the sound levels generated by Project equipment, including noise from the proposed solar array inverter stations, a substation transformer, and BESS equipment.

The solar generation portion of the Project will only produce electricity between sunrise and sunset. After sunset, the site no longer receives solar radiation, and the inverters will shift into stand-by mode and generate minimal noise. Although the solar arrays will only generate power during daylight hours, the Project substation power transformer and BESS equipment will operate periodically during daytime and nighttime hours.

The maximum Project-generated sound level was estimated to be 43 dBA during the daytime and nighttime periods at the closest residence. The noise assessment results demonstrate that Project operational sound levels are not expected to exceed the recommended Project noise goal of 55 dBA during the day and 50 dBA during the night.

The operational sound assessment conservatively assumed that inverters would be in operation at all primary and secondary solar arrays and that the substation transformer and BESS equipment will be operating continuously. There will likely be less equipment operating than what was assumed in this assessment; thus, overall sound levels are also expected to be lower than estimated herein.

A construction sound analysis was also completed considering impact pile driving and other typical construction equipment. Worst-case construction sound levels at the nearest residence are expected to range from 67 to 90 dBA with multiple pieces of equipment operating simultaneously. At times, construction activities will be audible at nearby residences or other noise-sensitive receptors. However, not all equipment will be operating at the same time, and activities will be temporary in duration and located throughout the Project area.

The equipment types, quantities, and locations used for this sound assessment are based on a preliminary Project layout and equipment selection details provided. If the equipment sound levels or quantities change in further designs, or equipment locations move closer to noise-sensitive areas, it is recommended that the sound assessment be updated.

FIGURES

June 20, 2025

Figure 1

Common Sound Levels

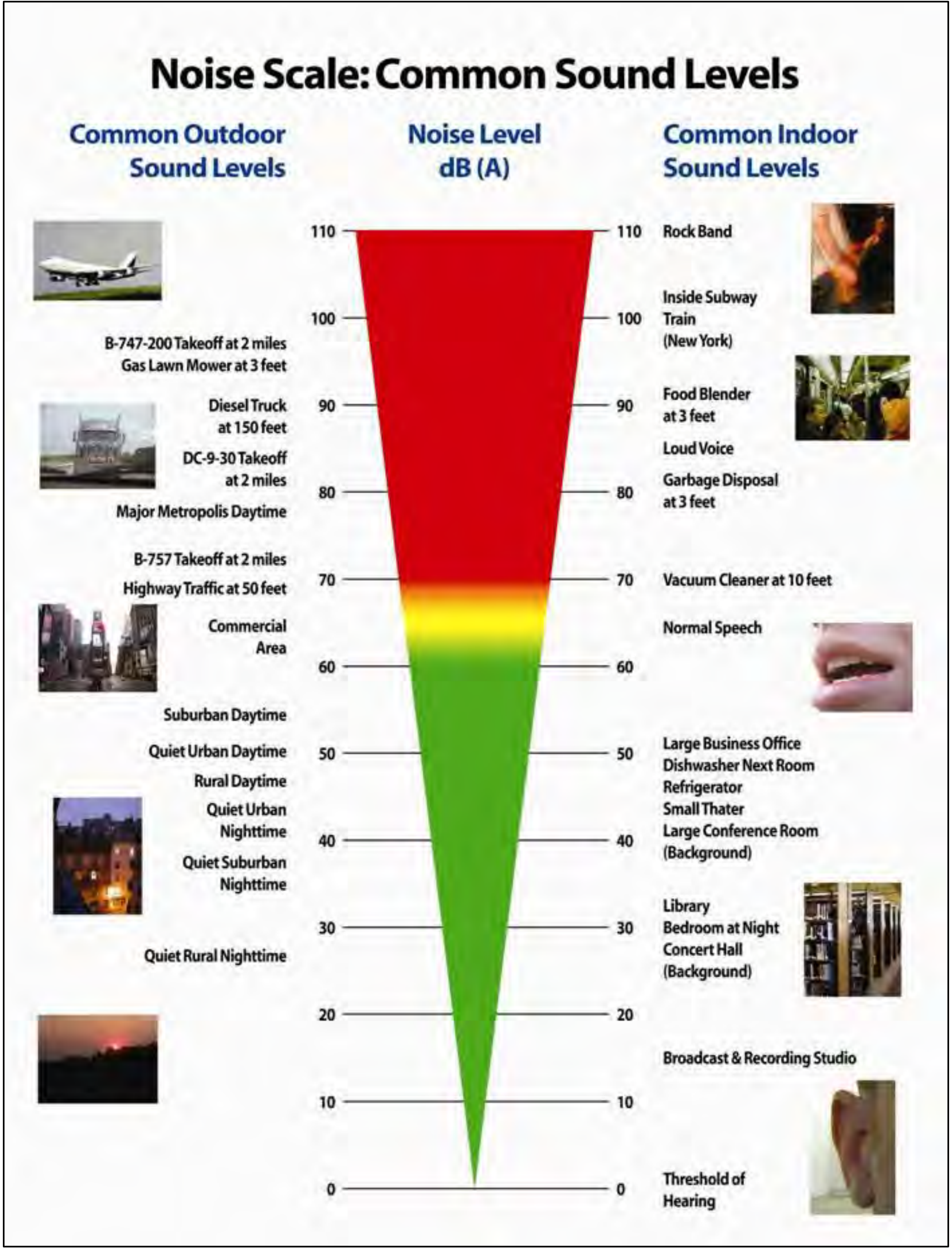
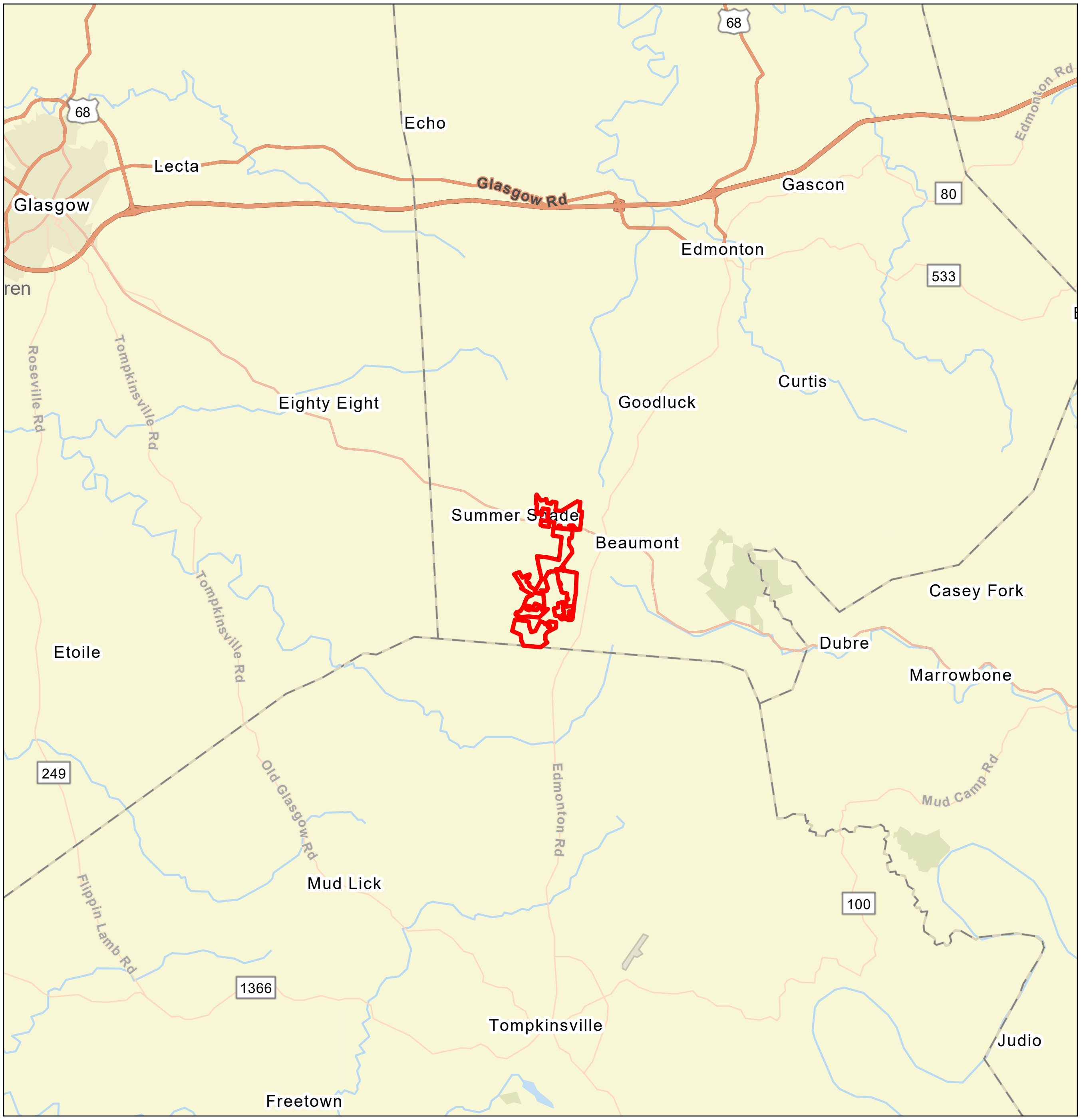
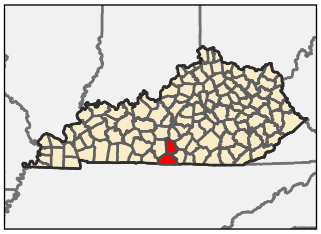


Figure 2

Project Vicinity Map





Legend

🟥 Project Study Area

0 10,000 20,000 Feet
(At original document size of 8.5x11)
1 inch = 20,000 feet

N

Stantec

Project Location
Metcalfe and Monroe Counties, Kentucky

Prepared by MNA on 2025-02-24
TR by SPK on 2025-02-24
IR by MC on 2025-02-25

Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
Pre-Construction Acoustic Assessment

Figure No.
2

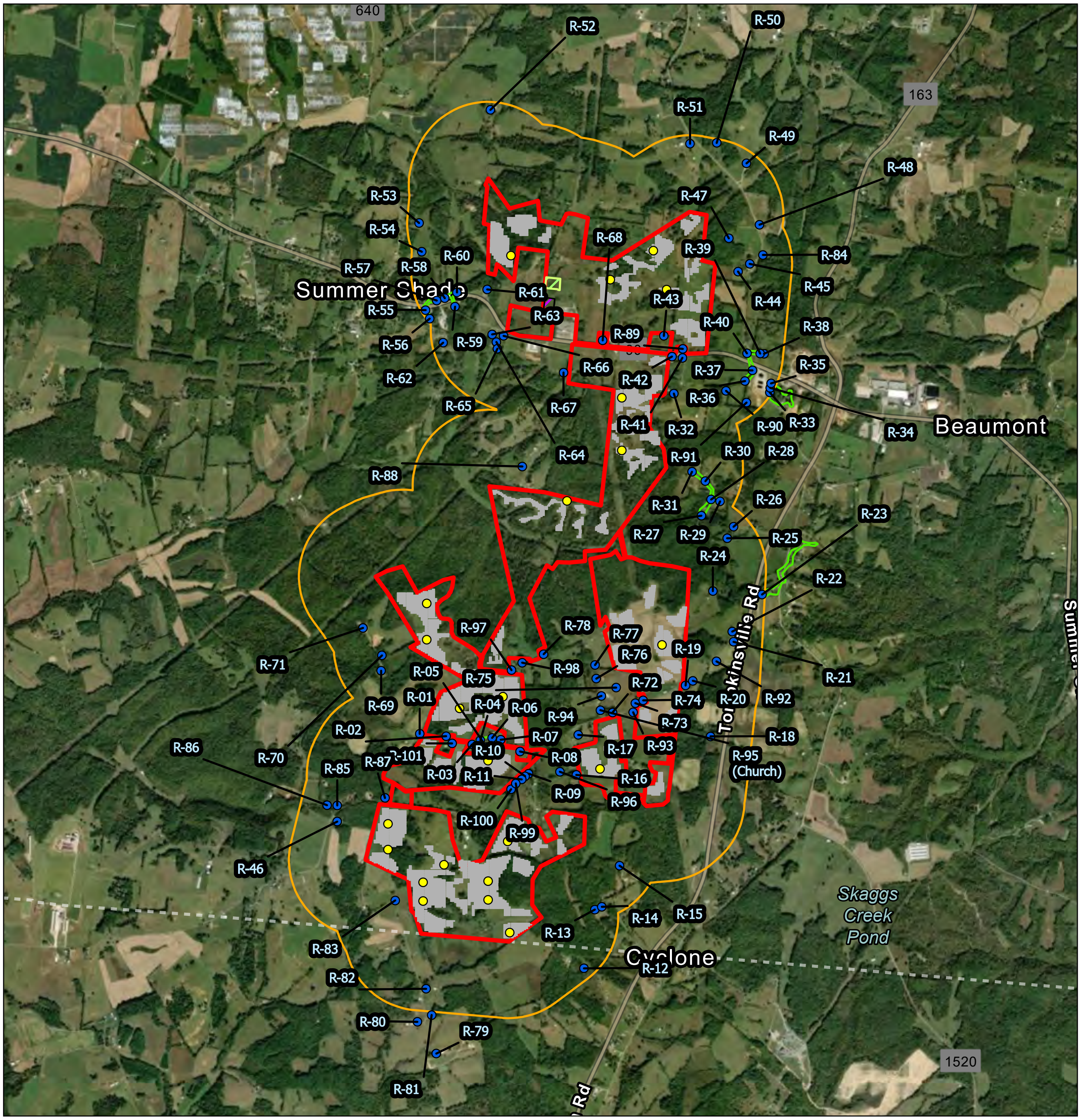
Title
Project Vicinity Map

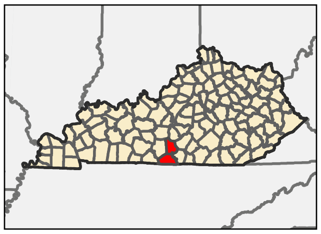
Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri World Street Basemap

C:\Users\mangel\Documents\ArcGIS\Projects_2024\Summer_Shade_Solar\SummerShadeSolar_Maps\SummerShadeSolar_Maps.aprx Revised: 2025-02-26 By: mangel

Figure 3

Project Layout and Noise-Sensitive Receptor Locations





Legend

🟥 Project Study Area

🟧 2000ft Buffer

🟩 Residential Neighborhoods as per KRS 278.700

☐ Panel Layout

▨ Proposed Project Substation

▨ Proposed Battery Energy Storage Site

● Noise Sensitive Receptors

● Noise Source Locations

0 2,000 4,000 Feet

(At original document size of 8.5x11)
1 inch = 4,000 feet

N

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri World Imagery Hybrid Basemap

Stantec

Project Location
Metcalfe and Monroe Counties, Kentucky

Prepared by MNA on 2025-02-24
TR by SPK on 2025-02-24
IR by MC on 2025-02-25

Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
Pre-Construction Acoustic Assessment

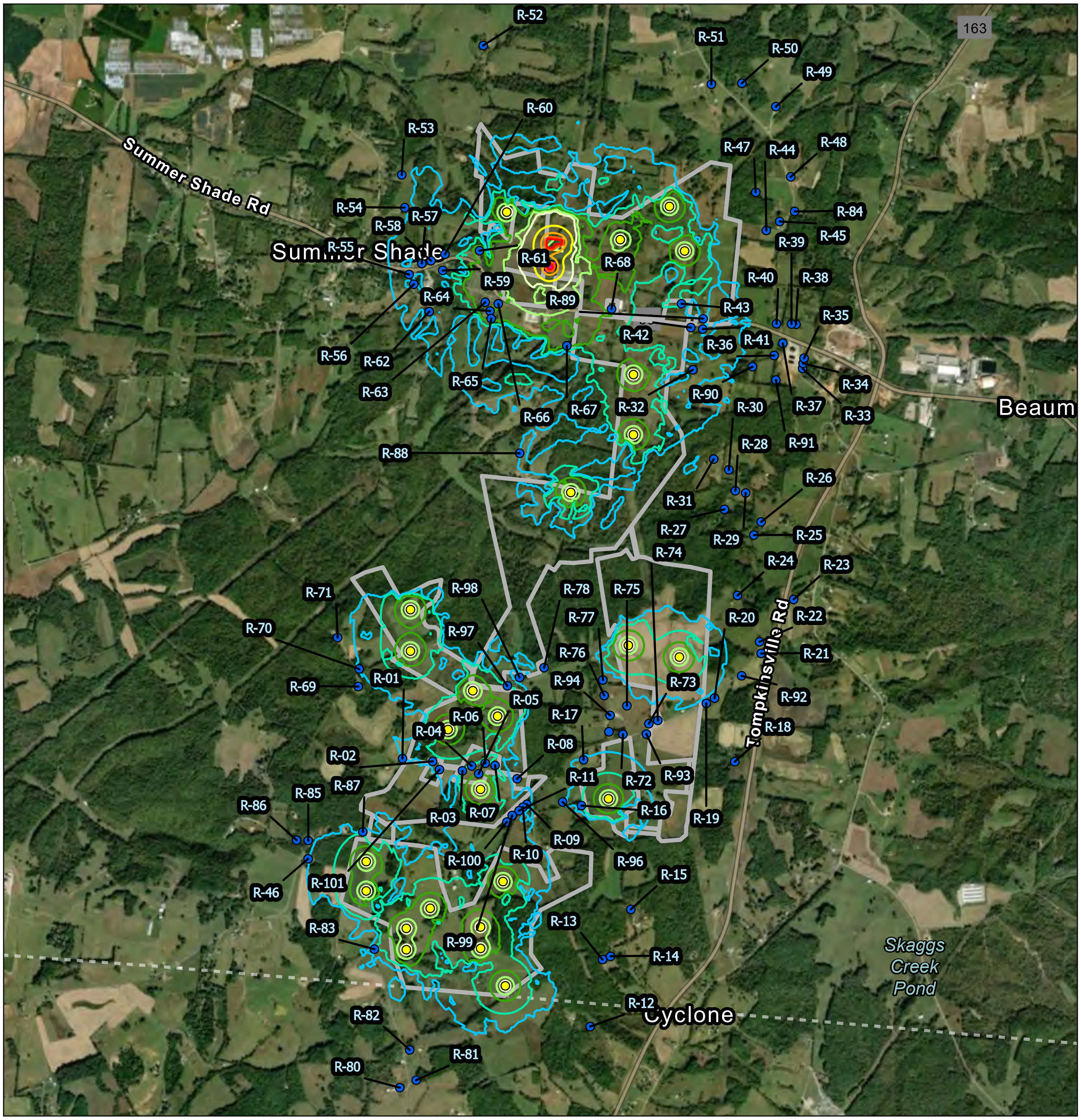
Figure No.
3

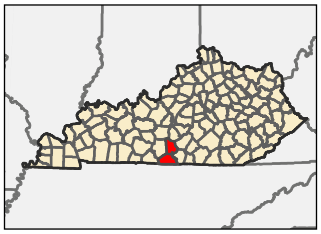
Title
Project Layout and Noise-Sensitive Receptor Locations

C:\Users\mangel\Documents\ArcGIS\Projects_2024\Summer_Shade_Solar\SummerShadeSolar_Maps\SummerShadeSolar_Maps.aprx   Revised: 2025-02-26 By: mangel

Figure 4

Estimated Operational Daytime Sound Level Contours





Legend

▭ Project Study Area

▨ Proposed Project Substation

▨ Proposed Battery Energy Storage Site

● Noise Sensitive Receptors

● Noise Source Locations

Sound Level Contour (dBA)

— 30
— 35
— 40
— 45
— 50
— 55
— 60
— 65
— 70

0 1,750 3,500 Feet

(At original document size of 8.5x11)
1 inch = 3,500 feet

N

Notes

1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri World Imagery Hybrid Basemap

Stantec

Project Location Metcalfe and Monroe Counties, Kentucky	Prepared by MNA on 2025-02-24 TR by SPK on 2025-02-24 IR by MC on 2025-02-25
Client/Project Summer Shade Solar, LLC Summer Shade Solar Project Pre-Construction Acoustic Assessment	172658275

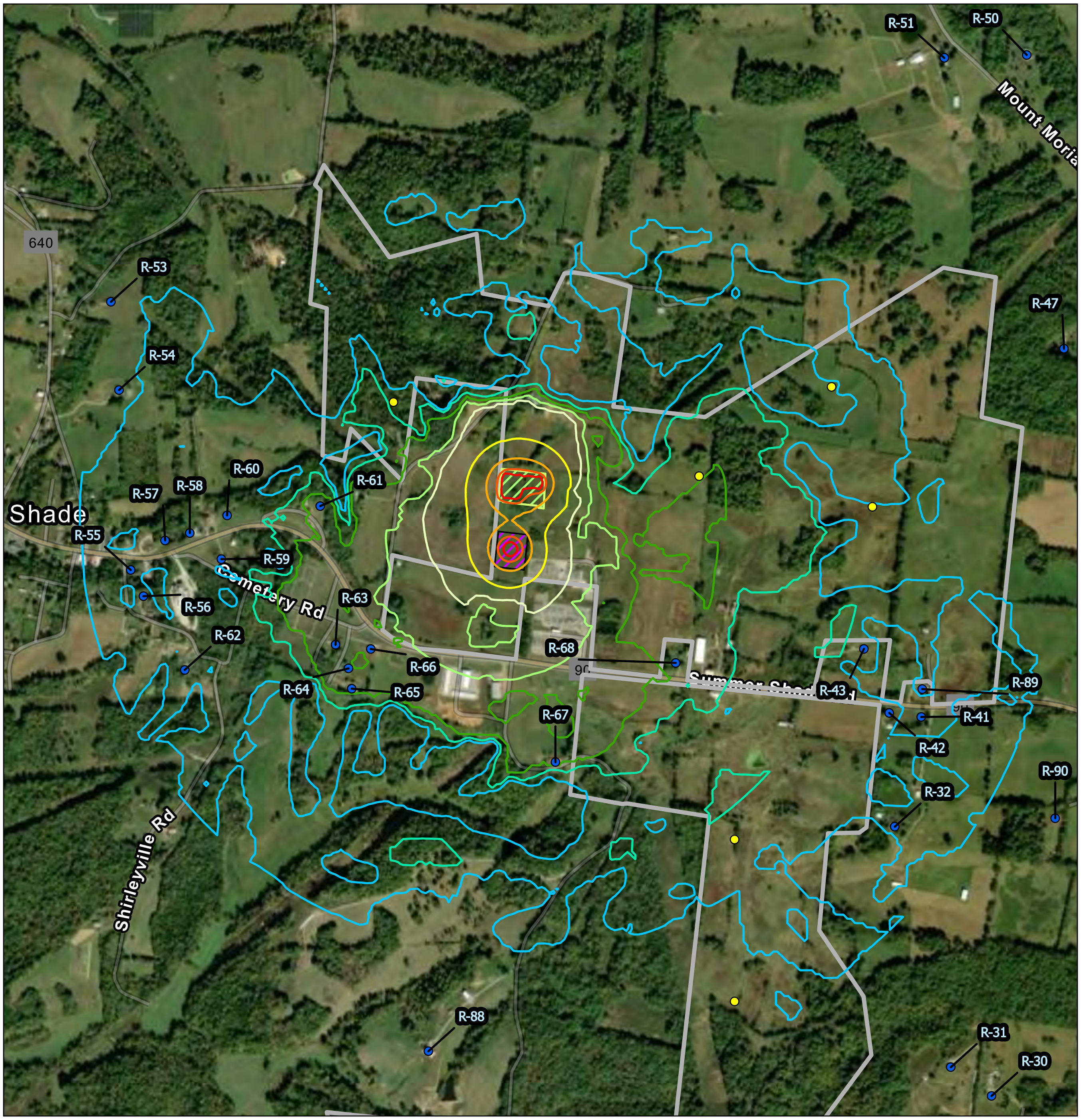
Figure No.
4

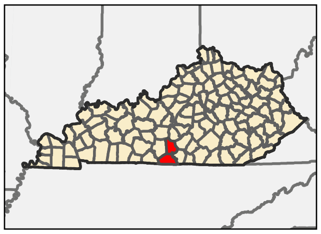
Title
Estimated Operational Daytime Sound Level Contours

C:\Users\mangel\Documents\ArcGIS\Projects_2024\Summer_Shade_Solar\Summer_Shade_Solar_Maps\SummerShadeSolar_Maps.aprx Revised: 2025-02-26 By: mangel

Figure 5

Estimated Operational Nighttime Sound Level Contours





Legend
▭ Project Study Area
▨ Proposed Project Substation
▨ Proposed Battery Energy Storage Site
● Noise Sensitive Receptors
● Noise Source Locations
Sound Level Contour (dBA)
— 30
— 35
— 40
— 45
— 50
— 55
— 60
— 65
— 70

0 650 1,300
Feet
(At original document size of 8.5x11)
1 inch = 1,300 feet

N

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: Esri World Imagery Hybrid Basemap

Stantec

Project Location
Metcalfe and Monroe Counties, Kentucky

Prepared by MNA on 2025-02-24
TR by SPK on 2025-02-24
IR by MC on 2025-02-25

Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
Pre-Construction Acoustic Assessment

Figure No.
5

Title
Estimated Operational Nighttime Sound Level Contours

C:\Users\mangel\Documents\ArcGIS\Projects_2024\Summer_Shade_Solar\SummerShadeSolar_Maps\SummerShadeSolar_Maps.aprx Revised: 2025-02-26 By: mangel

Appendix A

Receptor Locations (UTM 16 Coordinates) and Operational Sound Model Results

Summer Shade Solar Pre-Construction Noise Assessment
Appendix A: Project Operational Noise Modeling Results

Receptor ID	Estimated Project Operational Sound Level		Distance to fence	Distance to Nearest Solar Panel	Distance to Near Solar Inverter	Distance to Substation	Distance to BESS equipment	Coordinates (UTM 16N)			Height above ground
	Daytime	Nighttime						X	Y	Z (ground)	
	dBA L_{eq}	dBA L_{eq}	ft	ft	ft	ft	ft	ft	ft	ft	ft
R-01	30	15	149	193	1,231	11,534	12,033	2,020,197	13,383,770	989	5
R-02	34	15	93	182	807	11,423	11,910	2,020,885	13,383,714	1,024	5
R-03	37	15	297	327	590	11,503	11,975	2,021,567	13,383,509	1,056	5
R-04	37	15	292	332	568	11,363	11,830	2,021,777	13,383,620	1,056	5
R-05	40	15	258	320	357	11,516	11,979	2,021,939	13,383,446	1,033	5
R-06	37	15	302	362	603	11,260	11,721	2,022,084	13,383,687	1,062	5
R-07	35	15	281	328	638	11,283	11,738	2,022,309	13,383,641	1,050	5
R-08	29	15	147	229	868	11,539	11,992	2,022,816	13,383,342	1,007	5
R-09	31	14	436	521	1,111	12,103	12,555	2,023,047	13,382,765	1,014	5
R-10	31	14	377	475	1,049	12,176	12,628	2,022,956	13,382,696	1,011	5
R-11	31	14	359	460	1,006	12,262	12,714	2,022,870	13,382,614	1,007	5
R-12	15	0	1,712	1,768	2,147	17,177	17,613	2,024,555	13,377,712	1,007	5
R-13	21	10	1,597	1,643	2,298	15,666	16,097	2,024,819	13,379,245	1,004	5
R-14	17	11	1,779	1,709	2,492	15,606	16,036	2,024,999	13,379,321	986	5
R-15	19	11	1,746	1,442	2,575	14,586	15,008	2,025,449	13,380,398	1,037	5
R-16	35	14	210	285	635	12,130	12,566	2,024,292	13,382,751	1,068	5
R-17	31	15	386	424	1,054	11,091	11,525	2,024,327	13,383,796	1,043	5
R-18	20	15	913	964	2,702	11,846	12,208	2,027,777	13,383,797	1,052	5
R-19	25	16	154	358	1,223	10,373	10,740	2,027,108	13,385,119	1,092	5
R-20	26	16	276	390	1,234	10,326	10,686	2,027,294	13,385,241	1,102	5
R-21	25	17	1,265	1,334	1,867	9,838	10,154	2,028,344	13,386,275	1,102	5
R-22	25	17	1,200	1,252	1,863	9,590	9,902	2,028,306	13,386,539	1,102	5
R-23	22	18	1,929	1,990	2,919	9,195	9,462	2,029,070	13,387,515	1,135	5
R-24	25	20	718	798	1,932	8,422	8,732	2,027,789	13,387,590	1,077	5
R-25	23	21	1,991	2,078	3,260	7,476	7,738	2,028,144	13,388,972	1,065	5
R-26	23	21	2,334	2,421	3,528	7,344	7,589	2,028,305	13,389,274	1,084	5
R-27	23	21	1,813	1,845	2,685	6,603	6,877	2,027,464	13,389,551	1,024	5
R-28	23	21	1,650	1,728	2,654	6,422	6,668	2,027,709	13,389,978	1,050	5
R-29	23	21	1,861	1,948	2,884	6,611	6,848	2,027,943	13,389,931	1,043	5
R-30	23	21	1,246	1,357	2,319	5,962	6,196	2,027,553	13,390,453	1,067	5

Receptor ID	Estimated Project Operational Sound Level		Distance to fence	Distance to Nearest Solar Panel	Distance to Near Solar Inverter	Distance to Substation	Distance to BESS equipment	Coordinates (UTM 16N)			Height above ground
	Daytime	Nighttime						X	Y	Z (ground)	
	dBA L_{eq}	dBA L_{eq}	ft	ft	ft	ft	ft	ft	ft	ft	ft
R-31	29	27	825	946	1,914	5,551	5,793	2,027,205	13,390,693	1,114	5
R-32	33	32	284	329	1,361	3,820	3,961	2,026,703	13,392,724	1,083	5
R-33	24	24	2,047	2,094	3,798	6,036	6,056	2,029,205	13,392,788	1,088	5
R-34	25	24	1,990	2,037	3,724	6,005	6,017	2,029,214	13,392,904	1,084	5
R-35	24	24	1,947	1,994	3,660	5,987	5,989	2,029,234	13,393,023	1,083	5
R-36	24	23	1,355	1,401	3,138	5,324	5,342	2,028,552	13,393,076	1,078	5
R-37	26	25	1,359	1,406	3,073	5,422	5,411	2,028,745	13,393,357	1,073	5
R-38	25	24	1,521	1,566	3,042	5,608	5,554	2,029,041	13,393,792	1,092	5
R-39	28	28	1,420	1,464	2,954	5,508	5,455	2,028,940	13,393,797	1,096	5
R-40	29	28	1,080	1,125	2,674	5,171	5,126	2,028,597	13,393,799	1,076	5
R-41	30	30	308	411	1,828	3,587	3,616	2,026,915	13,393,657	1,017	5
R-42	31	30	138	182	1,693	3,322	3,361	2,026,644	13,393,687	1,012	5
R-43	36	34	166	246	1,206	2,955	2,931	2,026,422	13,394,226	1,043	5
R-44	27	25	646	826	1,921	4,833	4,650	2,028,336	13,395,926	1,089	5
R-45	25	25	962	1,188	2,270	5,167	4,969	2,028,638	13,396,133	1,078	5
R-46	30	12	988	1,053	1,326	14,404	14,920	2,018,074	13,381,454	1,039	5
R-47	18	17	648	797	1,995	4,806	4,540	2,028,084	13,396,793	1,056	5
R-48	23	23	1,508	1,554	2,847	5,675	5,401	2,028,877	13,397,154	1,056	5
R-49	24	24	1,776	1,848	3,329	6,120	5,741	2,028,517	13,398,752	1,106	5
R-50	21	21	1,915	1,963	3,262	5,863	5,436	2,027,736	13,399,277	1,024	5
R-51	24	24	1,798	1,849	2,947	5,364	4,913	2,027,038	13,399,244	1,037	5
R-52	25	24	2,787	2,823	3,838	5,100	4,629	2,021,825	13,400,059	906	5
R-53	28	28	1,834	1,874	2,541	3,817	3,622	2,020,005	13,397,084	965	5
R-54	29	29	1,743	1,783	2,328	3,430	3,322	2,020,083	13,396,337	954	5
R-55	31	31	2,188	2,236	2,642	3,082	3,188	2,020,203	13,394,814	897	5
R-56	32	32	2,236	2,294	2,682	2,985	3,135	2,020,313	13,394,594	925	5
R-57	32	32	1,808	1,854	2,263	2,800	2,860	2,020,490	13,395,068	921	5
R-58	33	33	1,598	1,649	2,052	2,597	2,644	2,020,699	13,395,134	925	5
R-59	34	34	1,541	1,602	1,974	2,315	2,418	2,020,969	13,394,916	941	5
R-60	34	34	1,254	1,311	1,705	2,299	2,315	2,021,013	13,395,287	938	5

Receptor ID	Estimated Project Operational Sound Level		Distance to fence	Distance to Nearest Solar Panel	Distance to Near Solar Inverter	Distance to Substation	Distance to BESS equipment	Coordinates (UTM 16N)			Height above ground
	Daytime	Nighttime						X	Y	Z (ground)	
	dBA L_{eq}	dBA L_{eq}	ft	ft	ft	ft	ft	ft	ft	ft	ft
R-61	41	41	705	759	1,078	1,525	1,522	2,021,801	13,395,376	991	5
R-62	32	32	2,474	2,539	2,877	2,766	3,046	2,020,672	13,393,973	940	5
R-63	42	42	1,755	1,802	2,113	1,500	1,871	2,021,946	13,394,204	1,009	5
R-64	42	42	1,933	1,981	2,288	1,507	1,933	2,022,059	13,394,005	1,005	5
R-65	41	41	2,101	2,149	2,454	1,591	2,047	2,022,088	13,393,833	1,009	5
R-66	43	43	1,752	1,802	2,101	1,259	1,686	2,022,245	13,394,171	1,010	5
R-67	41	41	1,376	1,444	1,654	1,649	2,073	2,023,822	13,393,234	1,050	5
R-68	38	37	801	942	1,577	1,507	1,662	2,024,830	13,394,087	1,004	5
R-69	29	21	1,048	1,104	1,438	10,338	10,860	2,019,167	13,385,400	1,050	5
R-70	30	21	888	935	1,239	9,966	10,490	2,019,182	13,385,800	1,037	5
R-71	28	17	1,081	1,133	1,690	9,557	10,086	2,018,680	13,386,507	1,043	5
R-72	27	16	270	306	1,505	10,604	11,020	2,025,215	13,384,388	1,021	5
R-73	27	16	165	222	1,672	10,468	10,871	2,025,805	13,384,639	1,037	5
R-74	28	16	151	227	1,527	10,439	10,836	2,026,007	13,384,716	1,044	5
R-75	27	17	434	482	1,378	9,975	10,387	2,025,300	13,385,041	1,059	5
R-76	26	17	540	603	1,270	9,670	10,093	2,024,777	13,385,268	1,045	5
R-77	28	18	475	518	981	9,315	9,738	2,024,741	13,385,622	1,068	5
R-78	29	23	827	927	1,532	8,975	9,424	2,023,397	13,385,884	1,088	5
R-79	17	0	3,128	3,172	3,689	19,610	20,076	2,020,735	13,375,439	938	5
R-80	19	0	2,313	2,363	3,151	18,870	19,344	2,020,233	13,376,261	945	5
R-81	20	0	2,130	2,171	2,960	18,638	19,107	2,020,604	13,376,439	958	5
R-82	25	0	1,446	1,485	2,288	17,984	18,457	2,020,447	13,377,124	971	5
R-83	34	8	416	474	727	15,898	16,389	2,019,613	13,379,415	1,025	5
R-84	24	24	1,347	1,596	2,667	5,546	5,333	2,028,977	13,396,366	1,063	5
R-85	29	12	1,102	1,154	1,407	14,017	14,535	2,018,069	13,381,872	1,043	5
R-86	24	12	1,361	1,415	1,661	14,114	14,635	2,017,805	13,381,876	1,032	5
R-87	34	13	214	277	682	13,398	13,903	2,019,313	13,382,086	1,028	5
R-88	30	28	787	831	1,470	4,144	4,613	2,022,778	13,390,770	938	5
R-89	33	32	172	225	1,601	3,521	3,520	2,026,921	13,393,893	1,026	5
R-90	25	25	1,268	1,306	2,722	4,967	5,026	2,028,062	13,392,813	1,094	5

Summer Shade Solar Pre-Construction Noise Assessment
Appendix A: Project Operational Noise Modeling Results

Receptor ID	Estimated Project Operational Sound Level		Distance to fence	Distance to Nearest Solar Panel	Distance to Near Solar Inverter	Distance to Substation	Distance to BESS equipment	Coordinates (UTM 16N)			Height above ground
	Daytime	Nighttime						X	Y	Z (ground)	
	dBA L_{eq}	dBA L_{eq}	ft	ft	ft	ft	ft	ft	ft	ft	ft
R-91	25	24	1,801	1,844	3,253	5,580	5,641	2,028,600	13,392,515	1,097	5
R-92	25	17	853	900	1,483	10,094	10,431	2,027,906	13,385,759	1,113	5
R-93	27	16	147	188	1,709	10,689	11,094	2,025,751	13,384,401	1,035	5
R-94	26	17	752	788	1,650	10,136	10,558	2,024,918	13,384,816	1,030	5
R-95	28	16	402	444	1,529	10,503	10,926	2,024,897	13,384,444	1,024	5
R-96	28	14	526	605	1,048	12,036	12,478	2,023,862	13,382,826	1,067	5
R-97	35	22	110	201	728	9,447	9,902	2,022,566	13,385,461	1,083	5
R-98	28	18	330	414	1,016	9,229	9,683	2,022,841	13,385,655	1,070	5
R-99	32	14	355	413	937	12,381	12,834	2,022,715	13,382,505	1,010	5
R-100	32	14	409	445	958	12,540	12,994	2,022,595	13,382,353	1,007	5
R-101	33	15	198	264	934	11,573	12,055	2,021,044	13,383,529	1,031	5

SITING BOARD 1-109:

Refer to the SAR, Appendix D, Limited Noise Assessment. Provide an appendix to the noise assessment that provides all Construction Noise Modeling Results in the same tabular format as Appendix A (Operational Noise Modeling Results). All Receptor IDs and UTM 16 coordinates must match those used in the existing noise assessment. All estimated project construction noise levels (both average and maximum) must be listed for each receptor. All distances to relevant project infrastructure (e.g., fence, solar panel, solar inverter, substation, BESS equipment) must be listed, in feet, for each receptor.

Response: The noise study provided a worst-case estimate of maximum (Lmax) and average (Leq) construction sound levels at the nearest non-participating receptor to construction activities. We view this approach for construction noise assessment as being consistent with the requirements for the noise study to include an "evaluation of anticipated peak and average noise levels associated with the facility's construction and operation at the property boundary" (KRS 278.708(3)(d)), and it has been accepted on prior KSB noise studies. Equipment used for construction varies significantly at different stages of the project. If construction noise estimates at all sensitive receptors are required for future projects, please state this requirement, and indicate which phases of construction noise will need to be assessed.

Witness: Shane Kelley

SITING BOARD 1-110:

Describe the cumulative effects on noise from the construction activities of the two projects, any steps to minimize these effects.

Response: The Glover Creek project has completed construction; therefore, there will be no cumulative effects from construction noise from the Summer Shade and Glover Creek projects.

Witness: Aubree Muse

SITING BOARD 1-111:

Describe the potential for cumulative effects on traffic and roadways from construction activities of the two projects, and any steps planned to minimize these effects.

Response: The Glover Creek project has completed construction, and it is Summer Shade's understanding that Glover Creek has completed remediation and restoration of roadways that were impacted by their construction activities. Therefore, there will be no cumulative effects on traffic and roadways from construction activities from the Summer Shade and Glover Creek projects.

Witness: Aubree Muse

SITING BOARD 1-112:

Describe the potential cumulative effects on property values and land uses from the construction and operation of the two projects.

Response: The Glover Creek and Summer Shade projects are both located primarily on constrained land with limited other uses. There are no anticipated adverse effects on property values or land uses from the construction and operation of the two projects.

Witness: Shane Kelley

SITING BOARD 1-113:

Refer to the SAR. Provide why this location was chosen for the project, despite over 55 percent of adjoining parcels being classed as residential.

Response: The Project's location is similar to the rural areas in which most similarly sized solar-generating facilities are located or proposed to be located. It was selected due to market demand, proximity to existing transmission infrastructure, and the willingness of a group of landowners to lease land to the Project. The Project has been thoughtfully designed to provide buffer from residences, with the natural topography and existing vegetation providing additional screening from adjoining residences. To date, Summer Shade has heard from very few nearby residents with concerns about the project.

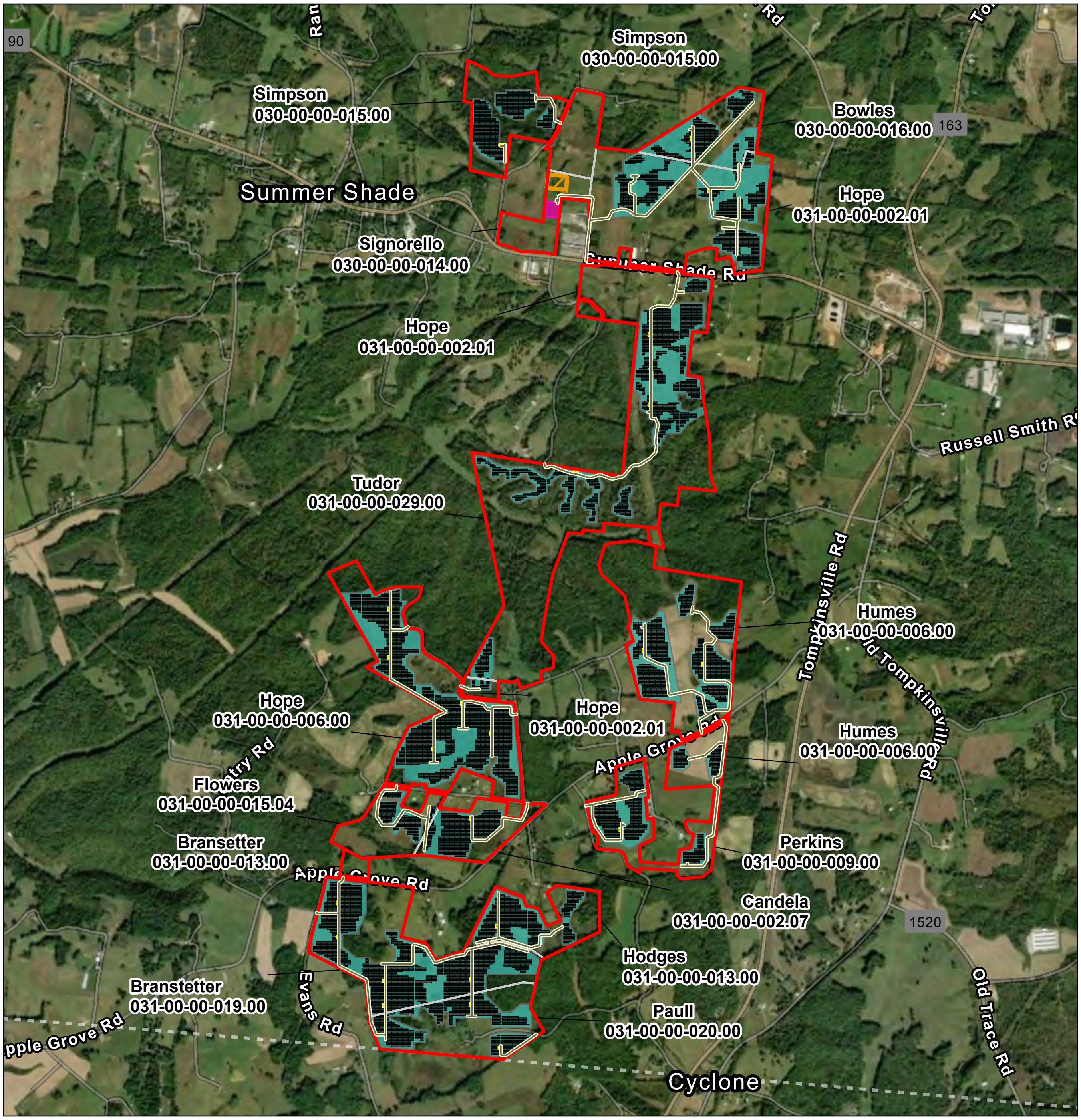
Witness: Aubree Muse

SITING BOARD 1-114:

Provide a parcel map for the proposed site. Include the parcel owner, acreage, whether they are participating or non-participating, parcel use, and all proposed project components presented in the site plan.

Response: Please see the attached figure below.

Witness: Shane Kelley



Legend

🟥 Project Boundary
☐ Parcel Boundary
■ Road
— Solar Array
🟪 Proposed Substation
🟨 Proposed Inverter
▨ Proposed BESS Location
🟩 Fenced Area

0 1,500 3,000
Feet
(At original document size of 8.5x11)
1:36,000

N

Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet
2. Data Sources: Stantec, Summer Shade Solar LLC
3. Background: ESRI World Imagery

Stantec

Project Location
Metcalfe County, Kentucky

Prepared by TCN on 2025-05-21

Client/Project
172658275
Summer Shade Solar, LLC
Summer Shade Solar Project
RFI Responses

Figure No.
F

Title
Parcels and Site Overview

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