Petition No. 1312
Candlewood Solar LLC
197 Candlewood Mountain Road
New Milford, CT
Interrogatories

Project Development

1. For the proposed Development and Management (D&M) Plan Revisions, identify the closest off-site residential structure to the proposed perimeter fence line and provide the distance. Also, identify the closest off-site residential structure to the limits of work (LOW) and provide the distance.

   Response: The closest off-site residential structure (guest house) is located at 183 Candlewood Mountain Road. The distance between the guest house (Northeast corner of the guest house) and the limit of work ("LOW") is approximately 354 feet. The distance between the guest house (Northeast corner of the guest house) and the proposed fence line is approximately 355 feet. An aerial photograph of the site showing the project LOW, and perimeter fence line with the requested information is included as Figure 1. Note that the proposed fence line is 1-ft inside the proposed LOW. Also note that the dimensions differ from those listed in the June 7, 2019 Findings of Fact (#44 and 134 which state this structure is 280 feet from the property line) because the design was modified, in consultation with the Connecticut Department of Energy and Environmental Protection (CT DEEP), to meet additional stormwater management requirements.

2. For the proposed D&M Plan Revisions, provide the distance from the residential structure at 185 Candlewood Mountain Road to the LOW. Provide the distance from the property line of the 185 Candlewood Mountain Road property to the LOW.

   Response: The distance between the residential structure at 185 Candlewood Mountain Road (eastern side or back of the residential structure) and the closest point along the LOW is approximately 588 feet. The distance between the property line (Northeast corner) of 185 Candlewood Mountain Road and the LOW at its closest point is approximately 95 feet. See Figure 1. Note that the dimensions differ from those listed in the June 7, 2019 Findings of Fact (#135 which states this structure is 525 feet from the revised (approved) project limit of work because the design was modified, in consultation with CT DEEP, to meet additional stormwater management requirements.

3. Referencing Drawing L-1 (Overall Planting Plan) of the D&M Plan Revisions, how many linear feet of 7-foot high cedar screening fence would be installed in total? Please clearly identify on a drawing which portions of the fence would be cedar versus chain link. How many linear feet of landscape plantings (measured along the fence line) would be installed in total?

   Response: The total linear footage of cedar fencing proposed for the project is approximately 3,367 feet. The fencing is shown on the drawings, provided to Council as Attachment A to the D&M Plan Revisions dated April 13, 2020, using two different line types: cedar fencing is identified as the square line type whereas locations of proposed chain link fence are shown using a circle line type. The total linear footage of landscape plantings proposed along the perimeter fence line is approximately 2,930 feet.

4. Referencing Drawing L-5 (Planting Details), Candlewood Solar, LLC (CS) depicts an approximately three-inch gap between the bottom of the cedar fence and finish grade. Drawing C-506 shows that the bottom portion of the cedar fence would be buried, i.e. there would be no gap at the bottom. Please clarify which is correct, and revise the drawing(s) as necessary.

   Response: The bottom of the perimeter fence will be embedded in all areas except where bedrock is encountered. Details shown on C-506 have been provided for installation specifications of the foundations and posts to support the cedar fencing. The cedar fence will be installed using the stockade fence detail shown on L-5. The cedar fence will be installed with a 3-inch clearance between the fence and ground surface, however, a section of chain link fence will be attached to the bottom of the cedar fence and embedded 6-inches into the ground surface as shown on the back elevation section of the stockade fence detail of drawing L-5. This embedment is included in accordance with NDDB requirements.

5. Does the proposed electrical interconnection still consist of two circuits of about 10 megavolt-amperes each? What is the line voltage? Provide the final quantity of new poles and estimate the heights.

   Response: Yes, the proposed electrical interconnection still consists of two 10 megavolt-ampere circuits. The line voltage is 13.8 kV, with a total utility pole count of 20 poles with heights ranging from 38.7 – 61.2 ft. Note that this differs from the June 7, 2019 Findings of Fact (#160) because the interconnection alignment was modified at the request of FirstLight so the interconnection is farther away from the existing dam on Candlewood Lake.

Energy Output

6. Provide the final projected annual alternating current (AC) megawatt-hours output and capacity factor based on the solar panel configuration of the D&M Plan Revisions. Indicate whether the capacity factor was calculated on an AC MWh/AC MWh or an AC MWh/DC MWh basis.

   Response: The final projected annual AC output of the facility is 28,832 megawatt-hours (MWh), which was calculated on an AC MWh/AC MWh basis. The capacity factor for the project is 16.5% based on AC output.

Public Safety

7. Provide the current status of the Federal Aviation Administration (FAA) Determinations of No Hazard to Air Navigation. Would CS need to seek any extensions or refiling with the FAA for revised determinations?

   Response: Candlewood Solar has filed for and obtained extensions to the Federal Aviation Administration ("FAA") Determinations of No Hazard to Air Navigation ("Extensions"). The Extensions were issued on October 25, 2019 (see Attachment A). The Extensions became final on December 4, 2019. The Extensions extend the effective period of the Determinations to April 25, 2021 unless otherwise extended, revised, or terminated by the FAA. All conditions identified in the original Determinations still apply. The three (3) FAA

Determinations of No Hazard to Air Navigation ("FAA Determinations" or "Determinations") that require marking/lighting as a condition of the Determinations are also included in Attachment A.

The marking/lighting condition requires the structure "to be marked/lighted in accordance with FAA Advisory circular 70/7460-1 L Change 1, Obstruction Marking and Lighting, red lights – Chapters 4,5(Red),&12." Attachment A contains a copy of FAA Advisory circular 70/7460-1 L Change 1 ("FAA Advisory circular"). It should be noted that, "If the structure/bridge/extensive obstruction exceeds 150 feet (46 m) horizontally, at least one steady-burning light should be displayed for each 150 feet (46 m), or fraction thereof, of the overall length of the major axis.." (See FAA Advisory circular, Section 5.8.2 Prominent Buildings, Bridges, and Similar Extensive Obstructions.) As such, while the FAA Determinations are associated with 3 points, the northern extent of the array requires obstruction marking/lighting. The lighting fixtures will be mounted on the perimeter fence surrounding the array and will be mounted roughly 10 feet above grade. A total of ten (10) lighting fixtures are proposed. Figure 2 shows the approximate locations of the FAA obstruction lighting that will be installed on the perimeter fence. In accordance with FAA requirements, the lights will be steady burning red lights. The lights will be operated by a photocell and will be activated when the ambient light falls below a specific level.

Section i of Council's April 25, 2019 Staff Report notes, "...CS will install approximately 14 each L-810 LED TRO series red obstruction lights per those spacing requirements along the top of the fence in response to the FAA evaluation." As noted above, a total of 10 lighting fixtures are proposed (see Figure 2).

Candlewood Solar entered into discussions with NDDB regarding FAA Lighting Requirements because the November 15, 2018 NDDB Final Determination under State Special Concern Ambystoma jeffersonianum (Jefferson salamander "complex") states, "No artificial lighting should be installed for the project."

On April 24, 2020, Candlewood Solar filed a letter and attachments with NDDB (see Attachment B). A response from NDDB is pending.

Environmental

8. Would the proposed changes to the electrical interconnection in the D&M Plan Revisions affect the visibility of the electrical interconnection from Candlewood Lake or Lynn Deming Park? Explain.

Response: Candlewood Solar's response to Interrogatory 31 (August 28, 2017) noted that, "The overhead 13.8kV poles will range from 45-55 ft. tall depending on local topography variation. There are 37 overhead poles in the current design that runs from the solar array site to Rte. 7 adjacent to the RRSS. The proposed plan is to run the 13.8kV line above ground to Route 7, and then the line will run underground across Route 7 into the RRSS. However, this routing configuration will be confirmed with Eversource engineering studies."

More recently, Council's April 25, 2019 staff report at a. notes, "Approximately 9.34 acres of the tree clearing will be required to accommodate the approximately 1.3-mile long by 60 feet wide electrical interconnection corridor. The interconnection line will consist of two,

overhead approximately 10 megavolt-ampere (MVA) circuits to be installed on approximately 18 single wood poles and 19 double wood poles. The heights of the wood poles will vary with the terrain, but the expected heights will range from between approximately 38-feet 8-inches to about 61 feet 2-inches above grade, with the majority less than 50 feet above grade."

Based on further evaluation and consultation with FirstLight, the owner of the two adjacent parcels (9/6 and 34/31.1) and NDDB and additional engineering, the electric interconnection corridor has been modified as described in Attachments 3 and 4 of the Development and Management Plan Revision filing dated April 13, 2020. Specifically, the revised electric interconnection corridor will still exit the Facility parcel from the southeastern portion of the Solar PV Facility and cross the two adjacent Project Area parcels to the east (parcels 9/6, and 34/31.1); however, shortly after the electric interconnection corridor enters adjacent FirstLight parcel 9/6, the electric interconnection corridor heads north/northeast along the eastern side of Candlewood Mountain as opposed to directly east, parallel to Candlewood Lake (see Figure 3) to maintain the required 300 foot minimum buffer from FirstLight infrastructure. The revised electric interconnection corridor re-joins the approved electric interconnection corridor, east of Wetland VIII where it follows an existing access road to Route 7 where it will interconnect with the Eversource Energy Rocky River Substation ("RRSS").

In order to minimize impacts along the entire length of the electric interconnection corridor, three different engineering methods (ground mount, overhead, and horizontal directional drill ["HDD"]) will be employed (see Figure 3). Specifically, the electric interconnection corridor will be constructed as follows:

- ***A Ground Mount Segment that extends from the Solar PV Facility to the Rocky River.***
  - ***Approximately 1,285 feet in length***
  - ***10 – 15 feet of selective clearing on each side***
  - ***38,550 square feet (0.88 acres) of total selective clearing***

- ***An Overhead Segment from the Rocky River to first Horizontal Directional Drilling (HDD) boring pit.***
  - ***Approximately 1,550 feet in length***
  - ***14 feet selective clearing from center of pole on each side***
  - ***46,500 square feet (1.07 acres) of total selective clearing***

- ***An HDD Segment***
  - ***Approximately 1,150 feet in length***
  - ***3,600 square feet (0.08 acres) of total clearing (temporary disturbance for bore pads/pits)***

- ***An Overhead Segment from the second HDD boring pit to Route 7/Kent Road***
  - ***Approximately 2,435 feet in length (Note, there are no changes to this segment from the approved design.)***

As such, the only modification to the electrical interconnection that could potentially affect the visibility of the electrical interconnection from Candlewood Lake or Lynn Deming Park are associated with the revised overhead segment from the Rocky River to first HDD boring pit (approximately 1,550 feet).

The majority of the overhead segment from the Rocky River to first HDD boring pit is located further north than the approved route included in the 2019 D&M Plan by approximately 61 – 985 feet (see Figure 3). Table 2.9-1 of the Environmental Assessment dated June 2017 notes that Lynn Deming Park is approximately 720 feet southeast of the interconnection route. Based on the revised electric interconnection corridor layout, the overhead segment from the Rocky River to first HDD boring pit is located approximately 1,575-2,224 feet from Lynn Deming Park (see Figure 4). A total of seven (7) poles will be installed along this overhead segment (see Figure 4). The poles will range from approximately 43 feet to 61 feet 2-inches tall as compared to 45-55 feet tall (2017 Interrogatory) and 38-feet 8-inches to about 61 feet 2-inches (2019 staff report) depending on local topography variation (see Attachment C).

As shown in Attachment C, the topographic profile, the poles will be installed down slope from a maximum ground elevation of 488.35 feet. Additionally, as noted above, selective clearing, 14 feet from center of pole on each side will be employed, minimizing the width of the cleared corridor by half (approximately 60 feet wide to approximately 30 feet wide (accounting for the approximate diameter of the pole)).

In New Milford, Lynn Deming Park is located on the northeastern side of Candlewood Lake. The elevation at Lynn Deming Park is approximately 429 feet. The revised overhead segment from the Rocky River to first HDD boring pit is an additional 61 - 985 feet north of the previous interconnection route. Existing trees will remain between the revised overhead segment, Candlewood Lake and Lynn Deming Park (see Figure 3 and Figure 4). As such, Candlewood Solar does not anticipate that the revised overhead segment from the Rocky River to first HDD boring pit (7 utility poles or cleared approximate 30 foot swath) will be visible from Candlewood Lake or Lynn Deming Park.

9. For the proposed D&M Plan Revisions, estimate the amount of net cut required for the solar array area and also for the project access road.

   Response: The total cut of material for the solar array parcel is approximately 24,410 cubic yards, of this volume, the access road has an approximate cut volume of 1,000 cubic yards. The intent of the project is to balance the cut volume in other areas of the site by using the cut material for grading and for construction of the embankments of the proposed BMPs. Final material volumes during construction will vary based on the material requirements associated with specific construction items (i.e., gravel for access roads, level spreaders, drip edges, common borrow, sand for the sand filters, and reused material onsite for general grading.)

10. Referencing Attachment 4 of the D&M Plan Revisions – February 7, 2020 Revised NDDB Request, page 7, it states, "The southern and northern access roads may require some improvements to facilitate the passage of construction equipment, however, large areas of clearing are not anticipated." (Emphasis added.) Would the clearing associated with the southern and northern

access roads materially impact Table 1, "2020 Forested Area to be Cleared" for the electrical interconnection which totals 6.36 acres?

Response: The northern access road is a former logging road and remains largely cleared. The clearing associated with this existing access road is anticipated to consist of limited removal of brush growth and downed logs. Based on aerial imagery of the northern access road and site inspections, it is estimated that additional clearing of less than 1,000 square feet may be required. The southern access road is an existing paved access road owned and maintained by FirstLight, there is no additional clearing that will be required along this access road. This will not significantly impact Table 2 "2020 Forested Area to be Cleared" for the electrical interconnection.

11. Would the proposed D&M Plan Revisions be consistent with the 2015 U.S. Army Corps of Engineers Vernal Pool Best Management Practices?

Response: As described in correspondence to CT DEEP NDDB from Amec Foster Wheeler, dated October 27, 2017, two (2) cryptic vernal pools were identified in Wetland I and one (1) vernal pool was identified in Wetland V. Wetland I is located east of the development area and Wetland V is located north/northeast of the development area (see D&M Plan Revisions dated April 13, 2020, Attachment 3).

The U.S. Army Corps of Engineers ("USACE") New England District January 2015 Vernal Pool Best Management Practices ("BMP") document (USACE Vernal Pool BMP document) offers two management tool concepts used to protect vernal pools. The two management tool concepts used to protect vernal pools include the concentric circle and directional corridor concepts. As noted in the USACE Vernal Pool BMP document:

> ***Directional corridors allow a flexible approach to conserving pool-breeding amphibian habitat, focus resources on conserving more essential habitat, and provide a balance between the human and amphibian communities and an alternative to circular zones, which often do not meet the terrestrial habitat needs of VP species. Directional corridors are designed to link habitats used by pool-breeding amphibians (i.e., breeding pools, forested wetlands, forested uplands) with forested travel corridors at appropriate migration scales (750 feet or greater). Landowners, consultants, and regulators can work together to design a corridor that is site-specific. This flexible approach considers pool-breeding amphibian habitat as a network of connected habitat elements.***

The approved design included avoidance of the vernal pool depressions and the 100-foot vernal pool envelopes, along with development of 31.6% (29.91 acres) of the critical terrestrial habitat ("CTH") area within a single combined CTH system associated with the two (2) cryptic vernal pools in Wetland I and the one (1) vernal pool in Wetland V. Specifically, as noted in the CT DEEP NDDB filing dated October 27, 2017, "Based on the overlapping, continuous, unfragmented system between the CTHs, these areas likely function as a single, mutually supportive system and therefore, should be assessed together. As a single system, the CTH totals approximately 94.57 acres and the development area (tree clearing area and solar array development) within the single combined CTH system totals approximately 29.91 acres or 31.6 percent." It should further be noted that approximately two (2) percent of the CTH (1.36 acres) is currently altered field area and the proposed condition will largely mimic the existing condition in that area in that it will

remain field. Additionally, "…unlike more conventional development (commercial, residential) when completed, the array field will not have many of the legacy mortality sources (to vernal pool wildlife) that result from conventional projects built in close proximity to vernal pools. Specifically, there will be no ongoing road mortality to frogs, toads or salamanders. Similarly, no animals will be captured in storm gutters and deep sump catch basins. Although the array field will not provide terrestrial habitat, it will impede, but not prevent movement by salamander species and will do little to impede nocturnal migration by wood frogs." The directional corridor for vernal pool species is constrained to the north, east and southeast as a result of existing steep slopes. As such, topography limits the extent of the directional corridor, and the directional corridor cannot be expanded to the southeast to Wetland VI or to the east or north.

The proposed revised design will have a minimal increase in development of the CTH over what the Council approved. CT DEEP Water Permitting and Enforcement Division requested that Candlewood Solar re-evaluate the design to relocate the solar PV panels sited within areas of 15% or steeper slopes to flatter slopes. Based on Candlewood Solar's evaluation, in order to reduce development in areas containing slopes that are 15% or greater, solar PV panels from the northwest have been relocated to the east side of the site near Wetland I and the two cryptic vernal pools within Wetlands I (see D&M Plan Revisions dated April 13, 2020, Attachment 3 - Figure 1 and Attachment C, Section ii, Annotated Project Plans). The proposed panel relocation and current design will increase development within the CTH from 31.6% (29.91 acres) to 32.0% (30.22 acres), which is an increase of 0.31 acres. The proposed revised design will have a minimal increase in development of the CTH over what was previously reviewed and approved by Council. Stormwater features to be located within the CTH include three (3) surface sand filters and an infiltration basin. Stormwater features are shown on Figure 1 and on the Annotated Project Plans included in Attachment C, Section ii (see D&M Plan Revisions dated April 13, 2020, Attachment 3).

Impacts to the vernal pools, their envelopes and the CTH has been avoided and minimized to the maximum extent practicable. The proposed revised design is consistent with four out of the five conservation recommendations using the concentric circle concept. Specifically, the revised design avoids disturbance within the VP depression and envelope, excludes roads and driveways from the VP envelope, maintains a directional corridor consisting of unfragmented forest with at least a partly-closed canopy of overstory trees to provide shade, deep litter and woody debris, and minimizes impedance to amphibian terrestrial passage. As described above, the project has been designed to minimize development of the CTH (conservation recommendation 2), however total development within the CTH is 32%.

It should be noted that these changes were filed with CT DEEP NDDB in a Request for Natural Diversity Data Base (NDDB) State Listed Species Review dated on September 23, 2019 (see D&M Plan Revisions dated April 13, 2020, Attachment 3). Additionally, based on project changes and further consultation with NDDB, the conservation easement has been modified slightly and expanded to include 120-acres. The area covered by blue and green hashing depicted in Figure 4 of the State Threatened Plethodon glutinosus (slimy salamander) Mitigation Plan depicts the proposed 120-acre conservation easement (see D&M Plan Revisions dated April 13, 2020, Attachment 4). On March 3, 2020, NDDB issued Determination #201911381 (see D&M Plan Revisions dated April 13, 2020, Attachment 6).

12. Referencing Attachment 3 of the D&M Plan Revisions – March 3, 2020 DEEP NDDB Correspondence, page 2, DEEP notes that CS has proposed to extend the tree clearing window to outside of the November 1 through March 30 time period. Acoustical monitoring for bats may be necessary. Please provide CS' projected target tree clearing window and an update on consultations with DEEP with regard to the acoustical bat monitoring.

    Response: The stormwater application was originally filed with CT DEEP on March 3, 2020, however, due to IT issues with the CT DEEP online ez-file system, the application was not officially received by CT DEEP until March 11, 2020. Candlewood Solar is expecting to receive feedback from CT DEEP on its stormwater application soon. In the meantime, Candlewood Solar has been working with a tree clearing contractor for tree clearing activities on the Solar Array Parcel only (parcel 26/67.1), including pre-construction environmental and Stormwater Pollution Control Plan ("SWPCP") training. Upon CT DEEP approval of the SWPCP and authorization of registration under the General Permit, and Council review and approval of the Development and Management ("D&M") Plan Revisions, Candlewood Solar must be ready to start tree clearing so the Project can meet critical schedule dates.

    Based on Candlewood Solar's April 17, 2020 conference call with NDDB, acoustic bat monitoring is required in order to further evaluate tree clearing outside of the November 1 to March 30 time period. Candlewood Solar has retained EnviroScience to provide bat survey services. (Please note, Attachment 2 of Candlewood Solar's April 24, 2020 filing with NDDB includes EnviroScience's Qualifications package for Listed Bat Survey Services. Candlewood Solar's April 24, 2020 filing with NDDB is Attachment B to this set of Interrogatories.).

    Additionally, as part of the April 24, 2020 filing with NDDB (see Attachment B), an acoustic bat survey study plan (Attachment 3) consistent with the U.S. Fish and Wildlife Service ("USFWS") Range-Wide Indiana Bat Survey Guidelines updated March 2020 ("USFWS Guidelines") for presence/absence surveys with the exception of the proposed time of year for conducting the survey was proposed and filed with NDDB. Specifically, Candlewood Solar requested CT DEEP NDDB approval to conduct survey for 8 detector nights under the prescribed weather conditions included in the USFWS Guidelines in advance of 15 May (USFWS guidelines define the summer survey season from 15 May through 15 August). A response from NDDB is pending.

Construction

13. Referencing page 2 of the Council's April 25, 2019 staff report for the D&M Plan, would there be any changes to the proposed work hours associated with the D&M Plan Revisions?

    Response: Council's April 25, 2019 staff report, c. notes:

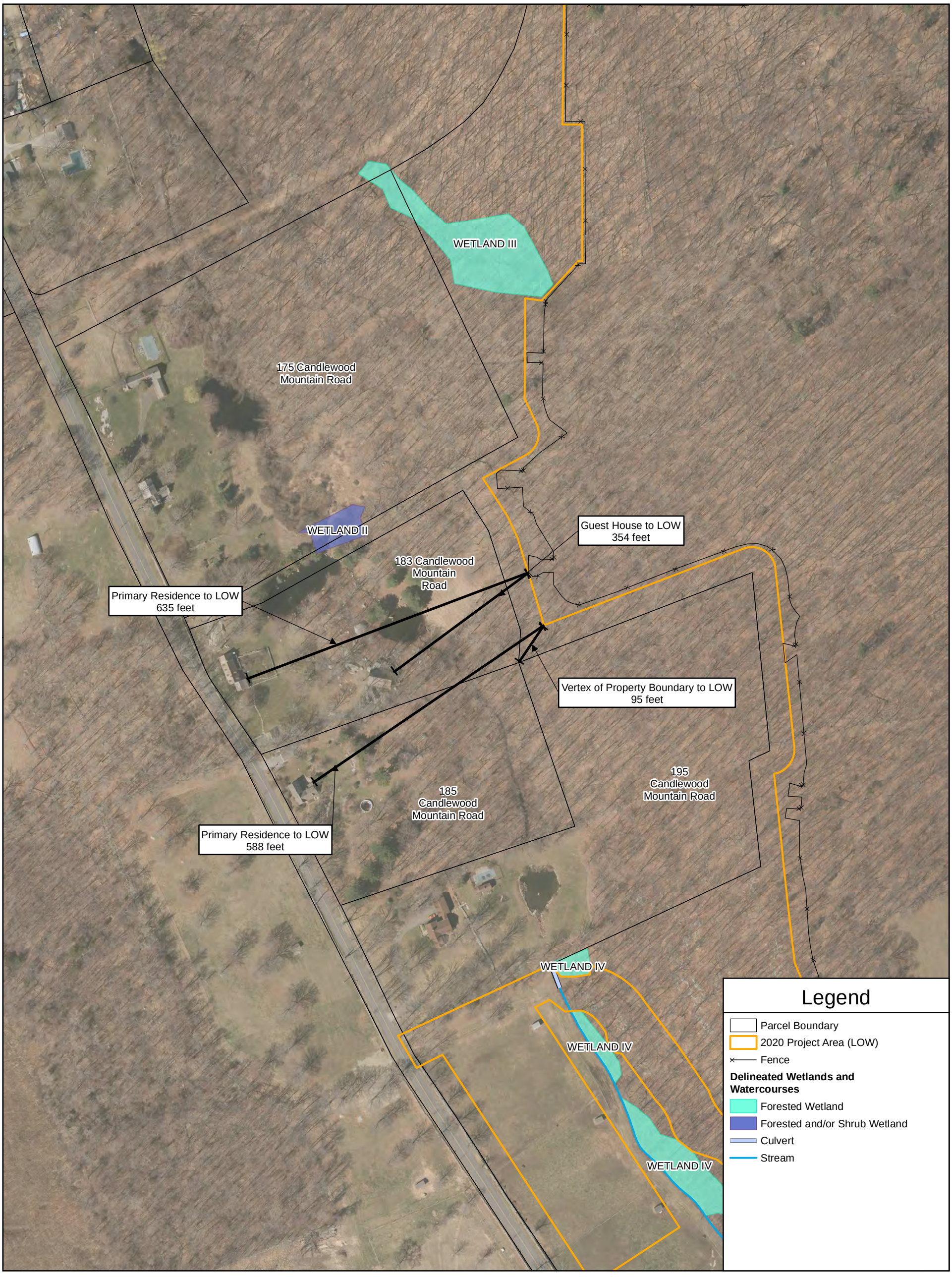
    > ***Work hours will typically be 7:00 a.m. to 5:00 p.m., Monday through Friday, while complying with the Town of New Milford's regulations, to minimize the length of calendar time the temporary construction impacts affect the area.***
    >
    > ***However, should the schedule require it, additional work may be performed on Saturdays… CS will coordinate with the municipality when work outside of these hours is necessary.***

Candlewood Solar is proposing a six-day per week schedule, between the hours of 7:00 a.m. and 5:00 p.m. while complying with any work hour restrictions listed in New Milford's regulations, to minimize the length of calendar time the temporary construction impacts affect the area.

14. Referencing page 2 of the D&M Plan Revisions and Attachment 10 – State Historic Preservation Office Correspondence dated April 9, 2020, page 2, it notes, "SHPO still suggests that construction matting be used in Area 4 to lessen the potential impact to undisturbed resources." Would CS utilize construction matting in the vicinity of Area 4? If no, explain why not.

    Response: CS will use construction matting in Area 4. This area will be prepped with a geotextile fabric and an 8-imch layer of crushed gravel prior to use as a laydown area. The details of this area are shown on Drawing C-111.

Figures



Location of Site

DISTANCE TO ABUTTING RESIDENTIAL STRUCTURES

Candlewood Solar LLC

Candlewood Solar Project
New Milford, Connecticut

Notes & Sources

Basemap Source: 2016 Connecticut Orthophotography created by the University of Connecticut - Connecticut Environmental Conditions Online (UCONN CTECO), distributed by ArcGIS Online.
Datalayer Sources: Parcel Boundary from CTDEEP GIS website.

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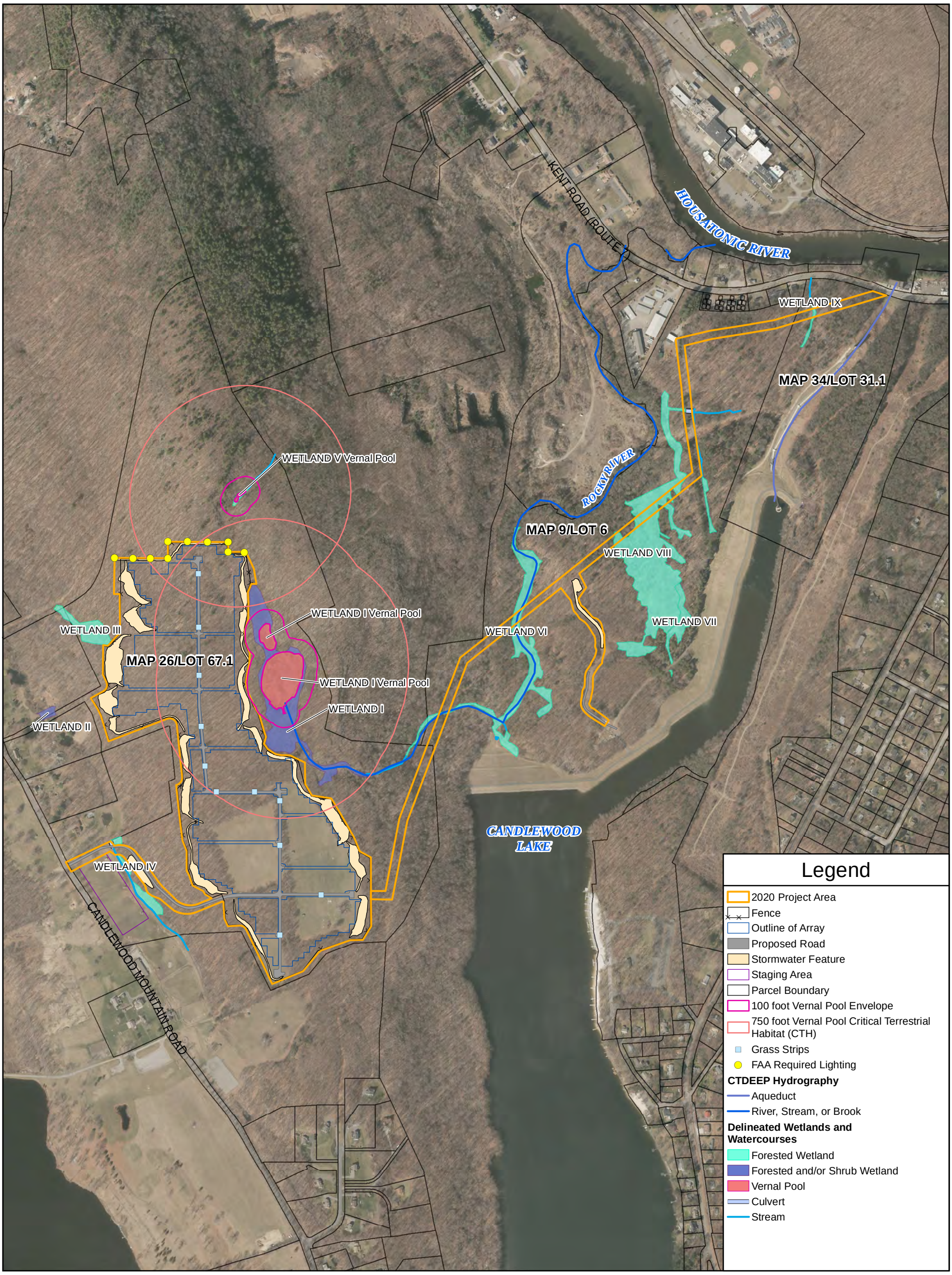
wood.
Wood Environment & Infrastructure Solutions, Inc.
271 Mill Road
Chelmsford, MA
Phone: (978) 692-9090

FIGURE 1

H:\Ameresco\NewMildford_CT\Task4\MXD\Fig1_Residential_Distance-Fence.mxd May 05, 2020 DWN: ilana.ton CHKD: AKN



Location of Site

FAA REQUIRED LIGHTING

Candlewood Solar LLC

Candlewood Solar Project New Milford, Connecticut

Notes & Sources

Basemap Source: 2016 Connecticut Orthophotography created by the University of Connecticut - Connecticut Environmental Conditions Online (UCONN CTECO), distributed by ArcGIS Online.
Datalayer Sources: Parcel Boundary from CTDEEP GIS website.

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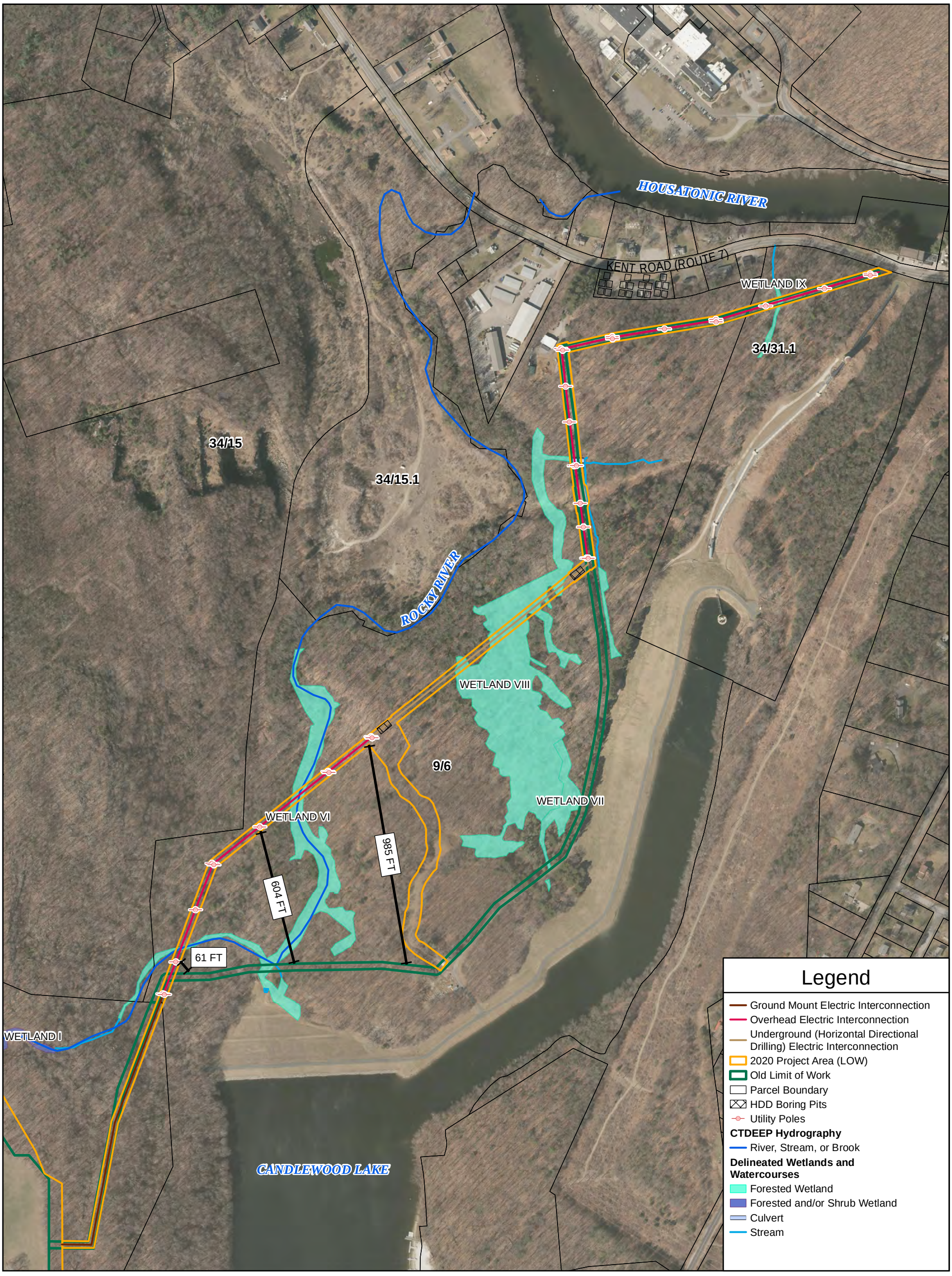
wood.
Wood Environment & Infrastructure Solutions, Inc.
271 Mill Road
Chelmsford, MA
Phone: (978) 692-9090

FIGURE 2

Document Path: H:\Ameresco\NewMildford_CT\Task4\MXD\Fig2_OverallSitePlan.mxd



Location of Site

2020 ELECTRIC INTERCONNECTION ROUTE DESIGN

Candlewood Solar LLC

Candlewood Solar Project
New Milford, Connecticut

Notes & Sources

Basemap Source: 2016 Connecticut Orthophotography created by the University of Connecticut - Connecticut Environmental Conditions Online (UCONN CTECO), distributed by ArcGIS Online.
Datalayer Sources: Parcel Boundary from CTDEEP GIS website.

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wood.
Wood Environment & Infrastructure Solutions, Inc.
271 Mill Road
Chelmsford, MA
Phone: (978) 692-9090

FIGURE 3

H:\Ameresco\NewMildford_CT\Task4\MXD\Fig3_Interconnection_Old-New.mxd May 05, 2020 DWN: ilana.ton CHKD: AKN

WETLAND VIII

9/6

WETLAND VII

WETLAND VI

2,224 FT

1,575 FT

CANDLEWOOD LAKE

LYNN DEMING PARK

Beach

Parking Lot

Legend

- Ground Mount Electric Interconnection
- Overhead Electric Interconnection
- Underground (Horizontal Directional Drilling) Electric Interconnection
- 2020 Project Area (LOW)
- Parcel Boundary
- HDD Boring Pits
- Lynn Deming Park
- Utility Poles

CTDEEP Hydrography

- River, Stream, or Brook

Delineated Wetlands and Watercourses

- Forested Wetland
- Stream

Location of Site

2020 ELECTRIC INTERCONNECTION ROUTE DESIGN TO LYNN DEMING PARK

Candlewood Solar LLC

Candlewood Solar Project
New Milford, Connecticut

Notes & Sources

Basemap Source: 2016 Connecticut Orthophotography created by the University of Connecticut - Connecticut Environmental Conditions Online (UCONN CTECO), distributed by ArcGIS Online.
Datalayer Sources: Parcel Boundary from CTDEEP GIS website.

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wood.
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FIGURE 4

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Attachment A

FAA Determinations and Extensions and
FAA Advisory circular 70/7460-1 L Change 1

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANE-209-OE
Prior Study No.
2017-ANE-2226-OE

Issued Date: 04/12/2018

Brian Pitreau
Brian Pitreau
30 Danforth Street
Suite 108
Portland, ME 04105

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Solar Panel Solar Panel Solar PV Array - NE Point
Location:	New Milford, CT
Latitude:	41-34-38.11N NAD 83
Longitude:	73-27-06.22W
Heights:	833 feet site elevation (SE) 10 feet above ground level (AGL) 843 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure would have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities. Therefore, pursuant to the authority delegated to me, it is hereby determined that the structure would not be a hazard to air navigation provided the following condition(s) is(are) met:

As a condition to this Determination, the structure is to be marked/lighted in accordance with FAA Advisory circular 70/7460-1 L Change 1, Obstruction Marking and Lighting, red lights - Chapters 4,5(Red),&12.

Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, should be reported immediately to (877) 487-6867 so a Notice to Airmen (NOTAM) can be issued. As soon as the normal operation is restored, notify the same number.

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

_____ At least 10 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

See attachment for additional condition(s) or information.

This determination expires on 10/12/2019 unless:

(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.
(b) extended, revised, or terminated by the issuing office.
(c) the construction is subject to the licensing authority of the Federal Communications Commission (FCC) and an application for a construction permit has been filed, as required by the FCC, within 6 months of the date of this determination. In such case, the determination expires on the date prescribed by the FCC for completion of construction, or the date the FCC denies the application.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE E-FILED AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE. AFTER RE-EVALUATION OF CURRENT OPERATIONS IN THE AREA OF THE STRUCTURE TO DETERMINE THAT NO SIGNIFICANT AERONAUTICAL CHANGES HAVE OCCURRED, YOUR DETERMINATION MAY BE ELIGIBLE FOR ONE EXTENSION OF THE EFFECTIVE PERIOD.

This determination is subject to review if an interested party files a petition that is received by the FAA on or before May 12, 2018. In the event a petition for review is filed, it must contain a full statement of the basis upon which it is made and be submitted to the Manager of the Airspace Policy Group. Petitions can be submitted via mail to Federal Aviation Administration, 800 Independence Ave, SW, Room 423, Washington, DC 20591, via email at OEPetitions@faa.gov, or via facsimile (202) 267-9328.

This determination becomes final on May 22, 2018 unless a petition is timely filed. In which case, this determination will not become final pending disposition of the petition. Interested parties will be notified of the grant of any review. For any questions regarding your petition, please contact Airspace Policy Group via telephone – 202-267-8783.

This determination is based, in part, on the foregoing description which includes specific coordinates, heights, frequency(ies) and power. Any changes in coordinates, heights and frequencies or use of greater power, except those frequencies specified in the Colo Void Clause Coalition; Antenna System Co-Location; Voluntary Best Practices, effective 21 Nov 2007, will void this determination. Any future construction or alteration, including increase to heights, power or the addition of other transmitters, requires separate notice to the FAA. This determination includes all previously filed frequencies and power for this structure.

If construction or alteration is dismantled or destroyed, you must submit notice to the FAA within 5 days after the construction or alteration is dismantled or destroyed.

This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

This aeronautical study considered and analyzed the impact on existing and proposed arrival, departure, and en route procedures for aircraft operating under both visual flight rules and instrument flight rules; the impact on all existing and planned public-use airports, military airports and aeronautical facilities; and the cumulative impact resulting from the studied structure when combined with the impact of other existing or proposed

structures. The study disclosed that the described structure would have no substantial adverse effect on air navigation.

An account of the study findings, aeronautical objections received by the FAA during the study (if any), and the basis for the FAA's decision in this matter can be found on the following page(s).

If we can be of further assistance, please contact David Maddox, at (202) 267-4525, or david.maddox@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANE-209-OE.

Signature Control No: 352700405-362358451 (DNH)
Mike Helvey
Manager, Obstruction Evaluation Group

Attachment(s)
Additional Information
Case Description
Map(s)

Additional information for ASN 2018-ANE-209-OE

The three proposed locations of the solar array, at a height of 10 feet (ft.) above ground level (AGL) / 843 to 937 ft. above mean sea level (AMSL), would be located approximately 3,371 to 3,846 ft. northeast of the Approach End Runway (RWY) 17 at Candlelight Farms Airport (11N), New Milford, CT.

Each solar array corner was studied separately at the location(s) and height(s) shown below:

2018-ANE-209-OE: 41-34-38.11N / 73-27-06.22W / 10 ft. AGL / 843 ft. AMSL
2018-ANE-210-OE: 41-34-41.06N / 73-27-15.95W / 10 ft. AGL / 863 ft. AMSL
2018-ANE-211-OE: 41-34-41.70N / 73-27-10.39W / 10 ft. AGL / 937 ft. AMSL

The proposed locations have been identified as obstructions under the standards of Title 14, Code of Federal Regulations (CFR), Part 77, as applied to 11N as follows:

Section 77.17 (a) (5): The surface of a takeoff and landing area of an airport or any imaginary surface established under 77.19, 77.21, or 77.23. However, no part of the takeoff or landing area itself will be considered an obstruction.

Section 77.19 (a): A Horizontal plane 150 ft. above the established airport elevation, the perimeter of which is constructed by swinging arcs of a specified radii from the center of each end of the primary surface of each RWY of each airport and connecting the adjacent arcs by lines tangent to those arcs. The proposals exceed the Horizontal Surface by up to the following:

2018-ANE-209-OE: Exceeds by 18 ft.
2018-ANE-210-OE: Exceeds by 38 ft.
2018-ANE-211-OE: Exceeds by 112 ft.

The proposals would also be located within the traffic pattern airspace (TPA) for all categories of aircraft using 11N. The proposed locations are located abeam the airport, where aircraft would be in level flight, or where an aircraft would start their descent for landing to RWY 17. The proposals were shown to exceed the Horizontal Surface as applied to visual approach runways at 11N by the following:

2018-ANE-209-OE: Exceeds by 18 ft. (level flight area)
2018-ANE-210-OE: Exceeds by 38 ft. (descent area)
2018-ANE-211-OE: Exceeds by 112 ft. (descent area)

Note: Candlelight Farms airport is a single visual runway operation activated December 10, 1970. Runway 17/35 is a turf runway, 2,900 ft. in length by 50 ft. in width. The traffic pattern is left hand traffic with no restrictions. Controlling obstructions for the airport denote both hills and trees. The airport is closed to transient aircraft, helicopter, and glider activity. The airport is also closed to touch and go landings thereby potentially limiting traffic pattern activity. Experimental aircraft require prior permission before landing. The Airport Master Record (IQ5010) indicates 14 single engine aircraft are stationed at the airport, with airport activity totaling 13,000 aircraft operations for a 12-month period ending July 31, 2017.

The airport elevation is estimated at 675 ft. MSL. Surrounding terrain in proximity to the proposals on the northeast side of the airport exceed the airport elevation by an estimated 325 ft. on Candlewood Mountain. The proposals themselves are located on the side of the mountain and shielded by both terrain and natural

vegetation. FAA Order 7400.2, Procedures for Handling Airspace Matters, allows for an exception when the surrounding terrain is significantly higher than the airport elevation.

The proposals were issued Notices of Presumed Hazard letters on February 2, 2018. A request for public circularization was received from the proponent on February 8, 2018. To facilitate the public comment process in an efficient manner, all case studies were included in the public notice issued on February 9, 2018. under case study 2017-ANE-211-OE. Separate determinations shall be issued for each individual case associated with this proposal. After circularization to all known aviation interests and to non-aeronautical interests that may be affected by the proposal, five letters of objection were received as a result of circularization.

The objections are summarized as follows: Concerns were expressed that the proposed solar array will remove an "emergency alternate landing area" to the east of the airfield.

Response: After review of available terminal procedures, the Airport Master Record dated 3/1/2018, as well as information obtained from the appropriate FAA Airport District Office, the FAA has no records on file of any alternative/emergency landing field published for or in the vicinity of 11N on record. Off-airport property land use concerns do not fall within the scope of a Title 14 CFR Part 77 aeronautical study.

Objection: Solar panels would cause an increase to the VFR traffic pattern.

Response: The solar panels would cause a minimal increase in height in an area where existing terrain already penetrates the Part 77 Horizontal Surface as well as the VFR Traffic Pattern's Horizontal Surface at 11N. In addition, existing terrain in proximity to the proposal is of greater height, up to 1,000 ft. MSL, and also penetrates the traffic pattern. Additionally, Runway 17/35 has a published offset centerline (125 ft. left for RWY 17, 35 ft. left for RWY 35) due to the controlling obstructions east of the field, tress and the hill upon which the solar panels are proposed.

Objection: The solar panels will emit thermal effects, glare, and the risk of electric shock in case of an aircraft impacting the solar array itself, as well as negative impact to the appearance of natural surroundings.

Response: Thermal effects, glint, and glare do not fall within the scope of Title 14 CFR Part 77 requiring an aeronautical study for evaluation. The FAA has limited data regarding glint and glare from solar panels located off airport property, and these characteristics have no established standards from which to identify or measure effect. Additionally, land use concerns do not fall within the scope of a Title 14 CFR Part 77 aeronautical study. These types of concerns are best addressed through local zoning commissions/boards at the state or local level.

A suggestion was made recommending the initiation of new notice of proposed rulemaking action for addressing solar glare issues. The public is welcome to petition the FAA to add a new regulation, or amend or repeal a current regulation, in accordance with procedures contained in Title 14 CFR part 11, subpart 11.61, Petitions for Rulemaking and for Exemption. Unfortunately, those suggestions are not reviewable through this evaluation process.

Aeronautical study disclosed that the proposals would have no effects on existing or proposed arrival, departure, or en route instrument flight rule (IFR) operations, minimum flight altitudes, minimum vectoring altitudes (MVA), aeronautical procedures, aeronautical facilities or at any other know public use or military airport. Information on the proposals shall be forwarded for appropriate aeronautical charting.

Study for possible visual flight rules (VFR) effect disclosed that the proposals would exceed 77.19 (a) as noted above, but would have no substantial adverse effect on any existing or proposed arrival or departure VFR operations or procedures. The minimal increase is expected to have no greater aeronautical effects on aviation or 11N airport as existing terrain in proximity is of greater height, up to 1,000 ft. MSL. The proposal was found not to conflict with airspace required to conduct normal VFR traffic pattern operations at 11N, or at any other known or proposed public-use or military airports. At up to 10 ft. AGL, the proposals would not have a substantial adverse effect on VFR en route flight operations or on any VFR routes in the vicinity of this location.

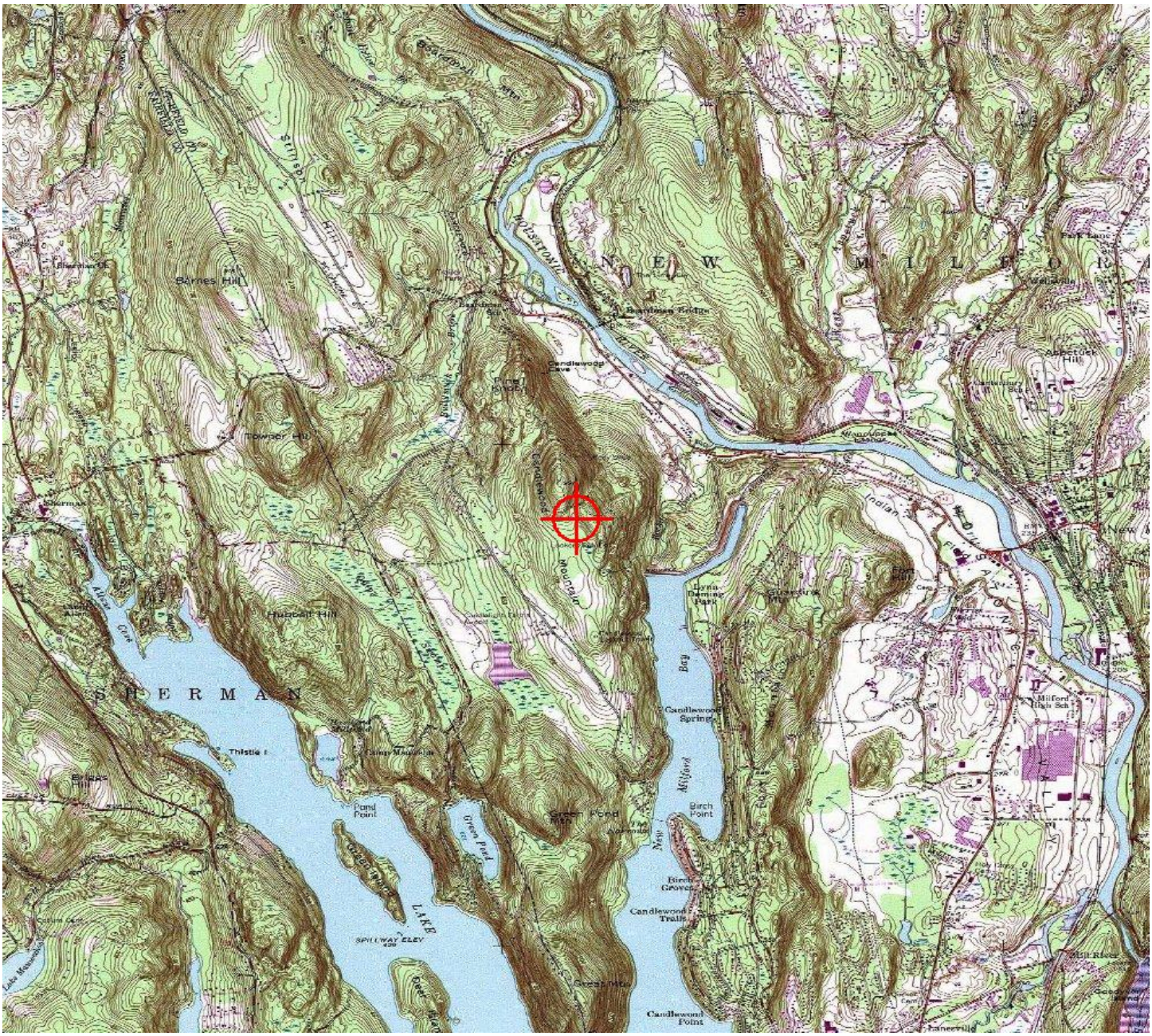
The proposals should be lit with red obstruction lights to make them more conspicuous to airmen should circumnavigation be necessary.

The cumulative impact of the proposals, when combined with other proposed and existing structures, is not considered to be significant. Study did not disclose any adverse effects on existing or proposed public-use or military airports or navigational facilities, nor does the proposal affect the capacity of any known existing or planned public-use or military airport.

Therefore, it is determined that the proposals would not have a substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on any air navigation facility and would not be a hazard to air navigation as long as all conditions written within this determination are met.

24MW solar array (please refer to Site Plan)

TOPO Map for ASN 2018-ANE-209-OE



Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANE-210-OE
Prior Study No.
2017-ANE-2226-OE

Issued Date: 04/12/2018

Brian Pitreau
Brian Pitreau
30 Danforth Street
Suite 108
Portland, ME 04105

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Solar Panel Solar Panel Solar PV Array - North Point 1
Location:	New Milford, CT
Latitude:	41-34-41.06N NAD 83
Longitude:	73-27-15.95W
Heights:	853 feet site elevation (SE)
	10 feet above ground level (AGL)
	863 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure would have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities. Therefore, pursuant to the authority delegated to me, it is hereby determined that the structure would not be a hazard to air navigation provided the following condition(s) is(are) met:

As a condition to this Determination, the structure is to be marked/lighted in accordance with FAA Advisory circular 70/7460-1 L Change 1, Obstruction Marking and Lighting, red lights - Chapters 4,5(Red),&12.

Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, should be reported immediately to (877) 487-6867 so a Notice to Airmen (NOTAM) can be issued. As soon as the normal operation is restored, notify the same number.

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

_____ At least 10 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

See attachment for additional condition(s) or information.

This determination expires on 10/12/2019 unless:

(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.
(b) extended, revised, or terminated by the issuing office.
(c) the construction is subject to the licensing authority of the Federal Communications Commission (FCC) and an application for a construction permit has been filed, as required by the FCC, within 6 months of the date of this determination. In such case, the determination expires on the date prescribed by the FCC for completion of construction, or the date the FCC denies the application.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE E-FILED AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE. AFTER RE-EVALUATION OF CURRENT OPERATIONS IN THE AREA OF THE STRUCTURE TO DETERMINE THAT NO SIGNIFICANT AERONAUTICAL CHANGES HAVE OCCURRED, YOUR DETERMINATION MAY BE ELIGIBLE FOR ONE EXTENSION OF THE EFFECTIVE PERIOD.

This determination is subject to review if an interested party files a petition that is received by the FAA on or before May 12, 2018. In the event a petition for review is filed, it must contain a full statement of the basis upon which it is made and be submitted to the Manager of the Airspace Policy Group. Petitions can be submitted via mail to Federal Aviation Administration, 800 Independence Ave, SW, Room 423, Washington, DC 20591, via email at OEPetitions@faa.gov, or via facsimile (202) 267-9328.

This determination becomes final on May 22, 2018 unless a petition is timely filed. In which case, this determination will not become final pending disposition of the petition. Interested parties will be notified of the grant of any review. For any questions regarding your petition, please contact Airspace Policy Group via telephone – 202-267-8783.

This determination is based, in part, on the foregoing description which includes specific coordinates, heights, frequency(ies) and power. Any changes in coordinates, heights and frequencies or use of greater power, except those frequencies specified in the Colo Void Clause Coalition; Antenna System Co-Location; Voluntary Best Practices, effective 21 Nov 2007, will void this determination. Any future construction or alteration, including increase to heights, power or the addition of other transmitters, requires separate notice to the FAA. This determination includes all previously filed frequencies and power for this structure.

If construction or alteration is dismantled or destroyed, you must submit notice to the FAA within 5 days after the construction or alteration is dismantled or destroyed.

This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

This aeronautical study considered and analyzed the impact on existing and proposed arrival, departure, and en route procedures for aircraft operating under both visual flight rules and instrument flight rules; the impact on all existing and planned public-use airports, military airports and aeronautical facilities; and the cumulative impact resulting from the studied structure when combined with the impact of other existing or proposed

structures. The study disclosed that the described structure would have no substantial adverse effect on air navigation.

An account of the study findings, aeronautical objections received by the FAA during the study (if any), and the basis for the FAA's decision in this matter can be found on the following page(s).

If we can be of further assistance, please contact David Maddox, at (202) 267-4525, or david.maddox@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANE-210-OE.

Signature Control No: 352700406-362358450 (DNH)
Mike Helvey
Manager, Obstruction Evaluation Group

Attachment(s)
Additional Information
Case Description
Map(s)

Additional information for ASN 2018-ANE-210-OE

The three proposed locations of the solar array, at a height of 10 feet (ft.) above ground level (AGL) / 843 to 937 ft. above mean sea level (AMSL), would be located approximately 3,371 to 3,846 ft. northeast of the Approach End Runway (RWY) 17 at Candlelight Farms Airport (11N), New Milford, CT.

Each solar array corner was studied separately at the location(s) and height(s) shown below:

2018-ANE-209-OE: 41-34-38.11N / 73-27-06.22W / 10 ft. AGL / 843 ft. AMSL
2018-ANE-210-OE: 41-34-41.06N / 73-27-15.95W / 10 ft. AGL / 863 ft. AMSL
2018-ANE-211-OE: 41-34-41.70N / 73-27-10.39W / 10 ft. AGL / 937 ft. AMSL

The proposed locations have been identified as obstructions under the standards of Title 14, Code of Federal Regulations (CFR), Part 77, as applied to 11N as follows:

Section 77.17 (a) (5): The surface of a takeoff and landing area of an airport or any imaginary surface established under 77.19, 77.21, or 77.23. However, no part of the takeoff or landing area itself will be considered an obstruction.

Section 77.19 (a): A Horizontal plane 150 ft. above the established airport elevation, the perimeter of which is constructed by swinging arcs of a specified radii from the center of each end of the primary surface of each RWY of each airport and connecting the adjacent arcs by lines tangent to those arcs. The proposals exceed the Horizontal Surface by up to the following:

2018-ANE-209-OE: Exceeds by 18 ft.
2018-ANE-210-OE: Exceeds by 38 ft.
2018-ANE-211-OE: Exceeds by 112 ft.

The proposals would also be located within the traffic pattern airspace (TPA) for all categories of aircraft using 11N. The proposed locations are located abeam the airport, where aircraft would be in level flight, or where an aircraft would start their descent for landing to RWY 17. The proposals were shown to exceed the Horizontal Surface as applied to visual approach runways at 11N by the following:

2018-ANE-209-OE: Exceeds by 18 ft. (level flight area)
2018-ANE-210-OE: Exceeds by 38 ft. (descent area)
2018-ANE-211-OE: Exceeds by 112 ft. (descent area)

Note: Candlelight Farms airport is a single visual runway operation activated December 10, 1970. Runway 17/35 is a turf runway, 2,900 ft. in length by 50 ft. in width. The traffic pattern is left hand traffic with no restrictions. Controlling obstructions for the airport denote both hills and trees. The airport is closed to transient aircraft, helicopter, and glider activity. The airport is also closed to touch and go landings thereby potentially limiting traffic pattern activity. Experimental aircraft require prior permission before landing. The Airport Master Record (IQ5010) indicates 14 single engine aircraft are stationed at the airport, with airport activity totaling 13,000 aircraft operations for a 12-month period ending July 31, 2017.

The airport elevation is estimated at 675 ft. MSL. Surrounding terrain in proximity to the proposals on the northeast side of the airport exceed the airport elevation by an estimated 325 ft. on Candlewood Mountain. The proposals themselves are located on the side of the mountain and shielded by both terrain and natural

vegetation. FAA Order 7400.2, Procedures for Handling Airspace Matters, allows for an exception when the surrounding terrain is significantly higher than the airport elevation.

The proposals were issued Notices of Presumed Hazard letters on February 2, 2018. A request for public circularization was received from the proponent on February 8, 2018. To facilitate the public comment process in an efficient manner, all case studies were included in the public notice issued on February 9, 2018. under case study 2017-ANE-211-OE. Separate determinations shall be issued for each individual case associated with this proposal. After circularization to all known aviation interests and to non-aeronautical interests that may be affected by the proposal, five letters of objection were received as a result of circularization.

The objections are summarized as follows: Concerns were expressed that the proposed solar array will remove an "emergency alternate landing area" to the east of the airfield.

Response: After review of available terminal procedures, the Airport Master Record dated 3/1/2018, as well as information obtained from the appropriate FAA Airport District Office, the FAA has no records on file of any alternative/emergency landing field published for or in the vicinity of 11N on record. Off-airport property land use concerns do not fall within the scope of a Title 14 CFR Part 77 aeronautical study.

Objection: Solar panels would cause an increase to the VFR traffic pattern.

Response: The solar panels would cause a minimal increase in height in an area where existing terrain already penetrates the Part 77 Horizontal Surface as well as the VFR Traffic Pattern's Horizontal Surface at 11N. In addition, existing terrain in proximity to the proposal is of greater height, up to 1,000 ft. MSL, and also penetrates the traffic pattern. Additionally, Runway 17/35 has a published offset centerline (125 ft. left for RWY 17, 35 ft. left for RWY 35) due to the controlling obstructions east of the field, tress and the hill upon which the solar panels are proposed.

Objection: The solar panels will emit thermal effects, glare, and the risk of electric shock in case of an aircraft impacting the solar array itself, as well as negative impact to the appearance of natural surroundings.

Response: Thermal effects, glint, and glare do not fall within the scope of Title 14 CFR Part 77 requiring an aeronautical study for evaluation. The FAA has limited data regarding glint and glare from solar panels located off airport property, and these characteristics have no established standards from which to identify or measure effect. Additionally, land use concerns do not fall within the scope of a Title 14 CFR Part 77 aeronautical study. These types of concerns are best addressed through local zoning commissions/boards at the state or local level.

A suggestion was made recommending the initiation of new notice of proposed rulemaking action for addressing solar glare issues. The public is welcome to petition the FAA to add a new regulation, or amend or repeal a current regulation, in accordance with procedures contained in Title 14 CFR part 11, subpart 11.61, Petitions for Rulemaking and for Exemption. Unfortunately, those suggestions are not reviewable through this evaluation process.

Aeronautical study disclosed that the proposals would have no effects on existing or proposed arrival, departure, or en route instrument flight rule (IFR) operations, minimum flight altitudes, minimum vectoring altitudes (MVA), aeronautical procedures, aeronautical facilities or at any other know public use or military airport. Information on the proposals shall be forwarded for appropriate aeronautical charting.

Study for possible visual flight rules (VFR) effect disclosed that the proposals would exceed 77.19 (a) as noted above, but would have no substantial adverse effect on any existing or proposed arrival or departure VFR operations or procedures. The minimal increase is expected to have no greater aeronautical effects on aviation or 11N airport as existing terrain in proximity is of greater height, up to 1,000 ft. MSL. The proposal was found not to conflict with airspace required to conduct normal VFR traffic pattern operations at 11N, or at any other known or proposed public-use or military airports. At up to 10 ft. AGL, the proposals would not have a substantial adverse effect on VFR en route flight operations or on any VFR routes in the vicinity of this location.

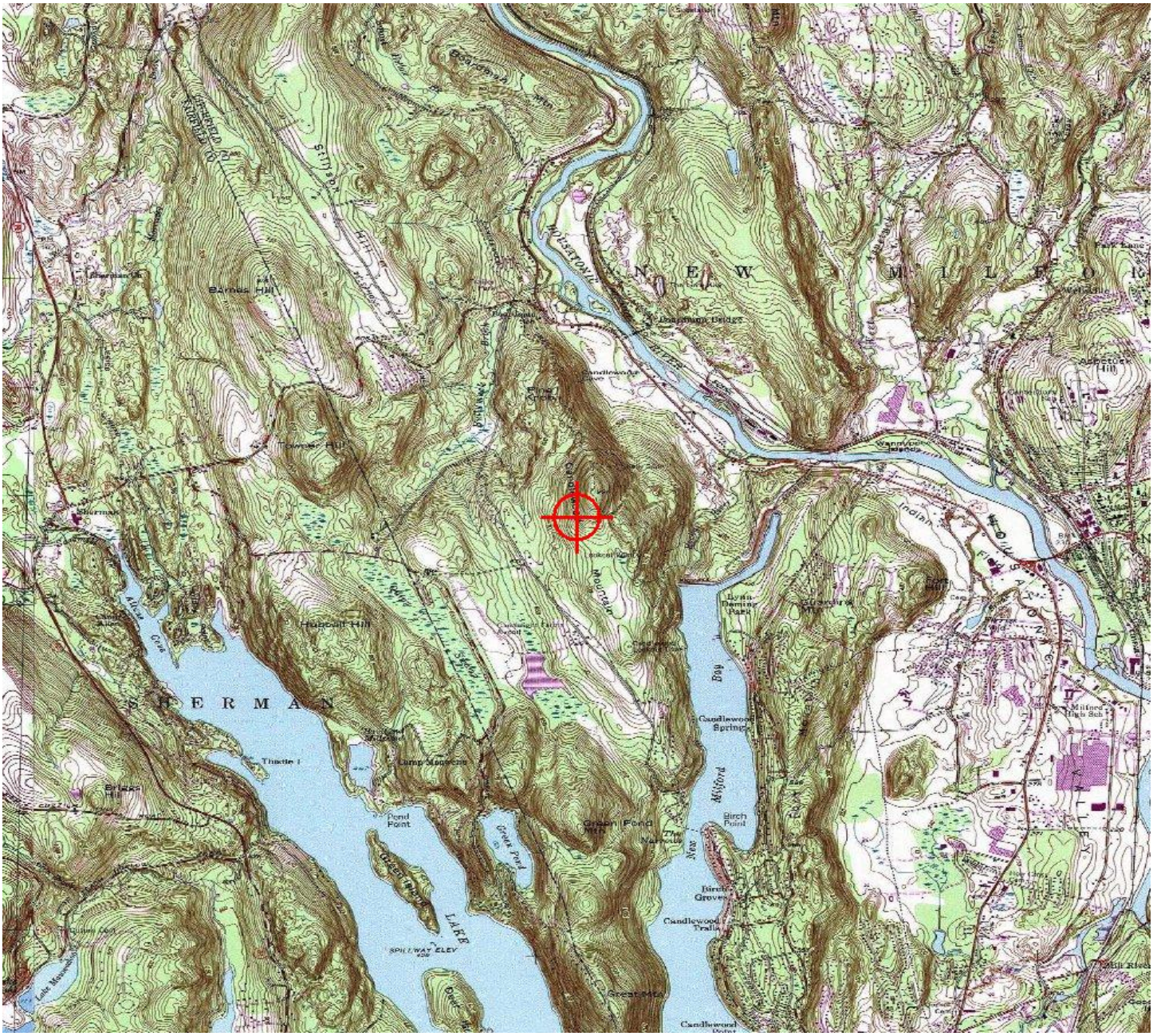
The proposals should be lit with red obstruction lights to make them more conspicuous to airmen should circumnavigation be necessary.

The cumulative impact of the proposals, when combined with other proposed and existing structures, is not considered to be significant. Study did not disclose any adverse effects on existing or proposed public-use or military airports or navigational facilities, nor does the proposal affect the capacity of any known existing or planned public-use or military airport.

Therefore, it is determined that the proposals would not have a substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on any air navigation facility and would not be a hazard to air navigation as long as all conditions written within this determination are met.

24MW solar array (please refer to Site Plan)

TOPO Map for ASN 2018-ANE-210-OE



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Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANE-211-OE
Prior Study No.
2017-ANE-2227-OE

Issued Date: 04/12/2018

Brian Pitreau
Brian Pitreau
30 Danforth Street
Suite 108
Portland, ME 04105

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Solar Panel Solar Panel Solar PV Array - North Point 2
Location:	New Milford, CT
Latitude:	41-34-41.70N NAD 83
Longitude:	73-27-10.39W
Heights:	927 feet site elevation (SE)
	10 feet above ground level (AGL)
	937 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure would have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities. Therefore, pursuant to the authority delegated to me, it is hereby determined that the structure would not be a hazard to air navigation provided the following condition(s) is(are) met:

As a condition to this Determination, the structure is to be marked/lighted in accordance with FAA Advisory circular 70/7460-1 L Change 1, Obstruction Marking and Lighting, red lights - Chapters 4,5(Red),&12.

Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, should be reported immediately to (877) 487-6867 so a Notice to Airmen (NOTAM) can be issued. As soon as the normal operation is restored, notify the same number.

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

_____ At least 10 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

See attachment for additional condition(s) or information.

This determination expires on 10/12/2019 unless:

(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.
(b) extended, revised, or terminated by the issuing office.
(c) the construction is subject to the licensing authority of the Federal Communications Commission (FCC) and an application for a construction permit has been filed, as required by the FCC, within 6 months of the date of this determination. In such case, the determination expires on the date prescribed by the FCC for completion of construction, or the date the FCC denies the application.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE E-FILED AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE. AFTER RE-EVALUATION OF CURRENT OPERATIONS IN THE AREA OF THE STRUCTURE TO DETERMINE THAT NO SIGNIFICANT AERONAUTICAL CHANGES HAVE OCCURRED, YOUR DETERMINATION MAY BE ELIGIBLE FOR ONE EXTENSION OF THE EFFECTIVE PERIOD.

This determination is subject to review if an interested party files a petition that is received by the FAA on or before May 12, 2018. In the event a petition for review is filed, it must contain a full statement of the basis upon which it is made and be submitted to the Manager of the Airspace Policy Group. Petitions can be submitted via mail to Federal Aviation Administration, 800 Independence Ave, SW, Room 423, Washington, DC 20591, via email at OEPetitions@faa.gov, or via facsimile (202) 267-9328.

This determination becomes final on May 22, 2018 unless a petition is timely filed. In which case, this determination will not become final pending disposition of the petition. Interested parties will be notified of the grant of any review. For any questions regarding your petition, please contact Airspace Policy Group via telephone – 202-267-8783.

This determination is based, in part, on the foregoing description which includes specific coordinates, heights, frequency(ies) and power. Any changes in coordinates, heights and frequencies or use of greater power, except those frequencies specified in the Colo Void Clause Coalition; Antenna System Co-Location; Voluntary Best Practices, effective 21 Nov 2007, will void this determination. Any future construction or alteration, including increase to heights, power or the addition of other transmitters, requires separate notice to the FAA. This determination includes all previously filed frequencies and power for this structure.

If construction or alteration is dismantled or destroyed, you must submit notice to the FAA within 5 days after the construction or alteration is dismantled or destroyed.

This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

This aeronautical study considered and analyzed the impact on existing and proposed arrival, departure, and en route procedures for aircraft operating under both visual flight rules and instrument flight rules; the impact on all existing and planned public-use airports, military airports and aeronautical facilities; and the cumulative impact resulting from the studied structure when combined with the impact of other existing or proposed

structures. The study disclosed that the described structure would have no substantial adverse effect on air navigation.

An account of the study findings, aeronautical objections received by the FAA during the study (if any), and the basis for the FAA's decision in this matter can be found on the following page(s).

If we can be of further assistance, please contact David Maddox, at (202) 267-4525, or david.maddox@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANE-211-OE.

Signature Control No: 352700407-362358452 (DNH)
Mike Helvey
Manager, Obstruction Evaluation Group

Attachment(s)
Additional Information
Case Description
Map(s)

Additional information for ASN 2018-ANE-211-OE

The three proposed locations of the solar array, at a height of 10 feet (ft.) above ground level (AGL) / 843 to 937 ft. above mean sea level (AMSL), would be located approximately 3,371 to 3,846 ft. northeast of the Approach End Runway (RWY) 17 at Candlelight Farms Airport (11N), New Milford, CT.

Each solar array corner was studied separately at the location(s) and height(s) shown below:

2018-ANE-209-OE: 41-34-38.11N / 73-27-06.22W / 10 ft. AGL / 843 ft. AMSL
2018-ANE-210-OE: 41-34-41.06N / 73-27-15.95W / 10 ft. AGL / 863 ft. AMSL
2018-ANE-211-OE: 41-34-41.70N / 73-27-10.39W / 10 ft. AGL / 937 ft. AMSL

The proposed locations have been identified as obstructions under the standards of Title 14, Code of Federal Regulations (CFR), Part 77, as applied to 11N as follows:

Section 77.17 (a) (5): The surface of a takeoff and landing area of an airport or any imaginary surface established under 77.19, 77.21, or 77.23. However, no part of the takeoff or landing area itself will be considered an obstruction.

Section 77.19 (a): A Horizontal plane 150 ft. above the established airport elevation, the perimeter of which is constructed by swinging arcs of a specified radii from the center of each end of the primary surface of each RWY of each airport and connecting the adjacent arcs by lines tangent to those arcs. The proposals exceed the Horizontal Surface by up to the following:

2018-ANE-209-OE: Exceeds by 18 ft.
2018-ANE-210-OE: Exceeds by 38 ft.
2018-ANE-211-OE: Exceeds by 112 ft.

The proposals would also be located within the traffic pattern airspace (TPA) for all categories of aircraft using 11N. The proposed locations are located abeam the airport, where aircraft would be in level flight, or where an aircraft would start their descent for landing to RWY 17. The proposals were shown to exceed the Horizontal Surface as applied to visual approach runways at 11N by the following:

2018-ANE-209-OE: Exceeds by 18 ft. (level flight area)
2018-ANE-210-OE: Exceeds by 38 ft. (descent area)
2018-ANE-211-OE: Exceeds by 112 ft. (descent area)

Note: Candlelight Farms airport is a single visual runway operation activated December 10, 1970. Runway 17/35 is a turf runway, 2,900 ft. in length by 50 ft. in width. The traffic pattern is left hand traffic with no restrictions. Controlling obstructions for the airport denote both hills and trees. The airport is closed to transient aircraft, helicopter, and glider activity. The airport is also closed to touch and go landings thereby potentially limiting traffic pattern activity. Experimental aircraft require prior permission before landing. The Airport Master Record (IQ5010) indicates 14 single engine aircraft are stationed at the airport, with airport activity totaling 13,000 aircraft operations for a 12-month period ending July 31, 2017.

The airport elevation is estimated at 675 ft. MSL. Surrounding terrain in proximity to the proposals on the northeast side of the airport exceed the airport elevation by an estimated 325 ft. on Candlewood Mountain. The proposals themselves are located on the side of the mountain and shielded by both terrain and natural

vegetation. FAA Order 7400.2, Procedures for Handling Airspace Matters, allows for an exception when the surrounding terrain is significantly higher than the airport elevation.

The proposals were issued Notices of Presumed Hazard letters on February 2, 2018. A request for public circularization was received from the proponent on February 8, 2018. To facilitate the public comment process in an efficient manner, all case studies were included in the public notice issued on February 9, 2018. under case study 2017-ANE-211-OE. Separate determinations shall be issued for each individual case associated with this proposal. After circularization to all known aviation interests and to non-aeronautical interests that may be affected by the proposal, five letters of objection were received as a result of circularization.

The objections are summarized as follows: Concerns were expressed that the proposed solar array will remove an "emergency alternate landing area" to the east of the airfield.

Response: After review of available terminal procedures, the Airport Master Record dated 3/1/2018, as well as information obtained from the appropriate FAA Airport District Office, the FAA has no records on file of any alternative/emergency landing field published for or in the vicinity of 11N on record. Off-airport property land use concerns do not fall within the scope of a Title 14 CFR Part 77 aeronautical study.

Objection: Solar panels would cause an increase to the VFR traffic pattern.

Response: The solar panels would cause a minimal increase in height in an area where existing terrain already penetrates the Part 77 Horizontal Surface as well as the VFR Traffic Pattern's Horizontal Surface at 11N. In addition, existing terrain in proximity to the proposal is of greater height, up to 1,000 ft. MSL, and also penetrates the traffic pattern. Additionally, Runway 17/35 has a published offset centerline (125 ft. left for RWY 17, 35 ft. left for RWY 35) due to the controlling obstructions east of the field, tress and the hill upon which the solar panels are proposed.

Objection: The solar panels will emit thermal effects, glare, and the risk of electric shock in case of an aircraft impacting the solar array itself, as well as negative impact to the appearance of natural surroundings.

Response: Thermal effects, glint, and glare do not fall within the scope of Title 14 CFR Part 77 requiring an aeronautical study for evaluation. The FAA has limited data regarding glint and glare from solar panels located off airport property, and these characteristics have no established standards from which to identify or measure effect. Additionally, land use concerns do not fall within the scope of a Title 14 CFR Part 77 aeronautical study. These types of concerns are best addressed through local zoning commissions/boards at the state or local level.

A suggestion was made recommending the initiation of new notice of proposed rulemaking action for addressing solar glare issues. The public is welcome to petition the FAA to add a new regulation, or amend or repeal a current regulation, in accordance with procedures contained in Title 14 CFR part 11, subpart 11.61, Petitions for Rulemaking and for Exemption. Unfortunately, those suggestions are not reviewable through this evaluation process.

Aeronautical study disclosed that the proposals would have no effects on existing or proposed arrival, departure, or en route instrument flight rule (IFR) operations, minimum flight altitudes, minimum vectoring altitudes (MVA), aeronautical procedures, aeronautical facilities or at any other know public use or military airport. Information on the proposals shall be forwarded for appropriate aeronautical charting.

Study for possible visual flight rules (VFR) effect disclosed that the proposals would exceed 77.19 (a) as noted above, but would have no substantial adverse effect on any existing or proposed arrival or departure VFR operations or procedures. The minimal increase is expected to have no greater aeronautical effects on aviation or 11N airport as existing terrain in proximity is of greater height, up to 1,000 ft. MSL. The proposal was found not to conflict with airspace required to conduct normal VFR traffic pattern operations at 11N, or at any other known or proposed public-use or military airports. At up to 10 ft. AGL, the proposals would not have a substantial adverse effect on VFR en route flight operations or on any VFR routes in the vicinity of this location.

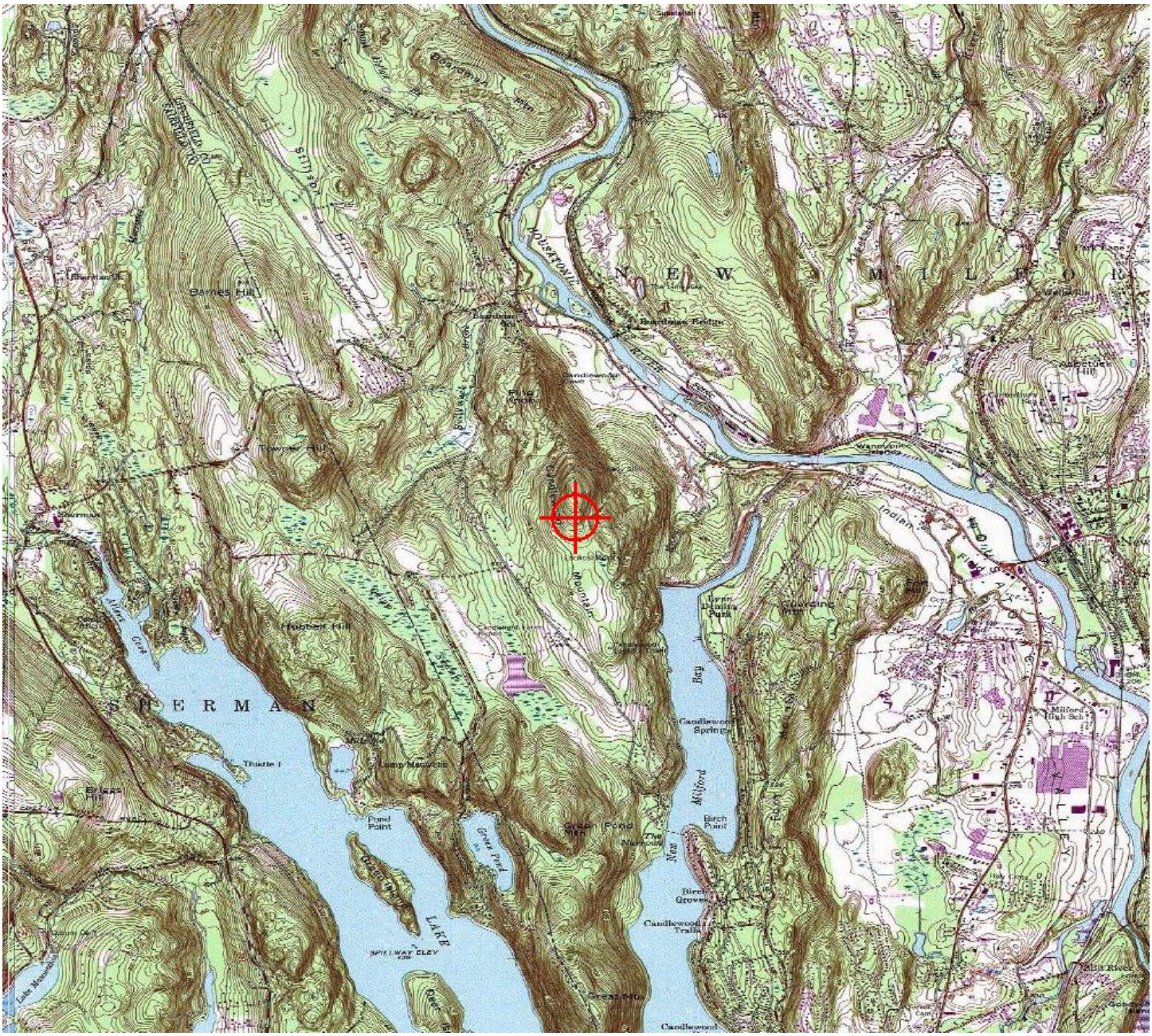
The proposals should be lit with red obstruction lights to make them more conspicuous to airmen should circumnavigation be necessary.

The cumulative impact of the proposals, when combined with other proposed and existing structures, is not considered to be significant. Study did not disclose any adverse effects on existing or proposed public-use or military airports or navigational facilities, nor does the proposal affect the capacity of any known existing or planned public-use or military airport.

Therefore, it is determined that the proposals would not have a substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on any air navigation facility and would not be a hazard to air navigation as long as all conditions written within this determination are met.

24MW solar array (please refer to Site Plan)

TOPO Map for ASN 2018-ANE-211-OE



Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANE-209-OE
Prior Study No.
2017-ANE-2226-OE

Issued Date: 10/25/2019

Brian Pitreau
Brian Pitreau
30 Danforth Street
Suite 108
Portland, ME 04105

**** Extension ****

A Determination was issued by the Federal Aviation Administration (FAA) concerning:

Structure:	Solar Panel Solar Panel Solar PV Array - NE Point
Location:	New Milford, CT
Latitude:	41-34-38.11N NAD 83
Longitude:	73-27-06.22W
Heights:	833 feet site elevation (SE) 10 feet above ground level (AGL) 843 feet above mean sea level (AMSL)

In response to your request for an extension of the effective period of the determination, the FAA has reviewed the aeronautical study in light of current aeronautical operations in the area of the structure and finds that no significant aeronautical changes have occurred which would alter the determination issued for this structure.

This extension is subject to review if an interested party files a petition that is received by the FAA on or before November 24, 2019. In the event a petition for review is filed, it must contain a full statement of the basis upon which it is made and be submitted to the Manager of the Airspace Policy Group. Petitions can be submitted via mail to Federal Aviation Administration, 800 Independence Ave, SW, Room 423, Washington, DC 20591, via email at OEPetitions@faa.gov, or via facsimile (202) 267-9328.

This extension becomes final on December 04, 2019 unless a petition is timely filed. In which case, this determination will not become final pending disposition of the petition. Interested parties will be notified of the grant of any review. For any questions regarding your petition, please contact Airspace Policy Group via telephone – 202-267-8783.

Accordingly, pursuant to the authority delegated to me, the effective period of the determination issued under the above cited aeronautical study number is hereby extended and will expire on 04/25/2021 unless otherwise extended, revised, or terminated by this office. You must adhere to all conditions identified in the original determination.

This extension issued in accordance with 49 U.S.C., Section 44718 and, if applicable, Title 14 of the Code of Federal Regulations, part 77, concerns the effect of the structure on the safe and efficient use of navigable

airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

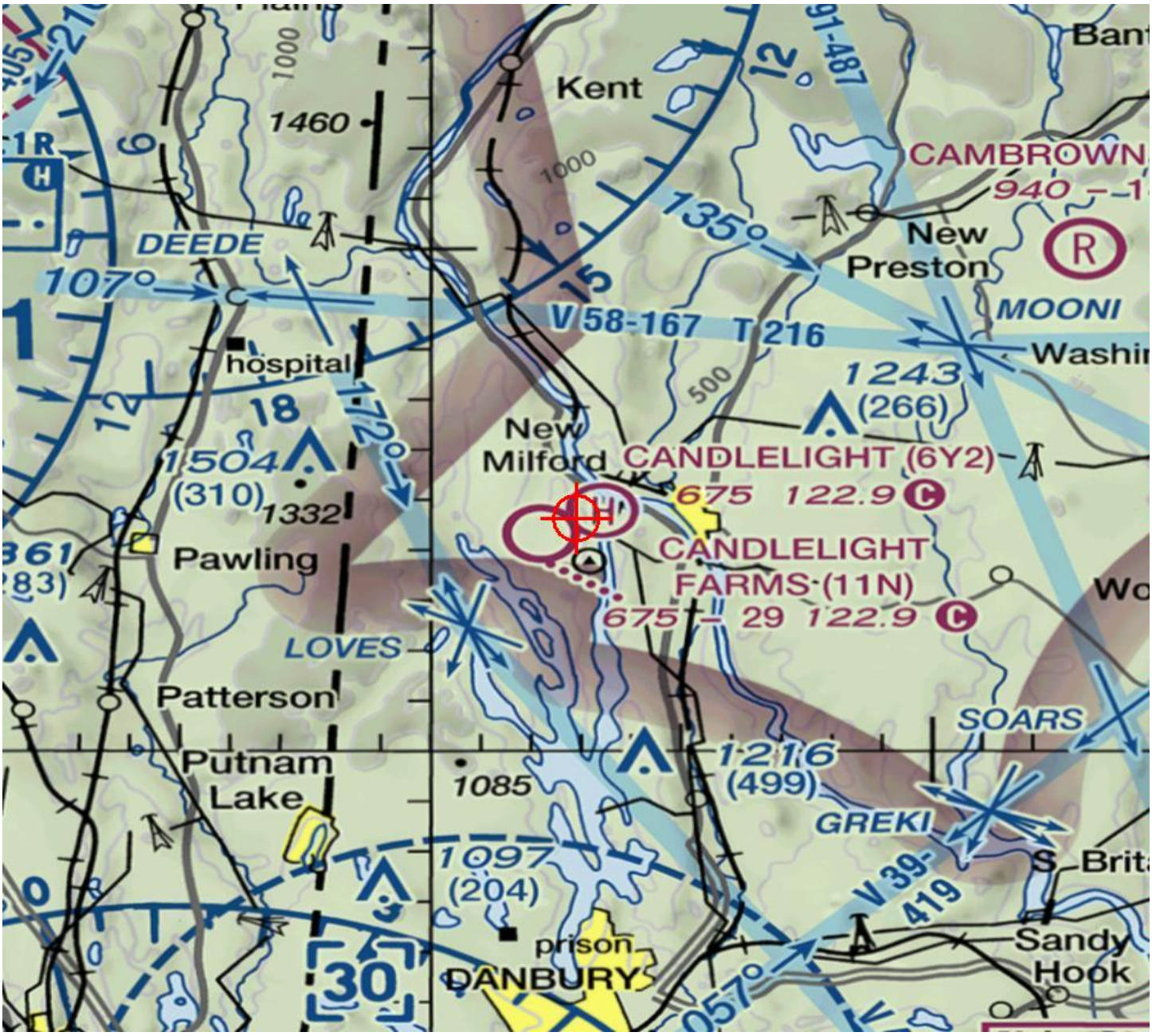
If we can be of further assistance, please contact our office at (202) 267-4525, or david.maddox@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANE-209-OE.

Signature Control No: 352700405-420912163 (EXT)
David Maddox
Specialist

Attachment(s)
Case Description
Map(s)

24MW solar array (please refer to Site Plan)

Sectional Map for ASN 2018-ANE-209-OE



Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANE-210-OE
Prior Study No.
2017-ANE-2226-OE

Issued Date: 10/25/2019

Brian Pitreau
Brian Pitreau
30 Danforth Street
Suite 108
Portland, ME 04105

**** Extension ****

A Determination was issued by the Federal Aviation Administration (FAA) concerning:

Structure:	Solar Panel Solar Panel Solar PV Array - North Point 1
Location:	New Milford, CT
Latitude:	41-34-41.06N NAD 83
Longitude:	73-27-15.95W
Heights:	853 feet site elevation (SE) 10 feet above ground level (AGL) 863 feet above mean sea level (AMSL)

In response to your request for an extension of the effective period of the determination, the FAA has reviewed the aeronautical study in light of current aeronautical operations in the area of the structure and finds that no significant aeronautical changes have occurred which would alter the determination issued for this structure.

This extension is subject to review if an interested party files a petition that is received by the FAA on or before November 24, 2019. In the event a petition for review is filed, it must contain a full statement of the basis upon which it is made and be submitted to the Manager of the Airspace Policy Group. Petitions can be submitted via mail to Federal Aviation Administration, 800 Independence Ave, SW, Room 423, Washington, DC 20591, via email at OEPetitions@faa.gov, or via facsimile (202) 267-9328.

This extension becomes final on December 04, 2019 unless a petition is timely filed. In which case, this determination will not become final pending disposition of the petition. Interested parties will be notified of the grant of any review. For any questions regarding your petition, please contact Airspace Policy Group via telephone – 202-267-8783.

Accordingly, pursuant to the authority delegated to me, the effective period of the determination issued under the above cited aeronautical study number is hereby extended and will expire on 04/25/2021 unless otherwise extended, revised, or terminated by this office. You must adhere to all conditions identified in the original determination.

This extension issued in accordance with 49 U.S.C., Section 44718 and, if applicable, Title 14 of the Code of Federal Regulations, part 77, concerns the effect of the structure on the safe and efficient use of navigable

airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

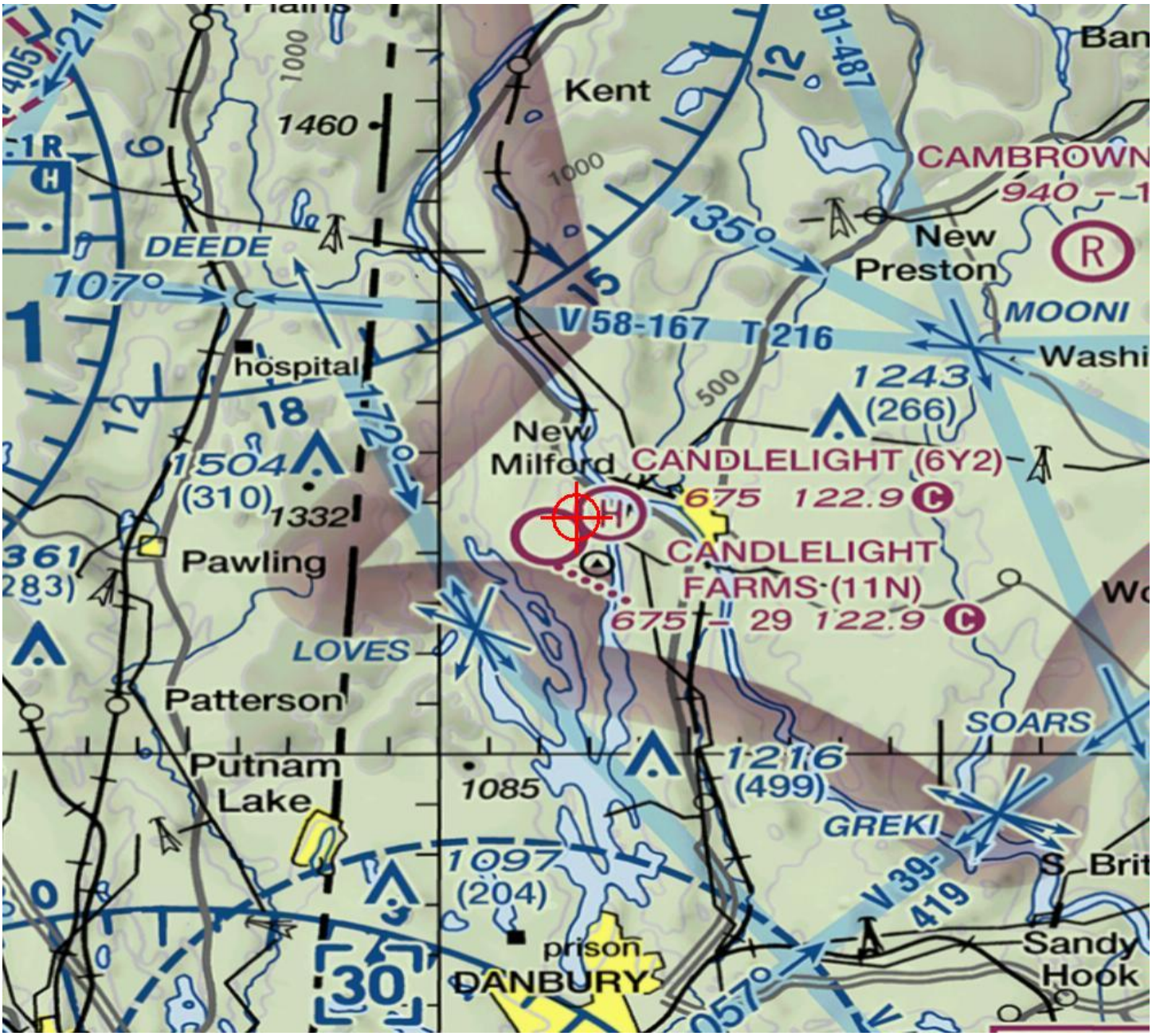
If we can be of further assistance, please contact our office at (202) 267-4525, or david.maddox@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANE-210-OE.

Signature Control No: 352700406-420913107 (EXT)
David Maddox
Specialist

Attachment(s)
Case Description
Map(s)

24MW solar array (please refer to Site Plan)

Sectional Map for ASN 2018-ANE-210-OE



Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANE-211-OE
Prior Study No.
2017-ANE-2227-OE

Issued Date: 10/25/2019

Brian Pitreau
Brian Pitreau
30 Danforth Street
Suite 108
Portland, ME 04105

**** Extension ****

A Determination was issued by the Federal Aviation Administration (FAA) concerning:

Structure:	Solar Panel Solar Panel Solar PV Array - North Point 2
Location:	New Milford, CT
Latitude:	41-34-41.70N NAD 83
Longitude:	73-27-10.39W
Heights:	927 feet site elevation (SE) 10 feet above ground level (AGL) 937 feet above mean sea level (AMSL)

In response to your request for an extension of the effective period of the determination, the FAA has reviewed the aeronautical study in light of current aeronautical operations in the area of the structure and finds that no significant aeronautical changes have occurred which would alter the determination issued for this structure.

This extension is subject to review if an interested party files a petition that is received by the FAA on or before November 24, 2019. In the event a petition for review is filed, it must contain a full statement of the basis upon which it is made and be submitted to the Manager of the Airspace Policy Group. Petitions can be submitted via mail to Federal Aviation Administration, 800 Independence Ave, SW, Room 423, Washington, DC 20591, via email at OEPetitions@faa.gov, or via facsimile (202) 267-9328.

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Accordingly, pursuant to the authority delegated to me, the effective period of the determination issued under the above cited aeronautical study number is hereby extended and will expire on 04/25/2021 unless otherwise extended, revised, or terminated by this office. You must adhere to all conditions identified in the original determination.

This extension issued in accordance with 49 U.S.C., Section 44718 and, if applicable, Title 14 of the Code of Federal Regulations, part 77, concerns the effect of the structure on the safe and efficient use of navigable

airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

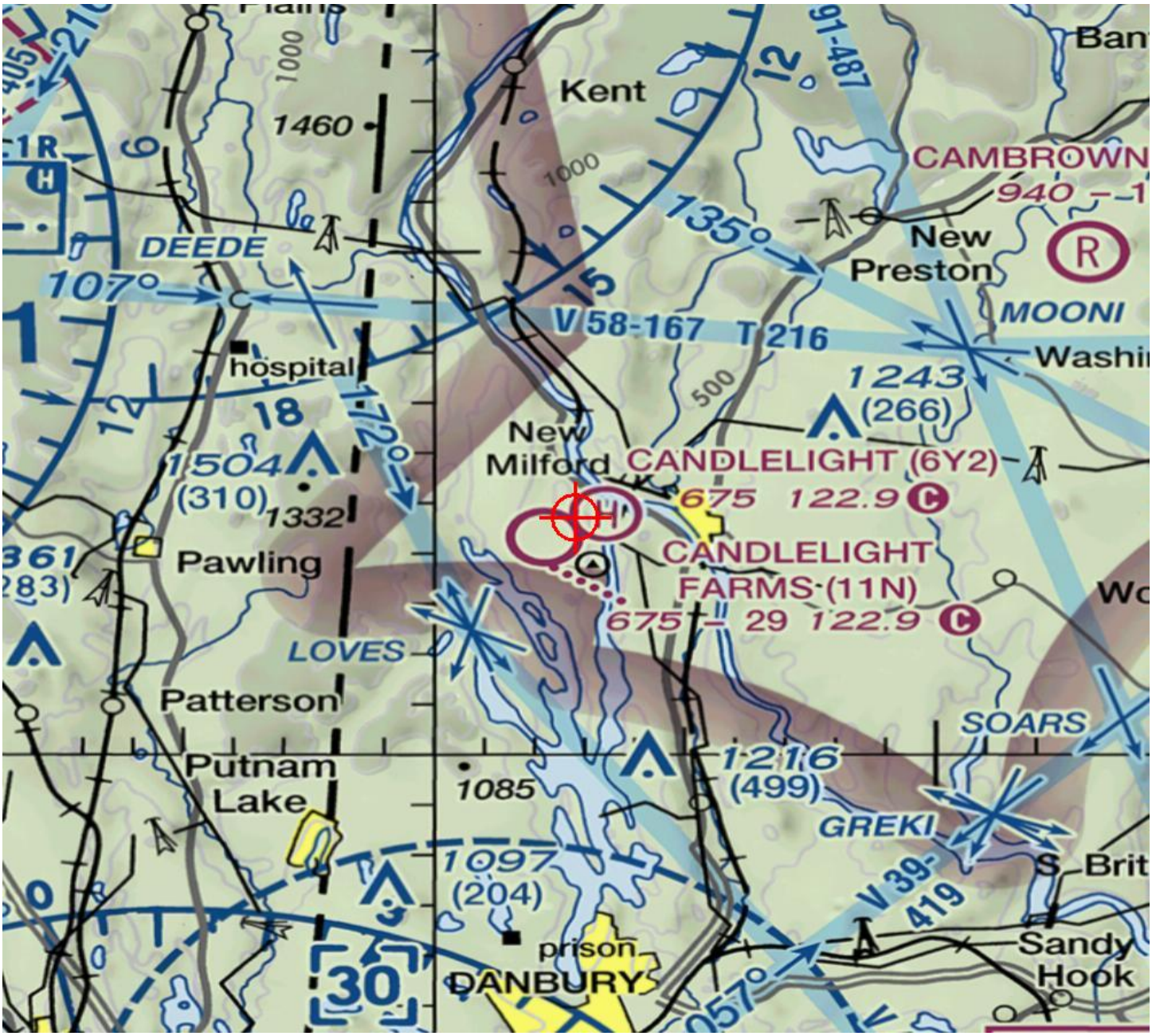
If we can be of further assistance, please contact our office at (202) 267-4525, or david.maddox@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANE-211-OE.

Signature Control No: 352700407-420914954 (EXT)
David Maddox
Specialist

Attachment(s)
Case Description
Map(s)

24MW solar array (please refer to Site Plan)

Sectional Map for ASN 2018-ANE-211-OE



U.S. Department
of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Obstruction Marking and Lighting **Date:** 10/8/2016 **AC No.** 70/7460-1L
Initiated By: AJV-15 **Change:** 1

1. **Purpose.** This Advisory Circular (AC) sets forth standards for marking and lighting obstructions that have been deemed to be a hazard to air navigation. The change number and date of the change material are located at the top of the page.

2. **Effective Date.** This change is effective October 8, 2016.

3. **Explanation of Changes.**
   a. Page 2-2. Paragraph 2.4.3 Note 2 stated NOTAMS were automatically deleted from the system after 15 days and the sponsor was responsible for calling outage reporting to extend the outage date or to report a return to service date. This paragraph has been deleted. Tower owners now have the option to select the amount of time their NOTAMS remain active.

   b. Page A-1. Appendix A, Specifications for Obstruction Lighting Equipment Classification, Table A-1 FAA-Approved Obstruction Lighting Fixtures indicated:
      L-885 – *Low Intensity Flashing* – RED
      It has been changed to L-885 Flashing Obstruction Light (60 FPM) – RED

   c. Entire publication. Additional editorial/format changes were made where necessary. Revision bars were not used because of the insignificant nature of these changes.

Gary A. Norek
Director, Airspace Services

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Obstruction Marking and Lighting

Date: 10/07/2016 **AC No.** 70/7460-1L
Initiated By: AJV-15 **Change:** 1

4. **Purpose.**
This Advisory Circular (AC) sets forth standards for marking and lighting obstructions that have been deemed to be a hazard to navigable airspace. Advisory Circular 70/7460-1L is effective immediately.

5. **Cancellation.**
Advisory Circular 70/7460-1K, Obstruction Lighting and Marking, dated February 1, 2007, is cancelled.

6. **Principal Changes.**
The principal changes in this AC are:

1. The height of a structure identified as an obstruction has been lowered from 500 feet above ground level (AGL) to 499 feet above ground level, by amendment to Title 14 Code of Federal Regulations (14 CFR) Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace* (75 Federal Register 42303, July 21, 2010). Accordingly, all structures that are above 499 feet AGL are considered obstructions and the Federal Aviation Administration (FAA) will study them to determine their effect on the navigable airspace. This will ensure that all usable airspace at and above 500 feet AGL is addressed during an aeronautical study and that this airspace is protected from obstructions that may create a hazard to air navigation.
2. Standards for voluntary marking of meteorological evaluation towers (METs), less than 200 feet above ground level (AGL), has been added to provide recommendations towards increasing conspicuity of these structures, particularly for low-level agricultural flight operations. These standards include those for lighting and marking of the tower and associated guy wires.

3. A new Chapter 14, Aircraft Detection Lighting Systems, has been added to provide performance standards for these types of systems.
4. New lighting and marking standards are provided to reduce impact on migratory bird populations.
5. Medium-intensity white and medium-intensity dual obstruction light are now authorized on towers up to and including 700 feet AGL.
6. Editorial changes have been made.

7. **Related Reading Material.**

1. Advisory Circular 150/5345-43, Specification of Obstruction Marking and Lighting.
2. 14 CFR Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace.

8. **Application.**

The FAA recommends the guidelines and standards in this AC for determining the proper way to light and mark obstructions affecting navigable airspace. This AC does not constitute a regulation and, in general, is not mandatory. However, a sponsor proposing any type of construction or alteration of a structure that may affect the National Airspace System (NAS) is required under the provisions of Title 14 Code of Federal Regulations to notify the FAA by completing the Notice of Proposed Construction or Alteration form (FAA Form 7460-1). These guidelines may become mandatory as part of the FAA's determination and should be followed on a case-by-case basis, as required.

9. **Comments or Suggestions.**

Direct comments or suggestions regarding this AC to:

Manager, Obstruction Evaluation Group
Federal Aviation Administration
ATTN: AJV-15
800 Independence Avenue, S.W.
Washington, DC 20591

CONTENTS

Paragraph **Page**

CHAPTER 1. ADMINISTRATIVE AND GENERAL PROCEDURES

1.1 Reporting Requirements.

A sponsor proposing any type of construction or alteration of a structure that may affect the NAS as required under the provisions of Title 14 Code of Federal Regulations (CFR) Part 77, Construction or alteration requiring notice, is to notify the Federal Aviation Administration (FAA) by completing the Notice of Proposed Construction or Alteration form (FAA Form 7460-1). This form should be filed electronically at https://oeaaa.faa.gov.

1.2 Preconstruction Notice.

The notice must be submitted:

1. At least 45 days prior to the date of proposed construction or alteration is to begin.
2. On or before the date an application for a construction permit is filed with the Federal Communications Commission (FCC). (The FCC advises its applicants to file with the FAA well in advance of the 45-day period to expedite FCC processing.)

1.3 FAA Acknowledgement.

The FAA will acknowledge, in writing, each FAA Form 7460-1 notice received.

1.4 Supplemental Notice Requirement.

1. If required, the FAA will include a statement requiring the filing of FAA Form 7460-2, Notice of Actual Construction or Alteration, on the determination. All FAA Forms 7460-2 should be filed electronically at http://oeaaa.faa.gov.
2. FAA Form 7460-2 Part 1 is to be completed and sent to the FAA at least 10 days prior to starting the actual construction or alteration of a structure. Part 2 shall be submitted within 5 days after the structure has reached its greatest height. The form should be filed electronically at http://oeaaa.faa.gov.
3. In addition, a supplemental notice shall be submitted upon abandonment of construction.
4. Letters are acceptable in cases where the construction/alteration is temporary or a proposal is abandoned. This notification process gives the FAA the necessary time to change effected procedures and/or minimum flight altitudes and to otherwise alert airmen of the structure's presence.

   Note: Notification, as required in the determination, is critical to aviation safety.

1.5 Modifications and Deviations.

Requests for modification or deviation from the standards outlined in this AC must be submitted to the FAA Obstruction Evaluation Group (OEG). The sponsor is responsible for adhering to approved marking and/or lighting limitations, and/or recommendations given, and should notify the FAA and FCC (for those structures regulated by the FCC) prior to removal of marking and/or lighting. A request received after a determination is issued may require a new study and could result in a new determination.

1. Modification Examples. Modifications will be based on whether they impact aviation safety. Examples of modifications are as follows:

   a. Marking and/or Lighting Only a Portion of an Object. The object may be located with respect to other objects or terrain that only a portion of it needs to be marked or lighted.

   b. No Marking and/or Lighting. The object may be located with respect to other objects or terrain, removed from the general flow of air traffic, or may be so conspicuous by its shape, size or color that marking or lighting would serve no useful purpose.

   c. Voluntary Marking and/or Lighting. The object may be located with respect to other objects or terrain that the sponsor feels increased conspicuity would better serve aviation safety. Sponsors who desire to voluntarily mark and/or light their structure should do so in accordance with this AC.

   d. Marking or Lighting an Object in Accordance with the Standards for an Object of Greater Height or Size. The object may present such an extraordinary hazard potential that higher standards may be recommended for increased conspicuity to ensure aviation safety.

2. Deviations. The assigned Obstruction Evaluation Specialist will conduct an aeronautical study of the proposed deviation(s) and forward their recommendation to FAA Headquarters, OEG Manager, in Washington, DC, for final approval. Examples of deviations that may be considered:

   a. Colors of objects.

   b. Dimensions of color bands or rectangles.

   c. Colors/types of lights.

   d. Basic signals and intensity of lighting.

   e. Night/day lighting combinations.

   f. Flash rate.

3. The FAA strongly recommends that owners become familiar with the different types of lighting systems and to specifically request the type of lighting system desired when submitting FAA Form 7460-1. Information on these systems is given in Table A-1 in Appendix A. While the FAA will make every effort to accommodate the structure sponsor's request, sponsors should also request

information from system manufacturers to determine which system best meets their needs based on purpose, installation, and maintenance costs.

1.6 **Additional Notification.**

Any change to the submitted information on which the FAA has based its determination, including modification, deviation, or optional upgrade to white lighting on structures, may require notice to the FCC prior to making the change for proper authorization and annotations of obstruction marking and lighting. These structures may be subject to inspection and enforcement of marking and lighting requirements by the FCC. FCC Forms and Bulletins can be obtained from the FCC's National Call Center at 1-888-CALL-FCC (1-888-225-5322) or online at https://www.fcc.gov.edgekey.net/licensing-databases/forms. Upon completion of the actual change, complete the "Add Supplemental Notice (7460-2 Form)" at the http://oeaaa.faa.gov website. You may also mail the FAA Form 7460-2 to:

FAA Aeronautical Information Services
1305 E W Hwy
Silver Spring, MD 20910
1-800-626-3677

CHAPTER 2. GENERAL

2.1 Structures to be Marked and Lighted.

Any temporary or permanent structure, including all appurtenances, that exceeds an overall height of 200 feet (61 m) above ground level (AGL) or exceeds any obstruction standard contained in 14 CFR Part 77 should be marked and/or lighted. However, an FAA aeronautical study may reveal that the absence of marking and/or lighting will not impair aviation safety. Conversely, the object may present such an extraordinary hazard potential that higher standards may be recommended for increased conspicuity to ensure aviation safety. In general, commercial outside lighting should not be used in lieu of FAA-recommended marking and/or lighting. Recommendations on marking and/or lighting structures can vary, depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, the number of structures and overall design layout. The FAA may also recommend marking and/or lighting a structure that does not exceed 200 (61 m) feet AGL or 14 CFR Part 77 standards because of its particular location. The marking and lighting configurations are illustrated in Appendix A, Figures A-1 through A-27.

2.2 Guyed Structures.

The guys of a 2,000-foot (610-m) skeletal tower are anchored between 1,600 feet (488 m) and 2,000 feet (610 m) from the base of the structure. This places a portion of the guys 1,500 feet (458 m) from the tower at a height of between 125 feet (38 m) and 500 feet (153 m) AGL. Title 14 CFR Part 91, Section 119, requires pilots, when operating over other than congested areas, to remain at least 500 feet (153 m) from man-made structures. Therefore, the tower must be cleared by 2,000 feet (610 m) horizontally to avoid all guy wires. Properly maintained marking and lighting are important for increased conspicuity because the guys of a structure are difficult to see until the aircraft is dangerously close.

2.3 Marking and Lighting Equipment.

Considerable effort and research was expended to determine the minimum marking and lighting systems or quality of materials that will produce an acceptable level of aviation safety. The FAA will recommend only those marking and lighting systems that meet established technical standards. While additional lights may be desirable to identify an obstruction to air navigation and may, on occasion, be recommended, the FAA will recommend minimum standards in the interest of safety, economy, and related concerns. Therefore, to provide an adequate level of safety, obstruction lighting systems should be installed, operated, and maintained in accordance with the recommended standards herein. Table A-1 in Appendix A contains descriptions of each FAA-approved obstruction lighting fixture that is referred to in this AC.

2.4 Light Failure Notification.

2.4.1 Sponsors should consider that conspicuity is achieved only when all recommended lights are working. Partial equipment outages decrease the margin of safety. Any outage should be corrected as soon as possible. Failure of steady-burning side or intermediate lights should be corrected as soon as possible, but notification is not required.

2.4.2 Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, should be reported immediately by calling Outage Reporting and Notice to Airmen (NOTAM) 877-487-6867, or for Alaska 800-478-3576, so a NOTAM can be issued. Lights that are voluntary (not required by an FAA determination) do not require a NOTAM. For structures that are regulated by the FCC, the FCC advises that noncompliance with notification procedures could subject the sponsor to penalties or monetary forfeitures.

2.4.3 The following information should be specified for outage reporting:

1. Name of persons or organizations reporting the light failures, including any title, address, and telephone number.
2. The type of structure.
3. Location of structure (including latitude and longitude, if known, prominent structures, landmarks, etc.).
4. Height of structure AGL/above mean sea level (AMSL) if known.
5. A return to service date.
6. FCC Antenna Structure Registration Number (for structures that are regulated by the FCC).

Note: When the primary lamp in a double obstruction light fails, and the secondary lamp comes on, no report is required.

2.5 Notification of Restoration.

As soon as normal operation is restored, notify outage reporting. For structures that are regulated by the FCC, the FCC advises that noncompliance with notification procedures could subject the sponsor to penalties or monetary forfeitures.

2.6 Federal Communications Commission (FCC) Requirement.

The use of a high-intensity flashing white lighting system on structures located in residential neighborhoods (as defined by applicable zoning laws) trigger requirements for FCC licenses and an environmental assessment.

2.7 Voluntary Marking of Meteorological Evaluation Towers (METs) Less Than 200 Feet (61 m) AGL.

2.7.1 Recommendation.

The FAA recommends voluntary marking of METs less than 200 feet (61 m) AGL in accordance with marking guidance contained in this advisory circular (AC). Historically, this guidance has not been applied. However, the FAA recognizes the need to address safety impacts to low-level agricultural flight operations, and it believes that voluntarily marking METs less than 200 feet (61 m) AGL in remote and rural areas enhance the conspicuity of these structures.

2.7.2 Painting.

METs should be painted in accordance to the criteria contained in Chapter 3, paragraphs 3.1 through 3.4, specifically, with alternate bands of aviation orange and white paint. In addition, paragraph 3.5 states that all markings should be replaced when faded or otherwise deteriorated.

2.7.3 High-Visibility Sleeves.

It is recommended that several high-visibility sleeves be installed on the MET's outer guy wires. One high-visibility sleeve should be installed on each guy wire, as close to the anchor point as possible, but at a, height well above the crop or vegetation canopy. A second sleeve should be installed on the same outer guy wires midway between the location of the lower sleeve and the upper attachment point of the guy wire to the MET.

2.7.4 Spherical Markers.

It is also recommended that high-visibility aviation orange spherical marker (or cable) balls be attached to the guy wires. Spherical markers should be installed and displayed in accordance to Chapter 3, paragraph 3.5. The FAA, however, recognizes various weather conditions and manufacturing placement standards may affect the placement and use of high-visibility sleeves and/or spherical markers. Thus, some flexibility is allowed when determining sleeve length and marker placement on METs.

2.8 Obstruction Height Definition Changed to 499 Feet AGL.

Because of changes made to 14 CFR Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace*, on July 21, 2010, the height of a structure (identified as an obstruction) was lowered to 499 feet AGL from 500 feet AGL. Consequently, all structures that are above 499 feet AGL will be designated as obstructions. The FAA will conduct an aeronautical study to determine the effect on navigable airspace. This will ensure all usable airspace at and above 500 feet AGL is addressed during the study and the airspace is safe for air navigation.

CHAPTER 3. MARKING GUIDELINES

3.1 Purpose.

This chapter provides recommended guidelines to make certain structures conspicuous to pilots during daylight hours. One way to achieve this conspicuity is to paint and/or mark these structures. Recommendations on marking structures can vary, depending on terrain features, weather patterns, geographic location, and the number of structures. Specific marking guidelines for wind turbines are contained in Chapter 13.

3.2 Paint Colors.

Alternate sections of aviation orange and white paint should be used as the contrast in colors provides maximum visibility of an obstruction. Specific paint standards are contained in Chapter 12.

3.3 Paint Standards.

To be effective, the paint used should meet specific color requirements when freshly applied to a structure. Because all outdoor paints deteriorate with time, and it is not practical to give a maintenance schedule for all climates, surfaces should be repainted when the color changes noticeably or its effectiveness is reduced by scaling, oxidation, chipping, or layers of contamination. The subsequent standards should be followed.

3.3.1 Materials and Application.

The FAA recommends that quality paint and materials be selected to maximize years of service. The paint should be appropriate for the surfaces to be painted, including any previous coatings, and suitable for the environmental conditions. Surface preparation and paint application should follow the manufacturer's recommendations.

> **Note:** In-Service Aviation Orange Color Tolerance Charts are available from private suppliers for determining when repainting is required. The color should be sampled on the upper half of the structure, since weathering is greater there.

3.3.2 Surfaces not Requiring Paint.

Ladders, decks, and walkways of steel towers and similar structures do not need to be painted if a smooth surface presents a potential hazard to maintenance personnel. Painting may also be omitted from precision or critical surfaces if the paint would have an adverse effect on the transmission or radiation characteristics of a signal. However, the structure's overall marking effect should not be reduced.

3.3.3 Skeletal Structures.

Complete all marking/painting prior to or immediately upon completion of construction. This applies to catenary support structures, radio and television towers, and similar skeletal structures. To be effective, paint should be applied to all inner and outer surfaces of the framework.

3.4 Paint Patterns.

Various types of paint patterns are used to mark structures. The pattern is determined by the size and shape of the structure. The following patterns are recommended.

3.4.1 Solid Pattern.

Obstacles should be painted aviation orange if the structure's horizontal and vertical dimensions do not exceed 10.5 feet (3.2 m).

3.4.2 Checkerboard Pattern.

Alternating rectangles of aviation orange and white are normally displayed on the following structures:

1. Water, gas, and grain storage tanks.
2. Buildings, as required.
3. Large structures exceeding 10.5 feet (3.2 m) across, having a horizontal dimension that is equal to or greater than the vertical dimension.

3.4.3 Size of Patterns.

The sides of the checkerboard pattern should measure not less than 5 feet (1.5 m) or more than 20 feet (6 m) and should be as nearly square as possible. However, if it is impractical because of the size or shape of a structure, the sides of the patterns may be less than 5 feet (1.5 m). When possible, the corner surfaces should be painted aviation orange. (See Figures A-15 and A-16 in Appendix A.)

3.4.4 Alternate Bands.

Alternate bands of aviation orange and white are normally displayed on the following structures:

1. Communication towers and catenary support structures.
2. Poles.
3. Smokestacks.
4. Skeletal framework of storage tanks and similar structures.
5. Structures that appear narrow from a side view are 10.5 feet (3.2 m) or more across, and the horizontal dimension is less than the vertical dimension.
6. Coaxial cable, conduits, and other cables attached to the face of a tower.

3.4.5 Color Band Characteristics.

Bands for structures of any height should be:

1. Equal in width, provided each band is not less than 1 1/2 feet (0.5 m) or more than 100 feet (31 m) wide.
2. Perpendicular to the vertical axis with the bands at the top and bottom painted orange.

3. An odd number of bands on the structure.
4. Approximately one-seventh the height, if the structure is equal to or less than 700 feet (214 m) AGL. For each additional 200 feet (61 m) or fraction thereof, add one (1) additional orange and one (1) additional white band. Table 3-1 shows the required band widths based on the height of the structure.
5. Equal and in proportion to the structure's AGL height.

Table 3-1. Structure Height to Bandwidth Ratio

If a structure is:		**Then Band Width:**
Greater Than	**Equal to or Less Than**	**Band Width**
10.5 feet (3.2 m)	700 feet (214 m)	1/7 of height
700 feet (214 m)	900 feet (275 m)	1/9 of height
900 feet (275 m)	1,100 feet (336 m)	1/11of height
1,100 feet (336 m)	1,300 feet (397 m)	1/13 of height

3.4.6 Structures With a Cover or Roof.

If the structure has a cover or roof, the highest orange band should be continued to cover the entire top of the structure. (See Figures A-15 and A-16 in Appendix A.)

3.4.7 Skeletal Structures Atop Buildings.

If a flagpole, skeletal structure, or similar object is erected on top of a building, the combined height of the object and building will determine whether marking is recommended. However, only the height of the object filed with the FAA determines the width of the color bands.

3.4.8 Partial Marking.

If marking is recommended for only a portion of a structure because the structure is shielded by other objects or terrain, the width of the bands should be determined by the overall height of the structure. A minimum of three bands should be displayed on the upper portion of the structure.

3.4.9 Teardrop Pattern.

Spherical water storage tanks with a single, circular standpipe support may be marked in a teardrop-striped pattern. The tank should show alternate stripes of aviation orange and white. The stripes should extend from the top center of the tank to its supporting standpipe. The width of the stripes should be equal, and the width of each stripe at the greatest girth of the tank should not be less than 5 feet (1.5 m) nor more than 15 feet (4.6 m). (See Figure A-17 in Appendix A.)

3.4.10 Community Names.

If it is desirable to paint the name of the community on the side of a tank, the stripe pattern may be broken to serve this purpose. This open area should have a maximum height of 3 feet (0.9 m). (See Figure A-17 in Appendix A.)

3.4.11 Exceptions.

Structural designs not conducive to standard markings may be marked as follows:

1. If it is not practical to paint the roof of a structure in a checkerboard pattern, it may be painted solid orange.
2. If a spherical structure is not suitable for an exact checkerboard pattern, the shape of the rectangles may be modified to fit the shape of the surface.
3. Storage tanks not suitable for a checkerboard pattern may have alternating bands of aviation orange and white or a limited checkerboard pattern applied to the upper one-third of the structure.
4. The skeletal framework of certain water, gas, and grain storage tanks may be excluded from the checkerboard pattern.

3.5 **Unlighted Markers.**

Unlighted markers are used to identify structures and to make them more conspicuous when it is impractical to paint them. Unlighted markers may also be used in addition to aviation orange and white paint when additional conspicuity is necessary for aviation safety. Unlighted markers should be displayed in conspicuous positions on or adjacent to the structures so as to retain the general definition of the structure. They should be recognizable in clear, daytime visibility from a distance of at least 4,000 feet (1,219 m) and in all directions from which aircraft are likely to approach. Unlighted markers should be distinctively shaped, i.e., spherical or cylindrical, so that they are not mistaken for items that are used to convey other information. They should be replaced when faded or otherwise deteriorated.

3.5.1 Spherical Markers.

Spherical markers are used to identify overhead wires and catenary transmission lines that are less than 69 kV. Markers may be of another shape, i.e., cylindrical, provided the projected area of such markers is not less than that presented by a spherical marker.

1. Size and Color.

   The diameter of the markers used on extensive catenary wires (catenary wires that cross canyons, lakes, rivers, etc.) should not be less than 36 inches (91 cm). Smaller 20-inch (51-cm) spheres are permitted on less extensive catenary wires or on power lines below 50 feet (15 m) AGL and within 1,500 feet (458 m) of an airport runway end. Each marker should be a solid color, specifically aviation orange, white, or yellow.

2. Installations.

   a. Spacing. Unlighted markers should be spaced equally along the wire at approximately 200-foot (61-m) intervals, or fraction thereof. There should be less space between markers in critical areas near runway ends [i.e., 30 feet to 50 feet (10 m to 15 m)]. They should be displayed on the highest wire or by another means at the same height as the highest wire. Where there is more than one wire at the highest point, the markers may be installed alternately along each wire if the distance between adjacent markers meets the spacing standard of 200 feet or less. This method distributes the weight and wind-loading factors. (See Figure A-1 in Appendix A.)

   b. Pattern. An alternating color scheme provides the most conspicuity against all backgrounds. Unlighted markers should be installed by alternating solid-colored markers of aviation orange, white, and yellow. Normally, an orange marker is placed at each end of a line and the spacing is adjusted [not to exceed 200 feet (61 m)] to accommodate the rest of the markers. When less than four markers are used, they should all be aviation orange. (See Figure A-1 in Appendix A.)

   c. Wire Sag. Wire Sag, or droop, will occur due to temperature, wire weight, wind, etc. Twenty-five (25) feet (7.62 m) is the maximum allowable distance between the highest wire installed with marker balls and the highest wire without marker balls, and shall not violate the sag requirements of the transmission line design.

   d. Adjacent Lines. Catenary crossings with multiple transmission lines require appropriate markers when the adjacent catenary structure's outside lines are greater than 200 feet (61 m) away from the center of the primary structure. (See Figure A-2 in Appendix A.) If the outside lines of the adjacent catenary structure are within 200 feet (61 m) or less from the center of the primary structure, markers are not required on the adjacent lines. (See Figure A-3 in Appendix A.)

3.5.2 Flag Markers.

Flags are used to mark certain structures or objects when it is technically impractical to use spherical markers or paint. Some examples are temporary construction equipment, cranes, derricks, oil and other drilling rigs. Catenaries should use spherical markers.

1. Minimum Size. Each side of the flag marker should be at least 2 feet (0.6 m) in length.

2. Color Patterns. Flags should be colored as follows:

   a. Solid. Aviation orange.

   b. Orange and White. Arrange two triangular sections, one aviation orange and the other white to form a rectangle.

c. Checkerboard. Flags 3 feet (0.9 m) or larger should be a checkerboard pattern of aviation orange and white squares, each 1 foot (0.3 m) plus or minus 10 percent.

3. Shape. Flags should be rectangular in shape and have stiffeners to keep them from drooping in calm wind.

4. Display. Flag markers should be displayed around, on top, or along the highest edge of the obstruction. When flags are used to mark extensive or closely grouped obstructions, they should be displayed approximately 50 feet (15 m) apart. The flag stakes should be strong enough to support the flags and be higher than the surrounding ground, structures, and/or objects of natural growth.

3.6 Unusual Complexities.

The FAA may also recommend appropriate marking in an area in which grouped obstructions present a common obstruction to air navigation.

3.7 Omission or Alternatives to Marking.

The alternatives listed below require FAA review and concurrence.

3.7.1 High-Intensity Flashing White Lighting Systems.

High-intensity flashing white lighting systems are more effective than aviation orange and white paint and therefore can be recommended instead of paint marking. This is particularly true under certain ambient light conditions involving the position of the sun relative to the direction of flight. When high-intensity lighting systems are operated during daytime and twilight, other methods of marking may be omitted. When operated 24 hours a day, other methods of marking and lighting may be omitted.

3.7.2 Medium-Intensity Flashing White Lighting Systems.

When medium-intensity flashing white lighting systems are operated during daytime and twilight on structures 700 feet (213 m) AGL or less, other methods of marking may be omitted.

Note: Sponsors must ensure that alternatives to marking are coordinated with the FCC for structures under its jurisdiction prior to making the change.

CHAPTER 4. LIGHTING GUIDELINE

4.1 Purpose.

This chapter describes the various obstruction lighting systems used to identify structures that have been determined to require added conspicuity. The lighting standards in this AC are the minimum necessary for aviation safety. Recommendations on lighting structures can vary, depending on terrain features, weather patterns, geographic location, and number of structures. Specific lighting guidelines for wind turbines are contained in Chapter 13.

4.2 Standards.

The standards outlined in this AC are based on using light units that meet specified intensities, beam patterns, color, and flash rates as stated in AC 150/5345-43, *Specification for Obstruction Lighting Equipment*. These standards may be obtained from: www.faa.gov/airports/resources/advisory_circulars/

4.3 Lighting Systems.

Obstruction lighting may be displayed on structures as follows:

1. Aviation Red Obstruction Lights. Use flashing lights and/or steady-burning lights during nighttime. Tower structures are typically marked with flashing red lights. Buildings and smaller obstructions located near airports should be marked with steady-burning red lights. (See Chapter 5).

2. Medium-Intensity Flashing White Obstruction Lights. Medium-intensity flashing white obstruction lights may be used during daytime and twilight with automatically selected reduced intensity for nighttime operation. When this system is used on structures 700 feet (213 m) AGL or less, other methods of marking and lighting the structure may be omitted. Aviation orange and white paint is always required for daytime marking on structures exceeding 700 feet (213 m) AGL. This system is not normally recommended on structures 200 feet (61 m) AGL or less.

3. High-Intensity Flashing White Obstruction Lights. High-intensity flashing white obstruction lights may be used during daytime with automatically selected reduced intensities for twilight and nighttime operations. When this system is used, other methods of marking and lighting the structure may be omitted. This system should not be used on structures 700 feet (213 m) AGL or less, unless an FAA aeronautical study shows otherwise.

   Note: All flashing lights on a structure should flash simultaneously except for catenary support structures, which have a distinct flashing sequence between the levels of lights (see paragraph 4.4).

4. Dual Lighting. This system consists of red lights for nighttime and high- or medium-intensity flashing white obstruction lights for daytime and twilight. When a dual lighting system incorporates medium-intensity flashing white lights on

structures 700 feet (213 m) AGL or less or high-intensity flashing white lights on structures greater than 700 feet (213 m) AGL, other methods of marking the structure may be omitted.

5. Obstruction Lights During Construction. As the height of the structure exceeds each level at which permanent obstruction lights would be recommended, two or more lights of the type specified in the determination should be installed at that level. Temporary high or medium-intensity flashing white lights, as recommended in the determination, should be operated 24 hours a day until all permanent lights are in operation. In either case, two or more lights should be installed on the uppermost part of the structure any time it exceeds the height of the temporary construction equipment. They may be turned off for periods when they could interfere with construction personnel. If practical, permanent obstruction lights should be installed and operated at each level as construction progresses. The lights should be positioned to ensure that a pilot has an unobstructed view of at least one light at each level.

6. Obstruction Lights in Urban Areas. When a structure is located in an urban area where there are numerous other white lights (e.g., streetlights) red obstruction lights with painting or a medium-intensity dual system is recommended. Medium-intensity lighting is not normally recommended on structures less than 200 feet (61 m).

7. Temporary Construction Equipment Lighting. Since there is such a variance in construction cranes, derricks and other drilling rigs, each case should be considered individually. Lights should be installed according to the standards given in Chapters 5, 6, 7, or 8, as they would apply to permanent structures.

4.4 **Lighted Spherical Markers.**

4.4.1 Lighted markers are available for increased night conspicuity of high-voltage (69 kV or greater) transmission line catenary wires. These markers should be used on transmission line catenary wires near airports, heliports, across rivers, canyons, lakes, etc. The lighted markers should be manufacturer-certified as recognizable from a minimum distance of 4,000 feet (1,219 m) under nighttime conditions, minimum Visual Flight Rule (VFR) conditions or having a minimum intensity of at least 32.5 candelas. The lighting unit should emit a steady-burning, red light.

4.4.2 Lighted markers should be installed on the highest energized line. If the lighted markers are installed on a line other than the highest catenary, then markers specified in Chapter 3 paragraph 3.5 should be used in addition to the lighted markers. The maximum distance between the line energizing the lighted markers and the highest catenary above the lighted marker should be no more than 25 feet (7.62 m) and shall not violate the sag requirements of the transmission line design.

4.4.3 Lighted markers should be distinctively shaped, (i.e., spherical or cylindrical) so they are not mistaken for items that are used to convey other information. They should be visible in all directions from which aircraft are likely to approach. The area in the

immediate vicinity of the supporting structure's base should be clear of all items and/or objects of natural growth that could interfere with the line-of-sight between a pilot and the structure's lights. (See Figure A-4 in Appendix A.) When a catenary wire crossing requires three or more supporting structures, the inner structures should be equipped with enough light units per level to provide full coverage from which aircraft are likely to approach.

4.5 Inspection, Repair, and Maintenance.

To ensure the proper candela output for fixtures with incandescent lamps, the voltage provided to the lamp filament should not vary more than plus or minus three percent of the lamp's rated voltage. The input voltage should be measured at the closest disconnecting means to the lamp fixture with the lamp operating during the hours of normal operation. (For strobes, the input voltage of the power supplies should be within 10 percent of rated voltage.) Lamps should be replaced after being in operation for approximately 75 percent of their rated life or immediately upon failure. Flashtubes in a light unit should be replaced immediately upon failure, when the peak effective intensity falls below specification limits or when the fixture begins skipping flashes, or at the manufacturer's recommended intervals. Due to the effects of harsh environments, light fixture lenses should be visually inspected every 24 months, or when the light fixture fails, for ultraviolet (UV) damage, cracks, crazing, dirt buildup, etc., to ensure the certified light output has not deteriorated. (See Chapter 2 paragraph 2.4 for reporting requirements in case of failure.) Lenses that have cracks, UV damage, crazing, or excessive dirt buildup should be cleaned or replaced.

4.6 Nonstandard Lights.

Moored balloons, chimneys, church steeples, and similar obstructions may be floodlighted by fixed search light projectors installed at three or more equidistant points around the base of each obstruction. The searchlight projectors should provide an average illumination of at least 15 foot-candles (161.45 lux) over the top one-third of the obstruction.

4.7 Placement Factors.

The height of the structure AGL determines the number of light levels. The light levels may be adjusted slightly, but not to exceed 10 feet (3 m) when necessary to accommodate guy wires and personnel who replace or repair light fixtures. Except for catenary wire support structures, the following factors should be considered when determining the placement of obstruction lights on a structure.

1. Red Obstruction Lighting Systems. The structure's overall height, including all appurtenances, such as rods, antennas, and obstruction lights, determines the number of light levels.
2. Medium-Intensity Flashing White Obstruction Lighting Systems. The structure's overall height, including all appurtenances such as rods, antennas, and obstruction lights, determines the number of light levels.

3. High-Intensity Flashing White Obstruction Lighting Systems. The main structure's overall height, excluding all appurtenances, such as rods, antennas, and obstruction lights, determines the number of light levels.

4. Dual Obstruction Lighting Systems. The structure's overall height, including all appurtenances, such as rods, antennas, and obstruction lights, is used to determine the number of light levels for a medium-intensity white obstruction light/red obstruction dual lighting system. The structure's overall height, excluding all appurtenances, is used to determine the number of light levels for a high-intensity white obstruction light/red obstruction dual lighting system.

5. Adjacent Structures. The elevation of the tops of adjacent buildings in congested areas may be used as the equivalent of ground level to determine the correct number of light levels required.

6. Shielded Lights. If an adjacent structure or object blocks the visibility of an obstruction light, the light's horizontal placement should be adjusted or additional lights should be mounted on that object to retain or contribute to the definition of the obstruction.

7. Nesting of Lights. Care should be taken to ensure that obstruction lights do not become blocked or "nested" as new antennas, hardware, or appurtenances are added to the top of a structure. If new equipment is added that blocks the obstruction light's visibility, the light fixtures must be relocated and/or raised so that it is not blocked by the new equipment. For example, when new larger cellular antenna panels are fitted to older towers, the obstruction light will need to be raised so that it is not blocked by the larger antenna panels. The widest structure, appurtenance, lightning rod, or antenna that can be placed in front of an obstruction light (excluding the L-810 light) without significantly blocking the obstruction light's visibility should be no wider than 7/8 of an inch. Due to their smaller size, L-810 lights should not be blocked by any structure.

4.8 Monitoring Obstruction Lights.

Obstruction lighting systems should be closely monitored by visual or automatic means. It is extremely important to visually inspect obstruction lighting in all operating intensities at least once every 24 hours on systems without automatic monitoring. In the event a structure is not readily accessible for visual observation, a properly maintained automatic monitor should be used. This monitor should be designed to register the malfunction of any light on the obstruction regardless of its position or color. When using remote monitoring devices, the system's communication and operational status should be confirmed at least once every 24 hours. The monitor (aural or visual) should be located in an area generally occupied by the responsible personnel. In some cases, this may require a remote monitor in an attended location. For each structure, a log should be maintained in which the lighting system's daily operations status is recorded. Light fixture lenses should be replaced if serious cracks, hazing, dirt buildup, etc., has occurred.

4.9 **Ice Shields.**

Where icing is likely to occur, metal grates or similar protective ice shields should be installed directly over each light unit to prevent falling ice or accumulation from damaging the light units. The light should be mounted in a manner to ensure an unobstructed view of at least one light by a pilot approaching from any direction.

4.10 **Light Shields.**

In general, light shields are not permitted because of the adverse effects they have on the obstruction light fixture's photometrics. In addition, these shields can promote undesired snow accumulation, bird nesting, and wind loading.

4.11 **Distraction.**

When obstruction lights are in proximity to a navigable waterway, they may distract vessel operators. To avoid interference with marine navigation, coordinate with the Office of Navigation Systems, United States (U.S.) Coast Guard before installing the lighting system. The contact information for the U.S. Coast Guard is:

Commandant (CG-NAV-1)
U.S. Coast Guard
2703 Martin Luther King Jr. Ave SE STOP 7418
Washington, DC 20593-7418
202-372-1546

CHAPTER 5. RED OBSTRUCTION LIGHT SYSTEM

5.1 Purpose.

Red obstruction lights are used to increase conspicuity during nighttime. Daytime and twilight marking is required. Recommendations on lighting structures can vary, depending on terrain features, weather patterns, geographic location, and number of structures. Specific lighting guidelines for wind turbines are contained in Chapter 13.

5.2 Standards.

The red obstruction light system is composed of flashing omnidirectional lights (L-864) and/or steady-burning or flashing (L-810) lights. When one or more levels are comprised of flashing lights, the lights should flash simultaneously. The number of light levels needed is shown in Figure A-6 in Appendix A.

1. Single Obstruction Light. A single red obstruction light (L-810) may be used when more than one obstruction light is required either vertically or horizontally, or when maintenance is needed, and can be installed within a reasonable time.

    a. Top Level. A single steady-burning light (L-810) may be used to identify low structures, such as airport instrument landing system buildings, as well as long horizontal structures, such as perimeter fences and building roof outlines.

    b. Intermediate Level. Single flashing or steady-burning lights (as appropriate for size and type of structure) may be used on skeletal and solid structures when more than one level of lights is installed, and there are two or more single lights per level.

2. Double Obstruction Light. A double steady-burning (L-810) light should be installed when used as a top light, at each end of a row of single obstruction lights, and in areas or locations where the failure of a single unit could cause an obstruction to be totally unlighted.

    a. Top Level. Structures 150 feet (46 m) AGL or less should have one or more double steady-burning lights installed at the highest point and operating simultaneously.

    b. Intermediate Level. Double flashing or steady-burning lights (as appropriate for size and type of structure) should be installed at intermediate levels when a malfunction of a single light could create an unsafe condition and in remote areas where maintenance cannot be performed within a reasonable time. Both units may operate simultaneously, or a transfer relay may be used to switch to a spare unit should the active system fail.

    c. Lowest Level. The lowest level of light units may be installed at a higher elevation than normal on a structure if the surrounding terrain, trees, or adjacent building(s) would obscure the lights. In certain instances, as determined by the FAA, the lowest level of lights may be eliminated.

5.3 **Control Device.**

Red obstruction lights should be operated by an acceptable control device (e.g., photocell, timer, etc.) adjusted so the lights will be turned on when the northern sky illuminance reaching a vertical surface falls below a level of 60 foot-candles (645.8 lux) but before reaching a level of 35 foot-candles (376.7 lux). The control device should turn the lights off when the northern sky illuminance rises to a level of not more than 60 foot-candles (645.8 lux). The lights may also remain on continuously. The sensing device should, if practical, face the northern sky in the Northern Hemisphere. (See AC 150/5345-43.)

5.4 **Poles, Towers, and Similar Skeletal Structures.**

The following standards apply to radio and television towers, supporting structures for overhead transmission lines, and similar structures.

1. Top-Mounted Obstruction Light.

   a. Structures 150 Feet (46 m) AGL or Less. Two or more steady-burning red (L-810) lights should be installed in a manner to ensure an unobstructed view of one or more lights by a pilot.

   b. Structures Exceeding 150 Feet (46 m) AGL. At least one red flashing (L-864) light should be installed in a manner to ensure an unobstructed view of one or more lights by a pilot.

   c. Appurtenances 40 Feet (12 m) or Less. If a rod, antenna, or other appurtenance 40 feet (12 m) or less in height is incapable of supporting a red flashing light, then it may be placed at the base of the appurtenance. If the mounting location does not allow an unobstructed view of the light by a pilot, then additional lights should be added.

   d. Appurtenances Exceeding 40 Feet (12 m). If a rod, antenna, or other appurtenance exceeding 40 feet (12 m) in height is incapable of supporting a red flashing light, a supporting mast with one or more lights should be installed adjacent to the appurtenance. Adjacent installations should not exceed the appurtenance's height and be within 40 feet (12 m) of the tip to allow the pilot an unobstructed view of at least one light. If the rod, antenna, or other appurtenance is 7/8 inch wide or more, at least two lights must be installed on the supporting mast to provide the necessary unobstructed view.

2. Mounting Intermediate Levels. The number of light levels is determined by the height of the structure, including all appurtenances, as shown in Figure A-6 in Appendix A. The number of lights on each level is determined by the shape and height of the structure. These lights should be mounted to ensure an unobstructed view of at least one light by a pilot.

   a. Steady-Burning Lights (L-810).

      i. Structures 150 Feet (46 m) AGL or Less. Two or more steady-burning (L-810) lights should be installed diagonally or on diametrically opposite positions.

ii. Structures Exceeding 150 Feet (46 m) AGL. These structures do not require steady-burning (L-810) lights.

b. Flashing Lights (L-810). For structures exceeding 151 feet (46 m) but not more than 350 feet (107 m) at intermediate levels, two or more flashing (L-810) lights should be mounted outside at diagonally opposite positions of intermediate levels. These lights should be configured to flash simultaneously with the L-864 flashing light on the top of the structure at a rate of 30 flashes per minute (fpm) (± 3 fpm).

c. Flashing Lights (L-864).

i. Structures 350 Feet (107 m) AGL or Less. These structures do not require flashing (L-864) lights at intermediate levels.

ii. Structures Exceeding 350 Feet (107 m) AGL. At intermediate levels, as shown in Figure A-6 in Appendix A, two (L-864) lights should be mounted outside at diagonally opposite positions.

5.5 **Chimneys, Flare Stacks, and Similar Solid Structures.**

5.5.1 Number of Light Units.

The number of units recommended depends on the diameter of the structure at the top. The number of lights recommended below is the minimum.

1. Structures 20 Feet (6 m) or Less in Diameter. Three light units per level (see Figure A-20 in Appendix A).
2. Structures Exceeding 20 Feet (6 m) but not More Than 100 Feet (31 m) in Diameter. Four light units per level (see Figure A-20 in Appendix A).
3. Structures Exceeding 100 Feet (31 m) but not More Than 200 Feet (61 m) in Diameter. Six light units per level (see Figure A-21 in Appendix A).
4. Structures Exceeding 200 Feet (61 m) in Diameter. Eight light units per level.

5.5.2 Top-Mounted Obstruction Lights.

1. Structures 150 Feet (46 m) AGL or Less. L-810 lights should be installed horizontally at regular intervals at or near the top.
2. Structures Exceeding 150 Feet (46 m) AGL. At least three L-864 lights should be installed.
3. Chimneys, Cooling Towers, and Flare Stacks. Lights may be displayed as low as 20 feet (6-m) below the top (see Figure A-13 in Appendix A) to avoid the obscuring effect of deposits and heat generally emitted by this type of structure. It is important that these lights are readily accessible for cleaning and lamp replacement. It is understood that with flare stacks, as well as any other structures associated with the petrol-chemical industry, normal lighting requirements may not be necessary. This could be due to the location of the flare stack/structure within a large, well-lighted,

petrol-chemical plant, or the fact that the flare, or working lights surrounding the flare stack/structure, is as conspicuous as obstruction lights.

5.5.3 Mounting Intermediate Levels.

The number of light levels is determined by the height of the structure including all appurtenances. For cooling towers 600 feet (183 m) AGL or less, intermediate light levels are not necessary. Structures between 150 feet and 350 feet AGL or less should have a second level of steady-burning red light units installed approximately at the midpoint of the structure and in a vertical line with the top level of lights. Structures exceeding 350 feet (107 m) AGL should have a second level of flashing light units.

1. Steady-Burning (L-810) Lights. The recommended number of light levels is shown in Figure A-15 in Appendix A. At least three lights should be installed on each level.
2. Flashing (L-864) Lights. The recommended number of light levels is shown in Figure A-6 in Appendix A. At least three lights should be installed on each level.
    a. Structures 350 Feet (107 m) AGL or Less. These structures do not need intermediate levels of flashing lights.
    b. Structures Exceeding 350 Feet (107 m) AGL. At least three flashing (L-864) lights should be installed on each level in a manner, allowing an unobstructed view of at least one light.

5.6 Group of Obstructions.

When individual objects, except wind turbines, within a group of obstructions are not the same height and are spaced a maximum of 150 feet (46 m) apart, the prominent objects within the group should be lighted in accordance with the standards for individual obstructions of a corresponding height. If the outer structure is shorter than the prominent object, the outer structure should be lighted in accordance with the standards for individual obstructions of a corresponding height. Light units should be placed to ensure that the light is visible to a pilot approaching from any direction. In addition, at least one flashing light should be installed at the top of a prominent center obstruction or on a special tower located near the center of the group. For the purpose of marking and lighting obstructions other than wind turbines, a group of obstructions is considered to be three (3) or more structures.

5.7 Alternate Method of Displaying Obstruction Lights.

The FAA may recommend that lights be placed on poles equal to the height of the obstruction and installed on or adjacent to the structure instead of installing lights on the obstruction.

5.8 Prominent Buildings, Bridges, and Similar Extensive Obstructions.

When objects within a group of obstructions are approximately the same overall height above the surface and are located a maximum of 150 feet (46 m) apart, the group of

obstructions may be considered an extensive obstruction. Light units should be installed on the same horizontal plane at the highest portion, or edge, of the prominent obstructions. Light units should be placed to ensure the light is visible to a pilot approaching from any direction. If the structure is a bridge and is over navigable water, the sponsor must obtain prior approval of the lighting installation from the Commander of the District Office of the U.S. Coast Guard to avoid interference with marine navigation. Steady-burning lights should be displayed to indicate the extent of the obstruction, as follows:

1. Structures 150 Feet (46 m) or Less in Any Horizontal Direction. If the structure/bridge/extensive obstruction is 150 feet (46 m) or less horizontally, at least one steady-burning light (L-810) should be displayed on the highest point at each end of the obstruction's major axis. If this is impractical because of the overall shape, display a double obstruction light in the center of the highest point.

2. Structures Exceeding 150 Feet (46 m) in at Least One Horizontal Direction. If the structure/bridge/extensive obstruction exceeds 150 feet (46 m) horizontally, at least one steady-burning light should be displayed for each 150 feet (46 m), or fraction thereof, of the overall length of the major axis. At least one of these lights should be displayed on the highest point at each end of the obstruction. Additional lights should be displayed at approximately equal intervals, not to exceed 150 feet (46 m) on the highest points along the edge between the end lights. If an obstruction is located near a landing area and two or more edges are the same height, the edge nearest the landing area should be lighted.

3. Structures Exceeding 150 Feet (46 m) AGL. Steady-burning red obstruction lights should be installed on the highest point at each end. At intermediate levels, steady-burning red lights should be displayed for each 150 feet (46 m), or fraction thereof. The vertical position of these lights should be equidistant between the top lights and the ground level, as the shape and type of obstruction will permit. A steady-burning red light should be displayed at each outside corner on each level with the remaining lights evenly spaced between the corner lights.

4. Exceptions. Flashing red lights (L-864) may be used instead of steady-burning lights if early or special warning is necessary. These lights should be displayed on the highest points of an extensive obstruction at intervals not exceeding 3,000 feet (915 m). At least three lights should be displayed on one side of the extensive obstruction to indicate a line of lights. (See Figure A-22 in Appendix A.)

5. Ice Shields. See paragraph 4.9.

CHAPTER 6. MEDIUM-INTENSITY FLASHING WHITE OBSTRUCTION LIGHT SYSTEMS

6.1 Purpose.

Medium-intensity flashing white (L-865) obstruction lights may provide conspicuity both day and night. Recommendations on lighting structures can vary, depending on terrain features, weather patterns, geographic location, and number of structures.

6.2 Standards.

6.2.1 The medium-intensity flashing white light system is normally composed of flashing omnidirectional lights. Medium-intensity flashing white obstruction lights may be used during daytime and twilight with automatically selected, reduced intensity for nighttime operation. When this system is used on structures 700 feet (213 m) AGL or less, other methods of marking and lighting the structure may be omitted. (Aviation orange and white paint is always required for daytime marking on structures exceeding 700 feet (213 m) AGL. This system is not normally recommended on structures 200 feet (61 m) AGL or less. The number of light levels needed is shown in Figure A-7 in Appendix A.

6.2.2 Using a 24-hour, medium-intensity, flashing white light system in urban/populated areas is not normally recommended due to their tendency to blend with the background lighting in these areas at night. This makes it extremely difficult for some types of aviation operations, i.e., medical-evacuation (medevac) and police helicopters to see these structures. Using this type of system in urban and rural areas often results in complaints. In addition, this system is not recommended on structures within 3 nautical miles (NM) of an airport.

6.3 Radio and Television Towers and Similar Skeletal Structures.

6.3.1 Mounting Lights.

The number of levels recommended depends on the height of the structure, including antennas and similar appurtenances.

1. Top Levels. One or more lights should be installed at the highest point to provide 360-degree coverage, ensuring an unobstructed view by a pilot approaching from any direction.
2. Appurtenances 40 Feet (12 m) or Less. If a rod, antenna, or other appurtenance 40 feet (12 m) or less in height is incapable of supporting the medium-intensity flashing white light, then it may be placed at the base of the appurtenance. If the mounting location does not allow an unobstructed view of the medium-intensity flashing white light by a pilot approaching from any direction, then additional lights should be added.
3. Appurtenances Exceeding 40 Feet (12 m). If a rod, antenna, or other appurtenance exceeds 40 feet (12 m) above the tip of the main structure, a medium-intensity flashing white light should be placed within 40 feet (12 m) from the top of the

appurtenance. If the appurtenance (such as a whip antenna) is incapable of supporting the light, one or more lights should be mounted on a pole adjacent to the appurtenance. Adjacent installations should not exceed the height of the appurtenance and be within 40 feet (12 m) of the tip to allow the pilot an unobstructed view of at least one light. If the rod, antenna, or other appurtenance is 7/8 of an inch wide or more, at least two lights must be installed on the supporting mast to provide the necessary unobstructed view.

6.3.2 Intermediate Levels.

At intermediate levels, two or more lights (L-865) should be mounted outside at diagonally or diametrically opposite positions of intermediate levels. The lowest light level should not be less than 200 feet (61 m) AGL.

6.3.3 Lowest Levels.

The lowest level of light units may be installed at a higher elevation than normal on a structure if the surrounding terrain, trees, or adjacent building(s) would obscure the lights. In certain instances, as determined by the FAA, the lowest level of lights may be eliminated.

6.3.4 Structures 700 Feet (213 m) AGL or Less.

When medium-intensity flashing white lights are used during nighttime and twilight only, marking is required for daytime. When operated 24 hours a day, other methods of marking and lighting are not required.

6.3.5 Structures Exceeding 700 Feet (213 m) AGL.

The lights should be used during nighttime and twilight and may be used 24 hours a day. Marking is always required for daytime.

6.3.6 Ice Shields.

See paragraph 4.9.

6.4 Control Device.

The light intensity is controlled by a device (photocell) that changes the light's intensity when the ambient light changes. The system should automatically change intensity steps when, in the Northern Hemisphere, the northern sky illumination reaching a north-facing vertical surface is as follows:

1. Twilight-to-Night. This should not occur before the illumination drops below 5 foot-candles (53.8 lux) but should occur before it drops below 2 foot-candles (21.5 lux).
2. Night-to-Day. The intensity changes listed in subparagraph 6.4 1 above should be reversed when changing from the night-to-day mode.

6.5 Chimneys, Flare Stacks, and Similar Solid Structures.

The number of light units recommended depends on the diameter of the structure at the top. Normally, the top level is on the highest point of a structure. However, the top level of chimney lights may be installed as low as 20 feet (6 m) below the top to minimize deposit build-up due to emissions. (See Figure A-13 in Appendix A.) The number of lights recommended below is the minimum, as shown in Figure A-20 in Appendix A.

1. Structures 20 Feet (6 m) or Less in Diameter. Three light units per level. (See Figure A-20 in Appendix A.)
2. Structures Exceeding 20 Feet (6 m) but not More Than 100 Feet (31 m) in Diameter. Four light units per level. (See Figure A-20 in Appendix A.)
3. Structures Exceeding 100 Feet (31 m) but not More Than 200 Feet (61 m) in Diameter. Six light units per level. (See Figure A-21 in Appendix A.)
4. Structures Exceeding 200 Feet (61 m) in Diameter. Eight light units per level.

6.6 Group of Obstructions.

When individual objects within a group of obstructions are not the same height and are spaced a maximum of 150 feet (46 m) apart, the prominent objects within the group should be lighted in accordance with the standards for individual obstructions of a corresponding height. If the outer structure is shorter than the prominent object, the outer structure should be lighted in accordance with the standards for individual obstructions of a corresponding height. Light units should be placed to ensure that the light is visible to a pilot approaching from any direction. In addition, at least one medium-intensity flashing white light should be installed at the top of a prominent center obstruction or on a special tower located near the center of the group.

6.7 Special Cases.

When lighting systems are installed on structures located near highways, waterways, airport approach areas, etc., caution should be exercised to ensure that the lights do not distract or otherwise cause a hazard to motorists, vessel operators, or pilots on an approach to an airport. In these cases, shielding may be necessary. This shielding should not derogate the lighting system's intended purpose.

6.8 Prominent Buildings and Similar Extensive Obstructions.

When objects within a group of obstructions are approximately the same overall height above the surface and are located a maximum of 150 feet (46 m) apart, the group of obstructions may be considered an extensive obstruction. Light units should be installed on the same horizontal plane at the highest portion, or edge, of the prominent obstructions. Light units should be placed to ensure that the light is visible to a pilot approaching from any direction. Lights should be displayed to indicate the extent of the obstruction as follows:

1. Structures 150 Feet (46 m) or Less in Any Horizontal Direction. If the structure/extensive obstruction is 150 feet (46 m) or less horizontally, at least one light should be displayed on the highest point at each end of the obstruction's major axis. If this is impractical because of the overall shape, display a double obstruction light in the center of the highest point.

2. Structures Exceeding 150 Feet (46 m) in at Least One Horizontal Direction. If the structure/extensive obstruction exceeds 150 feet (46 m) horizontally, at least one light should be displayed for each 150 feet (46 m), or fraction thereof, of the overall length of the major axis. At least one of these lights should be displayed on the highest point at each end of the obstruction. Additional lights should be displayed at approximately equal intervals not to exceed 150 feet (46 m) on the highest points along the edge between the end lights. If an obstruction is located near a landing area and two or more edges are the same height, the edge nearest the landing area should be lighted.

3. Structures Exceeding 150 Feet (46 m) AGL. Lights should be installed on the highest point at each end. At intermediate levels, lights should be displayed for each 150 feet (46 m), or fraction thereof. The vertical position of these lights should be equidistant between the top lights and the ground level as the shape and type of obstruction will permit. One such light should be displayed at each outside corner on each level with the remaining lights evenly spaced between the corner lights.

CHAPTER 7. HIGH-INTENSITY FLASHING WHITE OBSTRUCTION LIGHT SYSTEMS

7.1 Purpose.

High-intensity (L-856) flashing white obstruction lights provides the highest degree of conspicuity both day and night. Recommendations on lighting structures can vary, depending on terrain features, weather patterns, geographic location, and number of structures.

7.2 Standards.

High-intensity flashing white obstruction lights should be used during daytime with automatically selected, reduced intensities for twilight and nighttime operations. When high-intensity white obstruction lights are operated 24 hours a day, other methods of marking and lighting may be omitted. This system should not be recommended on structures 700 feet (213 m) AGL or less unless an FAA aeronautical study shows otherwise. The number of light levels needed is shown in Figures A-8 and A-9 in Appendix A.

7.3 Control Device.

7.3.1 Light intensity is controlled by a device (photocell) that changes the light's intensity when the ambient light changes. Using a 24-hour, high-intensity flashing white light system in urban/populated areas is not normally recommended due to their tendency to merge with background lighting in these areas at night. This makes it extremely difficult for some types of aviation operations (i.e., medevac) and police helicopters to see these structures. Using this type of system in urban and rural areas often results in complaints.

7.3.2 The system should automatically change intensity steps when, in the Northern Hemisphere, the northern sky illuminance reaching a north-facing vertical surface is as follows:

1. Day-to-Twilight. This should not occur before the illumination drops to 60 foot-candles (645.8 lux) but should occur before it drops below 35 foot-candles (376.7 lux). The illuminance-sensing device should, if practical, face the northern sky in the Northern Hemisphere.
2. Twilight-to-Night. This should not occur before the illumination drops below 5 foot-candles (53.8 lux) but should occur before it drops below 2 foot-candles (21.5 lux).
3. Night-to-Day. The intensity changes listed in subparagraphs 7.3.2 1 and 7.3.2.2 above should be reversed when changing from the night-to-day mode.

7.4 **Units per Level.**

One or more light units are needed to obtain the desired horizontal coverage. The number of light units recommended per level (except for the supporting structures of catenary wires and buildings) depends upon the average outside diameter of the specific structure and the horizontal beam width of the light fixture. Light units should be installed to ensure an unobstructed view of the system by a pilot approaching from **any** direction. The number of lights recommended below is the minimum.

1. Structures 20 Feet (6 m) or Less in Diameter. Three light units per level.
2. Structures Exceeding 20 Feet (6 m) but not More Than 100 Feet (31 m) in Diameter. Four light units per level.
3. Structures Exceeding 100 Feet (31 m) in Diameter. Six light units per level.

7.5 **Installation Guidance.**

On most obstruction high-intensity light fixtures, the effective peak intensity of the light beam can be adjusted from 0 to 8 degrees above the horizon. Standard installation should place the top light at 0 degrees to the horizontal and all other light units installed in accordance with Table 7-1.

Table 7-1. Light Unit Elevation Above the Horizontal

Height of Light Unit Above Terrain	Degrees of Elevation Above the Horizontal
Exceeding 500 feet AGL	0
Above 400 feet to 500 feet AGL	1
Above 300 feet to 400 feet AGL	2
300 feet AGL or less	3

1. Vertical Aiming. When terrain, nearby residential areas, or other situations dictate, the light beam may be further elevated above the horizontal. The main beam of light at the lowest level should not strike the ground closer than 3 statute miles (5 km) from the structure. If additional adjustments are necessary, the lights may be individually adjusted upward, in 1-degree increments, starting at the bottom. Excessive elevation may reduce its conspicuity by raising the beam above a collision course flight path.
2. Special Cases. When lighting systems are installed on structures located near highways, waterways, airport approach areas, etc., caution should be exercised to ensure that the lights do not distract or otherwise cause a hazard to motorists, vessel operators, or pilots on an approach to an airport. In these cases, shielding or adjusting the aim of the vertical or horizontal light may be necessary. This adjustment should not derogate the lighting system's intended purpose. Such

adjustments may require an additional review, as described in Chapter 1 paragraph 1.5.

3. Relocation or Omission of Light Units. Light units should not be installed in such a manner that the light pattern/output is disrupted by the structure.

   a. Lowest Level. The lowest level of light units may be installed at a higher elevation than normal on a structure if the surrounding terrain, trees, or adjacent building(s) would obscure the lights. In certain instances, as determined by the FAA, the lowest level of lights may be eliminated.

   b. Two Adjacent Structures. When two structures are within 500 feet (153 m) of each other and the light units are installed at the same levels, the sides of the structures facing each other do not need be lighted. (See Figures A-18 and A-19.) However, all lights on both structures must flash simultaneously, except for adjacent catenary support structures. Vertical placement of the lights should be adjusted to either or both structures' intermediate levels to place the lights on the same horizontal plane. If one structure is higher than the other, a complete level(s) of lights should be installed on the higher structure that extends above the top of the lower structure. If the structures are of such heights that the levels of lights cannot be placed in identical horizontal planes, then the light units should be placed so that the center of the horizontal beam patterns do not face toward the adjacent structure. For example, structures situated north and south of each other should have the light units on both structures installed on a northwest/southeast and northeast/southwest orientation.

   c. Three or More Adjacent Structures. The treatment of a cluster of structures as an individual or a complex of structures will be determined by the FAA, taking into consideration the location, heights, and spacing of other structures.

7.6 Antenna or Similar Appurtenance Light.

When a structure lighted by a high-intensity, flashing white light system is topped with an antenna or similar appurtenance exceeding 40 feet (12 m) in height, a medium-intensity flashing white light (L-865) should be placed within 40 feet (12 m) from the tip of the appurtenance. This light should operate 24 hours a day and flash simultaneously with the rest of the lighting system. The location of the appurtenance light is shown in Figure A-9 in Appendix A. Structures with an appurtenance 40 feet (12 m) or less in height should be lit in accordance with Figure A-8.

7.7 Chimneys, Flare Stacks, and Similar Solid Structures.

The number of light levels depends on the height of the structure, excluding appurtenances. Three or more lights should be installed on each level to ensure an unobstructed view by the pilot. Normally, the top level is on the highest point of a structure. However, the top level of chimney lights may be installed as low as 20 feet (6 m) below the top to minimize deposit buildup due to emissions.

7.8 Radio and Television Towers and Similar Skeletal Structures.

1. Mounting Lights. The number of levels recommended depends on the height of the structure, including antennas and similar appurtenances. At least three lights should be installed on each level and mounted to ensure that the effective intensity of the full horizontal beam coverage is not impaired by the structural members.
2. Top Level. One level of lights should be installed at the highest point of the structure. If the highest point is a rod or antenna incapable of supporting a lighting system, then the top level of lights should be installed at the highest portion of the main skeletal structure. If guy wires come together at the top, it may be necessary to install this level of lights as low as 10 feet (3 m) below the top. If the rod or antenna exceeds 40 feet (12 m) above the main structure, a medium-intensity, flashing white light (L-865) should be mounted on the highest point. (See Figure A-9 in Appendix A.) If the appurtenance (such as a whip antenna) is incapable of supporting a medium-intensity light, one or more lights should be installed on a pole adjacent to the appurtenance. The adjacent installation should not exceed the height of the appurtenance and be within 40 feet (12 m) of the top, allowing a pilot an unobstructed view of at least one light. If the rod, antenna, or other appurtenance is 7/8 of an inch wide or more, at least two lights must be installed on the supporting mast to provide the necessary unobstructed view.
3. Ice Shields. See paragraph 4.9.

7.9 Hyperbolic Cooling Towers.

Light units should be installed to ensure an unobstructed view of at least two lights by a pilot approaching from any direction.

1. Number of Light Units. The number of units recommended depends on the diameter of the structure at the top, as shown in Figure A-21 in Appendix A. The number of lights recommended below is the minimum.
   a. Structures 20 Feet (6 m) or Less in Diameter. Three light units per level.
   b. Structures Exceeding 20 Feet (6 m) but not More Than 100 Feet (31 m) in Diameter. Four light units per level.
   c. Structures Exceeding 100 Feet (31 m) but not More Than 200 Feet (61 m) Diameter. Six light units per level.
   d. Structures Exceeding 200 Feet (61 m) in Diameter. Eight light units per level.
2. Structures Exceeding 600 Feet (183 m) AGL. Structures exceeding 600 feet (183 m) AGL should have a second level of light units installed approximately at the midpoint of the structure and in a vertical line with the top level of lights.

7.10 **Prominent Buildings and Similar Extensive Obstructions.**

When objects within a group of obstructions are approximately the same overall height above the surface and are located not more than 150 feet (46 m) apart, the group of obstructions may be considered an extensive obstruction. Light units should be installed on the same horizontal plane at the highest portion, or edge, of the prominent obstructions. Light units should be placed to ensure that the light is visible to a pilot approaching from **any** direction. These lights may require shielding, such as louvers, to ensure minimum adverse impact on local communities. Use extreme caution when using high-intensity flashing white lights.

1. If the obstruction is 200 feet (61 m) or less in either horizontal dimension, three or more light units should be installed at the highest portion of the structure to ensure that at least one light is visible to a pilot approaching from any direction. Light units may be mounted on a single pedestal at or near the center of the obstruction. If the light units are placed more than 10 feet (3 m) from the center point of the structure, use a minimum of four light units.
2. If the obstruction exceeds 200 feet (61 m) in one horizontal dimension, but is 200 feet (61 m) or less in the other, two light units should be placed on each of the shorter sides. These light units may be installed either adjacent to each other at the midpoint of the obstruction's edge or at (near) each corner, with the light unit aimed to provide 180 degrees of coverage at each edge. One or more light units should be installed along the overall length of the major axis. These lights should be installed at approximately equal intervals, not to exceed a distance of 100 feet (31 m) from the corners or from each other.
3. If the obstruction exceeds 200 feet (61 m) in both horizontal dimensions, the light units should be equally spaced along the overall perimeter of the obstruction at intervals of 100 feet (31 m), or fraction thereof.

CHAPTER 8. DUAL LIGHTING WITH RED/MEDIUM-INTENSITY FLASHING WHITE LIGHT SYSTEMS

8.1 Purpose.

This dual lighting system includes red lights (L-864) for nighttime and medium-intensity, flashing white lights (L-865) for daytime and twilight use. This lighting system may be used in lieu of operating a medium-intensity flashing white lighting system at night. There may be some populated areas where nighttime use of medium-intensity light systems may cause significant environmental concerns. Using the dual lighting system should reduce/mitigate those concerns. Recommendations on lighting structures can vary, depending on terrain features, weather patterns, geographic location, and number of structures.

8.2 Installation.

The light units should be installed as specified in Chapters 4, 5, and 6. The number of light levels needed is dependent on the height of the obstruction, as shown in Figure A-10 in Appendix A.

8.3 Operation.

Light systems should be operated as specified in Chapter 3. Both systems should not be operated at the same time; however, there should be no more than a 2-second delay when changing from one system to the other. Outage of the uppermost red light shall cause the white obstruction light system to activate and operate in its specified "night" step intensity.

8.4 Control Device.

The light system is controlled by a device (photocell) that changes the light's intensity when the ambient light changes. The system should automatically change steps when, in the Northern Hemisphere, the northern sky illuminance reaching a north-facing vertical surface is as follows:

1. Twilight-to-Night. This should not occur before the illumination drops below 5 foot-candles (53.8 lux) but should occur before it drops below 2 foot-candles (21.5 lux).
2. Night-to-Day. The intensity changes listed in subparagraph 8.4 1 above should be reversed when changing from the night-to-day mode.

8.5 Antenna or Similar Appurtenance Light.

When a structure equipped with a dual lighting system is topped with an antenna or similar appurtenance exceeding 40 feet (12 m) in height, a medium-intensity flashing white (L-865) and a flashing red light (L-864) should be placed within 40 feet (12 m) from the tip of the appurtenance. The white light should operate during daytime and

twilight and the red light during nighttime. These lights should flash simultaneously with the rest of the lighting system.

8.6 **Omission of Marking.**

When medium-intensity white obstruction lights are operated on structures 700 feet (213 m) AGL or less during daytime and twilight, other methods of marking may be omitted.

CHAPTER 9. DUAL LIGHTING WITH RED/HIGH-INTENSITY FLASHING WHITE LIGHT SYSTEMS

9.1 Purpose.

This dual lighting system includes red lights (L-864) for nighttime and high-intensity flashing white lights (L-856) for daytime and twilight use. This lighting system may be used in lieu of operating a flashing white lighting system at night. There may be some populated areas where nighttime use of high-intensity lights may cause significant environmental concerns and complaints. Using the dual lighting system should reduce/mitigate those concerns. Recommendations on lighting structures can vary, depending on terrain features, weather patterns, geographic location, and number of structures.

9.2 Installation.

The light units should be installed as specified in Chapters 4, 5, and 7. The number of light levels needed is shown in Figures A-11 and A-12 in Appendix A.

9.3 Operation.

Lighting systems should be operated as specified in Chapters 4, 5, and 7. These systems should not be operated at simultaneously; however, there should be no more than a 2-second delay when changing from one system to the other. Outage of the uppermost red light shall cause the white obstruction lighting system to activate and operate in its specified "night" step intensity.

9.4 Control Device.

9.4.1 The light intensity is controlled by a device (photocell) that changes the light intensity when the ambient light changes.

9.4.2 The system should automatically change intensity steps when, in the Northern Hemisphere, the northern sky illuminance reaching a north-facing vertical surface is as follows:

1. Day-to-Twilight. This should not occur before the illumination drops to 60 foot-candles (645.8 lux) but should occur before it drops below 35 foot-candles (376.7 lux). The illuminance-sensing device should, if practical, face the northern sky in the Northern Hemisphere.
2. Twilight-to-Night. This should not occur before the illumination drops below 5 foot-candles (53.8 lux) but should occur before it drops below 2 foot-candles (21.5 lux).
3. Night-to-Day. The intensity changes listed in subparagraph 9.4.2 1 and 9.4.2.2 above should be reversed when changing from the night to day mode.

9.5 **Antenna or Similar Appurtenance Light.**

When a structure using this dual lighting system is topped with an antenna or similar appurtenance exceeding 40 feet (12 m) in height, a medium-intensity flashing white light (L-865) and a red flashing light (L-864) should be placed within 40 feet (12 m) from the tip of the appurtenance. (See Figure A-11 in Appendix A.) The white light should operate during daytime and twilight and the red light during nighttime. Structures with an appurtenance 40 feet (12 m) or less in height should be lit in accordance with Figure A-12 in Appendix A.

9.6 **Omission of Marking.**

When high-intensity white obstruction lights are operated during daytime and twilight, other methods of marking may be omitted.

CHAPTER 10. MARKING AND LIGHTING OF CATENARY AND CATENARY SUPPORT STRUCTURES

10.1 Purpose.

This chapter provides guidelines for marking and lighting catenary and catenary support structures. For the purpose of marking and lighting, catenary is defined as suspended wires (or lines) kept at a defined mechanical tension by supporting structures. These wires may be either energized or non-energized and are used for transmission, distribution, or for other purposes, as defined. The recommended marking and lighting of both the structures and wires provides day and night conspicuity and assists pilots in identifying and avoiding catenary wires and associated support structures.

10.2 Catenary Marking Standards.

Catenary wires should be marked with lighted or unlighted marker balls to make the wires more visible to pilots approaching the hazard. High-voltage (69 kV or greater) transmission lines are typically mounted on large catenary support structures and should be fitted with lighted markers to provide sufficient conspicuity in both day and nighttime conditions. Transmission lines that are less than 69 kV are typically mounted on smaller catenary support structures and should be fitted with unlighted markers that provide daytime conspicuity.

10.2.1 Catenary Markers.

Lighted markers provide increased nighttime conspicuity of high-voltage (69 kV or greater) transmission line catenary wires. However, since lighted markers require a minimum line load to operate, it should be noted that the lights may not be operational under certain transmission system conditions, such as power outages or line maintenance. These lighted markers should be used on transmission line catenary wires near airports, heliports, across rivers, canyons, lakes, areas of known risk to aviation, etc. The lighted markers should be manufacturer-certified as (1) recognizable from a minimum distance of 4,000 feet (1,219 m) under nighttime conditions, (2) minimum VFR conditions, or (3) have a minimum intensity of at least 32.5 candelas. The lighting unit should emit a steady-burning red light. Lighted markers should be used on the highest energized line. If the lighted markers are installed on a line other than the highest catenary wire, then the unlighted markers specified in Chapter 3 paragraph 3.5 should be used in addition to the lighted markers. The maximum sag distance between the line energizing the lighted markers and the highest catenary wire above the lighted markers should be no more than 25 feet (7.6 m), and it should not violate the sag requirements of the transmission line design. (See Figure A-5 in Appendix A.) Markers should be distinctively shaped, i.e., spherical or cylindrical, so that they are not mistaken for items used to convey other information. They should be visible to a pilot approaching from any direction. The area in the immediate vicinity of the supporting structure's base should be clear of all items and/or objects of natural growth that could interfere with the line-of-sight between a pilot and the structure's markers.

10.2.1.1 Size and Color.

The diameter of the markers (lighted and unlighted) used on extensive catenary wires that cross canyons, lakes, rivers, etc., should not be less than 36 inches (91 cm). Preferred 20-inch (51-cm) markers, or smaller 12-inch (30.48-cm) markers, are permitted on less extensive catenary wires or on power lines below 50 feet (15 m) above the ground and within 1,500 feet (458 m) of an airport runway end. Each lighted marker should be a solid color; specifically aviation orange, white, or yellow. For transmission lines that are configured in a "double-bundled" arrangement and would typically require the larger 36-inch markers, the next smaller size marker may be used to prevent the marker from rubbing against the parallel transmission line.

10.2.1.2 Installation.

1. Spacing. Lighted markers should be spaced equally along the wire at intervals of approximately 200 feet (61 m), or a fraction thereof. Intervals between markers should be less in critical areas near runway ends, i.e., 30 feet to 50 feet (10 m to 15 m). If the lighted markers are installed on a line other than the highest catenary wire, then unlighted markers specified in Chapter 3 paragraph 3.5 should be used in addition to the lighted markers. The maximum distance between the line energizing the lighted markers and the highest catenary wire above the line with the lighted markers can be no more than 25 feet (7.62 m), so long as the requirement does not violate the transmission line design's droop requirement. The lighted markers may be installed alternately along each wire if the distance between adjacent markers meets the 200-foot (61m) spacing standard. This method allows the weight and wind loading factors to be distributed. (See Figure A-5 in Appendix A.)

2. Pattern. An alternating color scheme provides the most conspicuity against all backgrounds. Lighted and unlighted markers should be installed by alternating solid-colored markers of aviation orange, white, and yellow. Normally, an orange marker is placed at each end of a line and the spacing is adjusted [not to exceed 200 feet (61 m)] to accommodate the rest of the markers. When less than four markers are used, they should all be aviation orange. (See Figure A-5 in Appendix A).

3. Wire Sag. Wire sag or droop will occur due to temperature, wire weight, wind, etc. Twenty-five (25) feet (7.62 m) is the maximum allowable distance between the highest wire installed with marker balls and the highest wire without marker balls, and it should not violate the transmission line design's sag requirements. (See Figure A-5 in Appendix A.)

4. Adjacent Lines. Catenary crossings with multiple transmission lines require appropriate markers when the adjacent catenary structure's

outside lines are greater than 200 ft (61 m) away from the center of the primary structure. (See Figure A-2 in Appendix A.) If the outside lines of the adjacent catenary structure are within 200 ft (61m) or less from the center of the primary structure, markers are not required on the adjacent lines. (See Figure A-3 in Appendix A.)

10.3 **Catenary Lighting Standards.**

When using medium-intensity flashing white (L-866), high-intensity flashing white (L-857), dual medium-intensity (L-866/L-885), or dual high-intensity (L-857/L-885) lighting systems operated 24 hours a day, other marking of the support structure is not necessary.

1. Levels. A system of three levels of sequentially flashing light units should be installed on each supporting structure or adjacent terrain. One level should be installed at the top of the structure, one at the height of the lowest point in the catenary wire, and one level approximately midway between the other two light levels. In general, the middle level should be at least 50 feet (15 m) from the other two levels. The middle light unit may be omitted when the distance between the top and the bottom light levels is less than 100 feet (30 m).

   a. Top Levels. One or more lights should be installed at the top of the structure to provide 360-degree coverage, ensuring an unobstructed view. If the installation presents a potential danger to maintenance personnel or inhibits lightning protection, the top level of lights may be mounted as low as 20 feet (6 m) below the highest point of the structure.

   b. Horizontal Coverage. The light units at the middle and bottom levels should be installed to provide a minimum of 180-degree coverage, centered perpendicularly to the flyway. When a catenary crossing is situated near a bend in a river, canyon, etc., or is not perpendicular to the flyway, the horizontal beam should be directed to provide the most effective light coverage to warn pilots approaching from either direction of the catenary wires.

   c. Variation. The vertical and horizontal arrangements of the lights may be subject to the structural limits of the towers and/or adjacent terrain. A tolerance of 20 percent from uniform spacing of the bottom and middle light is allowed. If the base of the supporting structure(s) is higher than the lowest point in the catenary, such as a canyon crossing, one or more lights should be installed on the adjacent terrain at the level of the lowest point in the span. These lights should be installed on the structure or terrain at the height of the lowest point in the catenary. (See Figure A-4 in Appendix A).

2. Flash Sequence and Duration. The flash sequence for catenary wire support structures should be middle, top, and bottom with all lights on the same level flashing simultaneously. This pattern of flashes is designed to present a unique signal that pilots should interpret as a warning that catenary wires are in the vicinity of the lights. The time intervals for the sequence and duration of the flash pattern are outlined in FAA AC 150/5345-43, Specification for Obstruction Lighting

Equipment. If Light-Emitting Diode (LED) obstruction light fixtures are used to light catenary wires, a slower flash rate of 40 fpm is allowed to enable each light fixture to make a well-defined flash so that the middle-top-bottom flash pattern will be easily recognized. Field experience has shown that LED fixtures flashing at 60 fpm, as specified in AC 150/5345-43, do not have enough time to turn off in between flash cycles, and appear as if they are steady-burning. Slowing the flash rate to 40 fpm promotes a cleaner, crisper presentation for the pilot to recognize. In the event there are only two levels of lights, the lights should simply alternate at the same flash rate/duration as if there were three lights.

3. Synchronization. Although not required, it is preferred that the corresponding light levels on associated supporting towers of a catenary crossing flash simultaneously.

4. Structures 700 feet (213 m) AGL or Less. When medium-intensity white lights (L-866) are operated 24 hours a day or when a dual red/medium-intensity light system (L-866 daytime and twilight/L-885 nighttime) is used, marking can be omitted. When using a medium-intensity white light (L-866) or a flashing red light (L-885) during twilight or nighttime only, paint should be used for daytime marking.

5. Structures Exceeding 700 Feet (213 m) AGL. When high-intensity white lights (L-857) are operated 24 hours a day or when a dual red/high-intensity system (L-857 daytime and twilight/L-885 nighttime) is used, marking can be omitted. This system should not be used on structures 700 feet (153 m) or less unless an FAA aeronautical study shows otherwise. When a flashing red obstruction light (L-885), a medium-intensity (L-866) flashing white lighting system, or a high-intensity white lighting system (L-857) is used for nighttime and twilight only, paint should be used for daytime marking.

10.4 **Control Device.**

The light intensity is controlled by a device (photocell) that changes the intensity when the ambient light changes. The lighting system should automatically change intensity steps when, in the Northern Hemisphere, the northern sky illuminance reaching a north-facing vertical surface is as follows:

1. Day-to-Twilight (L-857 System). This should not occur before the illumination drops to 60 foot-candles (645.8 lux) but should occur before it drops below 35 foot-candles (376.7 lux). The illuminance-sensing device should, if practical, face the northern sky in the Northern Hemisphere.

2. Twilight-to-Night (L-857 System). This should not occur before the illumination drops below 5 foot-candles (53.8 lux) but should occur before it drops below 2 foot-candles (21.5 lux).

3. Night-to-Day. The intensity changes listed in subparagraph 10.4.1 and 10.4.2 above should be reversed when changing from the night-to-day mode.

4. Day-to-Night (L-866 or L-885/L-866). This should not occur before the illumination drops below 5 foot-candles (563.8 lux) but should occur before it drops below 2 foot-candles (21.5 lux).
5. Night-to-Day. The intensity changes listed in subparagraph10.4.4 above should be reversed when changing from the night-to-day mode.
6. Red Obstruction (L-885). The red lights should not turn on until the illumination drops below 60 foot-candles (645.8 lux) but should occur before reaching a level of 35 foot-candles (367.7 lux). Lights should not turn off before the illumination rises above 35 foot-candles (367.7 lux) but should occur before reaching 60 foot-candles (645.8 lux).

10.5 Area Surrounding Catenary Wire Support Structures.

The area in the immediate vicinity of the supporting structure's base should be clear of all items and/or objects of natural growth that could interfere with the line-of-sight between a pilot and the structure's lights.

10.6 Three or More Catenary Wire Support Structures.

Where a catenary wire crossing requires three or more supporting structures, the inner structures should be equipped with enough light units per level to provide full 360-degree coverage across rivers, canyons, lakes, areas of known risk to aviation, etc.

10.7 Adjacent Catenary Structures.

Where an adjacent catenary wire crossing requires three or more supporting structures, the inner structures should be equipped with enough light units per level to provide full 360-degree coverage across rivers, canyons, lakes, areas of known risk to aviation, etc.

CHAPTER 11. MARKING AND LIGHTING MOORED BALLOONS AND KITES

11.1 Purpose.

The purpose of marking and lighting moored balloons, kites, and their cables or mooring lines is to indicate the presence and general definition of these objects to pilots when approaching from **any** direction.

11.2 Standards.

These marking and lighting standards pertain to all moored balloons and kites that require marking and lighting under 14 CFR Part 101.

11.3 Marking.

Flag markers should be used on mooring lines to warn pilots of their presence during daylight hours.

1. Display. Markers should be displayed at no more than 50-foot (15-m) intervals and should be visible for at least 1 statute mile.
2. Shape. Markers should be rectangular in shape and not less than 2 feet (0.6 m) on a side. Stiffeners should be used in the borders to expose a large area and to prevent drooping in calm wind or wrapping around the cable.
3. Color Patterns. One of the following color patterns should be used:
   a. Solid Color. Aviation orange.
   b. Orange and White. Two triangular sections, one of aviation orange and the other white, combined to form a rectangle.
   c. Refer to paragraph 12.2 Paint Standard.

11.4 Purpose.

Flashing obstruction lights should be used on moored balloons or kites and their mooring lines to warn pilots of their presence during the hours between sunset and sunrise and during periods of reduced visibility. These lights may be operated 24 hours a day.

1. Systems. Flashing red (L-864) or white lights (L-865) may be used to light moored balloons or kites. High-intensity lights (L-856) are not recommended.
2. Display. Flashing lights should be displayed on the top, nose section, tail section, and on the tether cable approximately 15 feet (4.6 m) below the craft to define the extremes of size and shape. Additional lights should be equally spaced along the cable's overall length for each 350 feet (107 m), or fraction thereof.
3. Exceptions. When the requirements of this paragraph cannot be met, floodlights may be used.

11.5 **Operational Characteristics.**

The light intensity is controlled by a device (photocell) that changes the intensity when the ambient light changes. The system should automatically turn the lights on and change intensities as ambient light conditions change. The reverse order should apply in changing from nighttime-to-daytime operation. The lights should flash simultaneously.

CHAPTER 12. MARKING AND LIGHTING EQUIPMENT AND INFORMATION

12.1 **Purpose.**

This chapter lists documents relating to obstruction marking and lighting systems and where they may be obtained.

12.2 **Paint Standard.**

12.2.1 Paint and aviation colors/gloss, referred to in this AC, with the exception of wind turbines, should conform to Federal Standard FED-STD-595. Wind turbines shall meet the standards in Chapter 13 paragraph 13.4 of this AC.

12.2.2 Approved colors shall be formulated without using lead, zinc chromate, or other heavy metals to match international aviation orange, white, and yellow, as listed in Table 12-1. All coatings shall be manufactured and labeled to meet Federal Environmental Protection Act Volatile Organic Compound(s) guidelines, including the National Volatile Organic Compound Emission Standards for architectural coatings.

1. Exterior Acrylic Waterborne Paint. Coatings should be ready-mixed, 100 percent acrylic, exterior latex formulated for application directly to galvanized surfaces. Ferrous iron and steel or nongalvanized surfaces shall be primed with a manufacturer-recommended primer compatible with the finish coat.
2. Exterior Solvent-Borne Alkyd-Based Paint. Coatings should be ready-mixed, alkyd-based, exterior enamel for application directly to nongalvanized surfaces, such as ferrous iron and steel. Galvanized surfaces shall be primed with a manufacturer-recommended primer compatible with the finish coat.

Table 12-1. Federal Standard FED-STD-595

Color	Number
Orange	12197
White	17875
Yellow	13538

12.3 **Availability of Specifications.**

Federal specifications describing the technical characteristics of various paints and their application techniques may be obtained from:

GSA - Specification Branch
301 7th Street NW
Room 6109
Washington, DC 20407
Telephone: (202) 619-8925

URL: https://gsafas.secure.force.com

12.4 **Lights and Associated Equipment.**

The lighting equipment referred to in this AC should conform to the latest edition of one of the following specifications, as applicable:

1. Obstruction Lighting Equipment.
   a. AC 150/5345-43, *FAA Specification for Obstruction Lighting Equipment*.
   b. Military Specifications MIL-L-6273, *Light, Navigational, Beacon, Obstacle or Code, Type G-1*.
   c. Military Specifications MIL-L-7830, *Light Assembly, Markers, Aircraft Obstruction*.
2. Certified Equipment.
   a. AC 150/5345-53, *Airport Lighting Certification Program*, lists the manufacturers that have demonstrated compliance with the specification requirements of AC 150/5345-43.
   b. Other manufacturers' equipment may be used provided the equipment meets the specification requirements of AC 150/5345-43.
3. Airport Lighting Installation and Maintenance.

   AC 150/5340-30, *Design and Installation Details for Airport Visual Aids*.
4. Vehicles.
   a. AC 150/5210-5, *Painting, Marking, and Lighting of Vehicles Used on an Airport*, contains provisions for marking vehicles principally used on airports.
   b. FAA Facilities**.** Obstruction marking for FAA facilities shall conform to FAA Drawing Number D-5480, referenced in FAA Standard FAA-STD-003, *Paint Systems for Structures*.

12.5 **Availability.**

The standards and specifications listed above may be obtained from:

1. Military Specifications: Copies of Military standards and specification may be obtained from:

   DAP/DODSSP
   Building 4, Section D.
   700 Robbins Ave.
   Philadelphia, PA 19111-5094
   Tel; (215)697-2179
   FAX: (215)697-1460
   URL: https://acc.dau.mil/DoDSSP

2. FAA Advisory Circulars: Copies of FAA ACs may be obtained online at:

   http://www.faa.gov/airports/resources/advisory_circulars/

CHAPTER 13. MARKING AND LIGHTING WIND TURBINES

13.1 Purpose.

This chapter provides guidelines for the marking and lighting of wind turbine farms. These guidelines are applicable to single wind turbines and wind turbine farms. For the purpose of this AC, wind turbine farms are defined as a wind turbine development that contains more than three turbines. The recommended marking and lighting of these structures is intended to provide day and night conspicuity and to assist pilots in identifying and avoiding these obstacles.

13.2 General Standards.

The development of wind turbine farms is a very dynamic process, which changes based on the terrain. Each wind turbine farm is unique. Therefore, it is important that a lighting plan be developed that provides sufficient safety for air traffic. Proximity to airports and VFR routes, extreme terrain where heights may vary widely, and local flight activity should be considered when developing a lighting plan. The following guidelines are recommended for wind turbines.

13.3 Wind Turbine Configurations.

Prior to marking and lighting the wind turbine farm, the configuration and the terrain of the wind turbine farm should be determined. The following is a description of the most common configurations.

1. Linear—wind turbine farms in a direct, consecutive configuration, often located along a ridge line, the face of a mountain, or along borders of a mesa or field. The line may be ragged in shape or be periodically broken, and may vary in size from just a few turbines to many turbines forming a line that is several miles long.
2. Cluster—wind turbine farms arranged in circular configuration. A cluster is typically characterized by having a pronounced perimeter, with various turbines placed inside the circle at various, erratic distances throughout the center of the circle.
3. Grid—wind turbine farms arranged in a geographical shape, such as a square or a rectangle, in which the turbines are placed a consistent distance from each other in rows, giving the appearance that they are part of a square pattern.

13.4 Marking Standards.

13.4.1 Wind turbines should be painted white or light grey, as these colors have been shown to be the most effective method for providing daytime conspicuity. Wind turbine manufacturers typically use a European color-matching system that is referred to as the RAL Color Standard. Unlike the Federal Specification 595, the RAL system used a four-digit code to identify a specific color of paint. For example, an RAL 9xxx code would represent a color in the white/black range, and an RAL 6xxx code would be in

the grey range. Most wind turbines currently produced are painted light grey, RAL 7035, which is the darkest acceptable off-white paint allowed. The preferred white paint color is pure white, RAL 9010, or an equivalent. Any shade of white between these two RAL specifications is strongly recommended. See Table 13-1.

Table 13-1. Wind Turbine Paint Standard Colors

Color	RAL Number
Pure White	9010
Light Grey (Darkest Acceptable)	7035

13.4.2 In geographic areas that experience lengthy periods of snow cover (i.e., Alaska), and where it is deemed necessary, the mast of the turbine may be painted alternating bands of aviation orange and white to provide additional contrast against the snow. The nacelle and blades of the turbine shall remain solid white or light grey. (See Figure A-24 in Appendix A.)

13.4.3 Blades or blade tips shall not be painted or manufactured in colors to camouflage wind turbines with the surrounding terrain. (See Figure A-25 in Appendix A.)

13.4.4 For turbines that are constructed with lattice-type masts, the mast structure shall be painted with alternating bands of aviation orange and white, in accordance with Chapter 3. The turbine's nacelle and blades shall remain solid white or light grey.

13.5 **Lighting Standards.**

13.5.1 Nighttime wind turbine obstruction lighting should consist of FAA L-864 aviation red flashing, strobe, or pulsed obstruction lights. Studies have shown that red lights provide the most conspicuity to pilots.

13.5.2 In most cases, not all wind turbine units within a wind turbine farm need to be lighted. Obstruction lights should be placed along the perimeter of the wind turbine farm so that there are no unlit separations or gaps more than 1/2 statute mile (sm) (804 m). Wind turbines within a grid or cluster should not have an unlighted separation or gap of more than 1 sm (1.6 km) across the interior of a grid or cluster of turbines. (See Figure A-26 in Appendix A.)

13.5.3 Any array of flashing, strobe, or pulsed obstruction lighting should be synchronized to flash simultaneously (within ±1/20 second (0.05 second) of each other).

13.5.4 Should any lighting fixture or the lighting system synchronization fail, a lighting outage report should be prepared in accordance with Chapter 2 paragraph 2.4.

13.5.5 Light fixtures should be placed as high as possible on the turbine nacelle so they are visible by a pilot approaching from **any** direction. (See Figure A-23 in Appendix A.)

13.5.6 Daytime lighting of wind turbines is not required. See paragraph 13.4 for daytime marking requirements.

13.5.7 When developing lighting plans for wind turbine farms, it is best to use an aerial-view map or diagram of the turbine farm to plan the location of the required lighting. This way, a certain degree of strategy plan can be applied, which, in many instances, results in a minimal number of lights.

13.5.8 For linear turbine configurations, lights should be placed on the turbine positioned at each end of a line or string of turbines. Lights should also be placed along the line of turbines so that there is no more than a 1/2-sm (2,640-foot (805-m)) gap between the lighted turbines. In the event the gap between lights on the last segment of turbines is significantly short, it may be appropriate to move the lights on the turbine string back toward the starting point to present a well-balanced string of lights. High concentrations of lights should be avoided. (See Figure A-26 in Appendix A.)

13.5.9 For cluster turbine configurations, a turbine should be selected as a starting point along the outer perimeter of the cluster. The turbine should be lighted, and a light should be placed on the next turbine along the perimeter of the cluster (clockwise or counterclockwise) so that no more than a 1/2-sm (2,640-foot (805-m)) gap exists. This pattern should be continued around the perimeter of the cluster until the starting point is reached. In the event that the gap between the lights on the last segment of turbines is significantly short, it may be appropriate to move the lights along the perimeter of the cluster back toward the starting point to present a well-balanced perimeter of lights. If the distance across the cluster is greater than 1 sm, additional lights should be placed on other turbines throughout the center of the cluster so that there are no unlighted gaps across the cluster. (See Figure A-26 in Appendix A.) (Example: If the distance across a wind turbine farm is 1.8 sm (2.9 km), a light should be placed on a turbine at approximately every 0.9 sm (1.4 km).

13.5.10 For grid turbine configurations, turbines on the corners of the farm should be lit, and then use the same concept for selecting which turbines should be lit as outlined in paragraph 13.5.9.

13.5.11 Special Considerations.

13.5.11.1 Occasionally, some wind turbines may be located apart from the main group of turbines. If one or two wind turbines protrude from the general limits of the turbine farm, these turbines should be lighted in addition to those identified in the main group.

13.5.11.2 Additional lighting may be necessary on wind turbines located on the interior of a cluster or grid configuration whose height is 100 feet (30 m) or higher than the other wind turbines located within the farm.

13.6 **Wind Turbines Above 499 Feet.**

13.6.1 For wind turbines with a rotor tip height, while at top dead center, greater than 499 feet (153 m) AGL, but less than 699 feet AGL, the turbines should be lighted in accordance with paragraph 13.5. In addition to these requirements, the top of the turbine's nacelle should be equipped with a second L-864 flashing red light. (See Figure A-23 in Appendix A.)

13.6.2 The two obstruction lights should be arranged horizontally, positioned on opposite sides of the nacelle, visible to a pilot approaching from **any** direction, and flash simultaneously. (See Figure A-23 in Appendix A.) This lighting configuration ensures the turbines in this size category are always lighted.

13.6.3 In the event one of the two obstruction lights fails, no light failure notification is required; however, the light should be restored to service as soon as possible.

13.6.4 All turbines within this size category should be illuminated, regardless of their location within a wind turbine farm, and should be configured to flash simultaneously with the other turbines in the same farm. This requirement ensures the pilots operating at 500 feet AGL have sufficient warning that a wind turbine obstruction may be within their flight path.

13.7 **Wind Turbines at or Above 699 Feet (213 m).**

13.7.1 For wind turbines with a rotor tip height, while at top dead center, at or above 699 feet (213 m) AGL, additional lighting is required. All wind turbines of this size, regardless of number or configuration should be lighted.

13.7.2 In addition to the lighting identified in paragraph 13.6, an additional level of lights is required at a point midway between the top of the nacelle and ground level. The location of the additional lights may be adjusted as necessary to allow mounting at a seam within the turbine's mast.

13.7.2.1 The additional level of lights should consist of a minimum of three L-810 flashing red lights configured to flash in unison with the two L-864 red flashing lights located at the top of the nacelle at a rate of 30 fpm (± 3 fpm). The L-810s should be spaced at equal distances around the mast. The light should be installed to ensure a pilot approaching from **any** direction has an unobstructed view of at least two of the lights. (See Figure A-23 in Appendix A.)

13.7.2.2 For wind turbine structures with a mast diameter greater than 20 feet (6 m), four L-810 red lights should be used.

13.7.2.3 All turbines within this size category should be illuminated, regardless of their location within a turbine farm, and should be configured to flash simultaneously with the other turbines in the same farm. This requirement

ensures the pilots operating at 500 feet AGL have sufficient warning that a wind turbine obstruction may be within their flight path.

13.8 **Lighting of Wind Turbines During Construction Phase.**

To ensure proper conspicuity of turbines at night during construction, all turbines should be lighted with temporary lighting once they reach a height of 200 feet (61 m) or greater until the permanent lighting configuration is turned on. As the structure's height continues to increase, the temporary lighting should be relocated to the structure's uppermost height. The temporary lighting may be turned off for short periods if they interfere with construction personnel. If practical, permanent obstruction lights should be installed and operated at each level as construction progresses. An L-810 steady-burning red light shall be used to light the structure during the construction phase, if the permanent L-864 flashing-red lights are not in place. If power is not available, turbines should be lighted with a self-contained, solar-powered, LED, steady-burning red light that meets the photometric requirements of an FAA L-810 lighting system. The lights should be positioned to ensure a pilot has an unobstructed view of at least one light at each level. Using a NOTAM (D) to justify not lighting the turbines until the entire project is completed is prohibited.

13.9 **Lighting and Marking of Airborne Wind Turbines.**

The FAA is currently conducting research to develop special lighting and marking standards for Airborne Wind Turbines. Sponsors should consult with their respective FAA OE Specialists for updated information.

13.10 **Lighting and Marking of Offshore Wind Turbines.**

FAA lighting and marking recommendations apply to structures out to 12 NM from the coast of the United States, which is the extent of the territorial seas. The Bureau of Ocean Energy Management (BOEM), which maintains jurisdiction of land leases beyond the 12 NM, may also require compliance with the marking and/or lighting recommendations identified in this AC.

CHAPTER 14. AIRCRAFT DETECTION LIGHTING SYSTEMS

14.1 Purpose.

Aircraft Detection Lighting Systems (ADLS) are sensor-based systems designed to detect aircraft as they approach an obstruction or group of obstructions; these systems automatically activate the appropriate obstruction lights until they are no longer needed by the aircraft. This technology reduces the impact of nighttime lighting on nearby communities and migratory birds and extends the life expectancy of obstruction lights.

14.2 General Standards.

14.2.1 The system should be designed with sufficient sensors to provide complete detection coverage for aircraft that enter a three-dimensional volume of airspace, or coverage area, around the obstruction(s) (see Figure A-27 in Appendix A), as follows:

1. Horizontal detection coverage should provide for obstruction lighting to be activated and illuminated prior to aircraft penetrating the perimeter of the volume, which is a minimum of 3 NM (5.5 km) away from the obstruction or the perimeter of a group of obstructions.
2. Vertical detection coverage should provide for obstruction lighting to be activated and illuminated prior to aircraft penetrating the volume, which extends from the ground up to 1,000 feet (304 m) above the highest part of the obstruction or group of obstructions, for all areas within the 3 NM (5.5 km) perimeter defined in subparagraph 14.2.1 1 above.
3. In some circumstances, it may not be possible to meet the volume area defined above because the terrain may mask the detection signal from acquiring an aircraft target within the 3 NM (5.5 km) perimeter. In these cases, the sponsor should identify these areas in their application to the FAA for further evaluation.
4. In some situations, lighting not controlled by the ADLS may be required when the 3 NM (5.5 km) perimeter is not achievable to ensure pilots have sufficient warning before approaching the obstructions.

14.2.2 The ADLS should activate the obstruction lighting system in sufficient time to allow the lights to illuminate and synchronize to flash simultaneously prior to an aircraft penetrating the volume defined above. The lights should remain on for a specific time period, as follows:

1. For ADLSs capable of continuously monitoring aircraft while they are within the 3 NM/1,000 foot (5.5 km/304 m) volume, the obstruction lights should stay on until the aircraft exits the volume. In the event detection of the aircraft is lost while being continuously monitored within the 3 NM/1,000 foot (5.5 km/304 m) volume, the ADLS should initiate a 30-minute timer and keep the obstruction lights on until the timer expires. This should provide the untracked aircraft sufficient time to exit the area and give the ADLS time to reset.

2. For ADLSs without the capability of monitoring aircraft targets in the 3 nm/1,000 foot (5.5 km/304 m) volume, the obstruction lights should stay on for a preset amount of time, calculated as follows:

   a. For single obstructions: 7 minutes.

   b. For groups of obstructions: (the widest dimension in nautical miles + 6) x 90 seconds equals the number of seconds the light(s) should remain on.

14.2.3 Acceptance of ADLS applications will be on a case-by-case basis and may be modified, adjusted, or denied based on proximity of the obstruction or group of obstructions to airports, low-altitude flight routes, military training areas, or other areas of frequent flight activity. It may be appropriate to keep certain obstructions closest to these known activity areas illuminated during the nighttime hours, while the remainder of the group's obstruction lighting is controlled by the ADLS.

14.2.4 Project sponsors requesting ADLS use should include in their application maps or diagrams indicating the location of the proposed sensors, the range of each sensor, and a visual indication showing how each sensor's detection arc provides the full horizontal and vertical coverage, as required under paragraph 14.2.1. In the event that detection coverage is not 100 percent due to terrain masking, project sponsors should provide multiple maps or diagrams that indicate coverage at the affected altitudes. A sample diagram is shown in Figure A-27 in Appendix A.

14.2.5 Types of ADLS Component or System Failure Events.

1. In the event of an ADLS component or system failure, the ADLS should automatically turn on all the obstruction lighting and operate in accordance with this AC as if it was not controlled by an ADLS. The obstruction lighting must remain in this state until the ADLS and its components are restored.

2. In the event that an ADLS component failure occurs and an individual obstruction light cannot be controlled by the ADLS, but the rest of the ADLS is functional, that particular obstruction light should automatically turn on and operate in accordance with this AC as if it was not controlled by an ADLS, and the remaining obstruction lights can continue to be controlled by the ADLS. The obstruction lighting will remain in this state until the ADLS and its components are restored.

3. Complete light failure should be addressed in accordance with Chapter 2 paragraph 2.4.

14.2.6 The ADLS's communication and operational status shall be checked at least once every 24 hours to ensure both are operational.

14.2.7 The ADLS should be able to detect an aircraft with a cross-sectional area of 1 square meter or more within the volume, as required in subparagraphs 14.2.1 1 and 14.2.1 2.

14.2.8 Each ADLS installation should maintain a log of activity data for a period of no less than the previous 15 days. This data should include, but not be limited to, the date, time, duration of all system activations/deactivations, track of aircraft activity,

maintenance issues, system errors, communication and operational issues, lighting outages/issues, etc.

14.2.9 Operational Frequencies.

1. Unlicensed devices (including FCC Part 15) devices cannot be used for this type of system.
2. Any frequency used for the operation of ADLS must be individually licensed through the FCC.

14.3 **Voice/Audio Option.**

14.3.1 ADLS may include an optional voice/audio feature that transmits a low-power, audible warning message to provide pilots additional information on the obstruction they are approaching.

14.3.2 The audible transmission should be in accordance with appropriate FAA and FCC regulations.

14.3.3 The audible transmission should be over an aviation frequency licensed by the FCC and authorized under the Code of Federal Regulations Title 47- Part 87.483 (excluding 121.5 MHz).

Note: Using air traffic control frequencies in the 117.975-MHz to 137-MHz frequency band is prohibited for this operation.

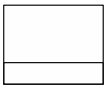
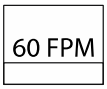
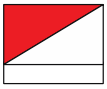
14.3.4 The audible message should consist of three quick tones, followed by a verbal message that describes the type of obstruction the system is protecting. Appropriate terms to be used include tower(s), wind turbine(s), or power line(s).

14.3.5 The audible message should be repeated three times or until the system determines the aircraft is no longer within the audible warning area defined in the following paragraph.

14.3.6 The audible message should be considered as a secondary, final warning and should be activated when an aircraft is within 1/2 NM (926 m) horizontally and 500 feet (152 m) vertically of the obstruction. The use of, or variation to, the audible warning zone may occur, depending on site-specific conditions or obstruction types.

APPENDIX A: Specifications for Obstruction Lighting Equipment Classification

Table A-1. FAA-Approved Obstruction Lighting Fixtures

Type	Symbol	Description
L-810		Steady-Burning - RED Single Obstruction Light
L-810		Steady-Burning – RED Double Obstruction Light
L-856		High-Intensity Flashing – WHITE Obstruction Light (40 FPM)
L-857		High-Intensity Flashing – WHITE Catenary Light (60 FPM)
L-864		Medium-Intensity Flashing – RED Obstruction Light (20-40 FPM)
L-865		Medium-Intensity Flashing – WHITE Obstruction Light (40-FPM)
L-866		Medium-Intensity Flashing - WHITE Catenary Light (60-FPM)
L-864/L-865		Medium-Intensity Flashing Dual – RED / WHITE Obstruction Light (20-40 FPM) Obstruction Light (40 FPM)
L-885		Flashing Obstruction Light - RED Obstruction Light (60 FPM)

FPM = Flashes Per Minute

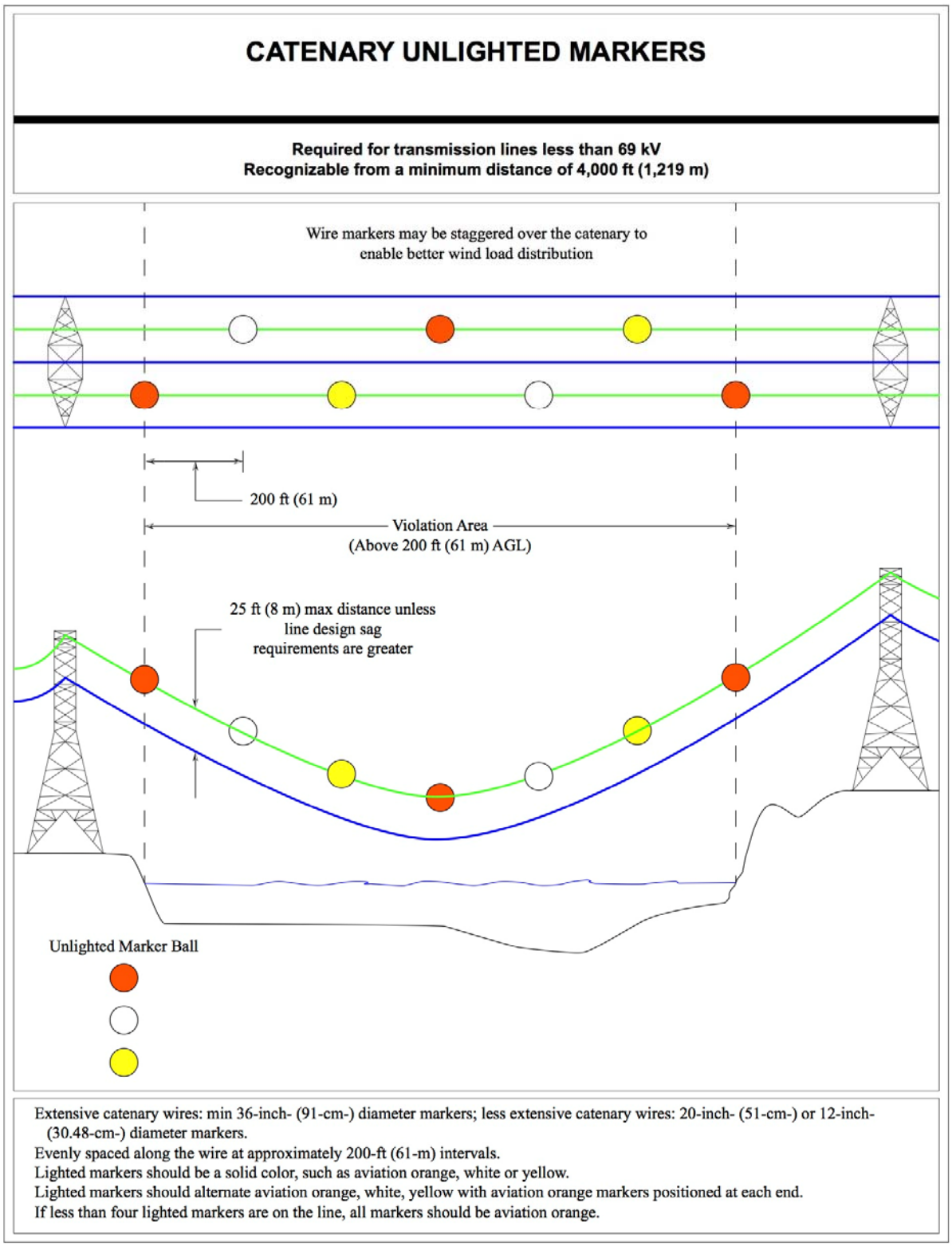


Figure A-1. Catenary Unlighted Markers

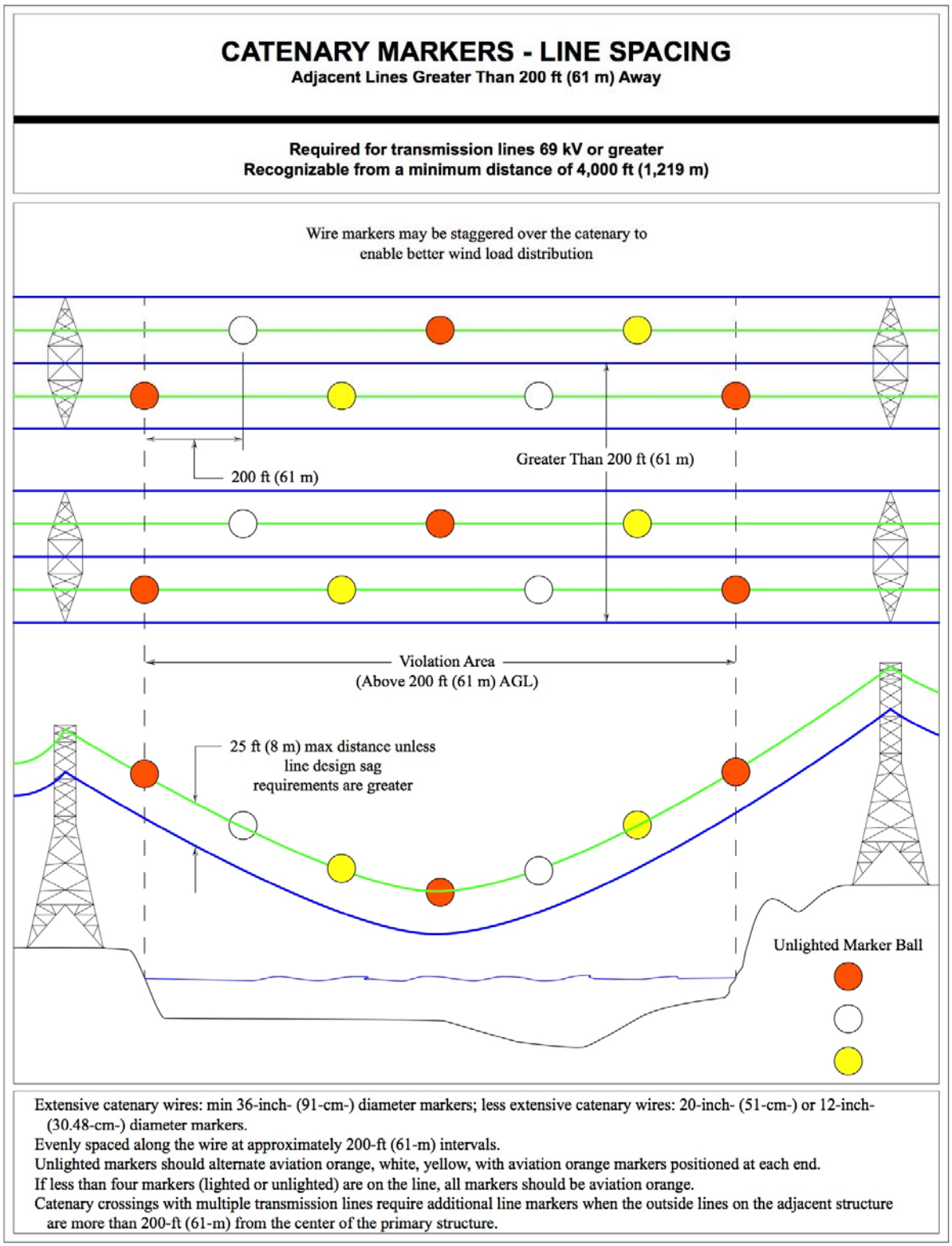


Figure A-2. Catenary Markers - Line Spacing (Adjacent Lines Greater Than 200 ft (61 m) Away)

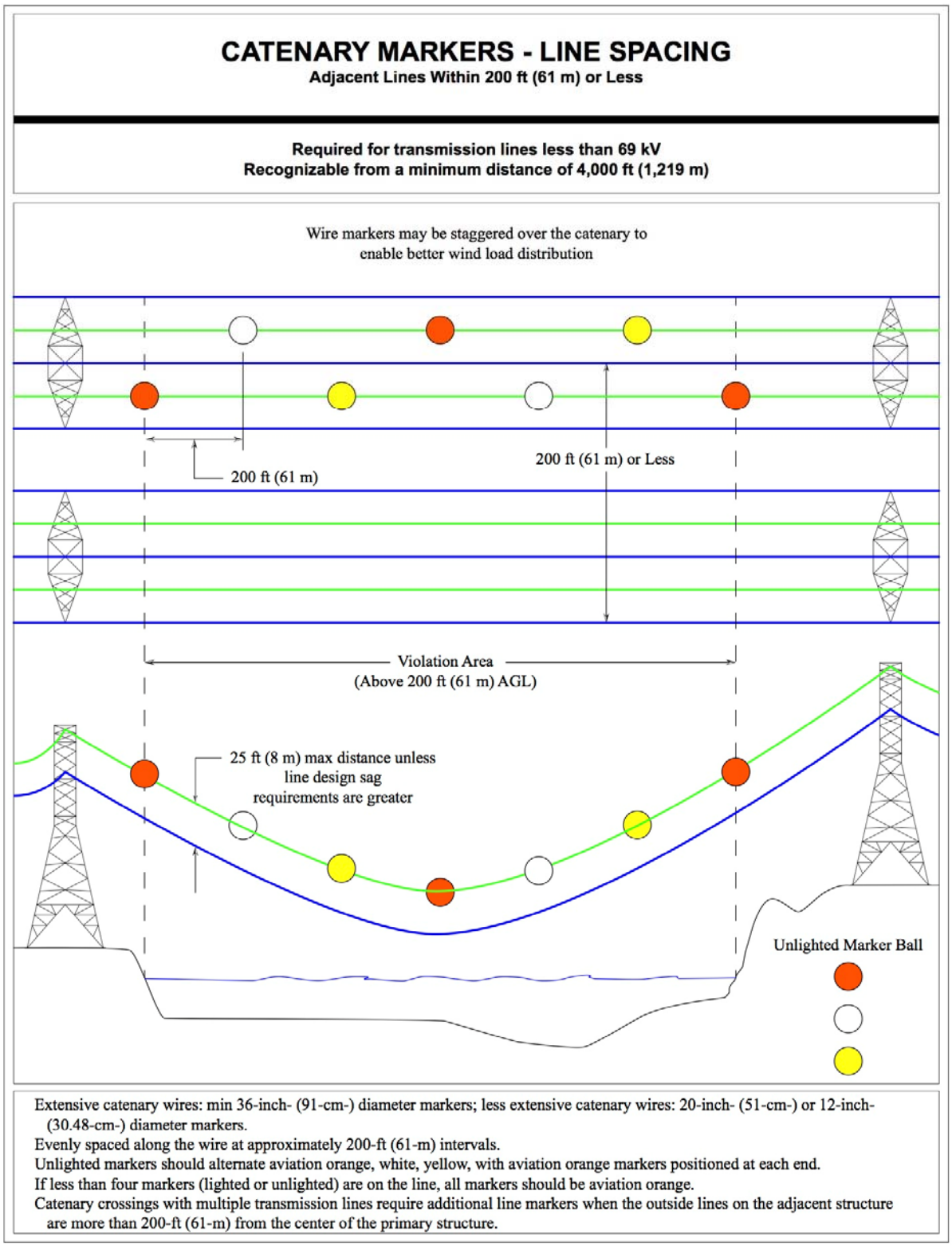


Figure A-3. Catenary Markers – Line Spacing (Adjacent Lines Within 200 ft (61 m) or Less

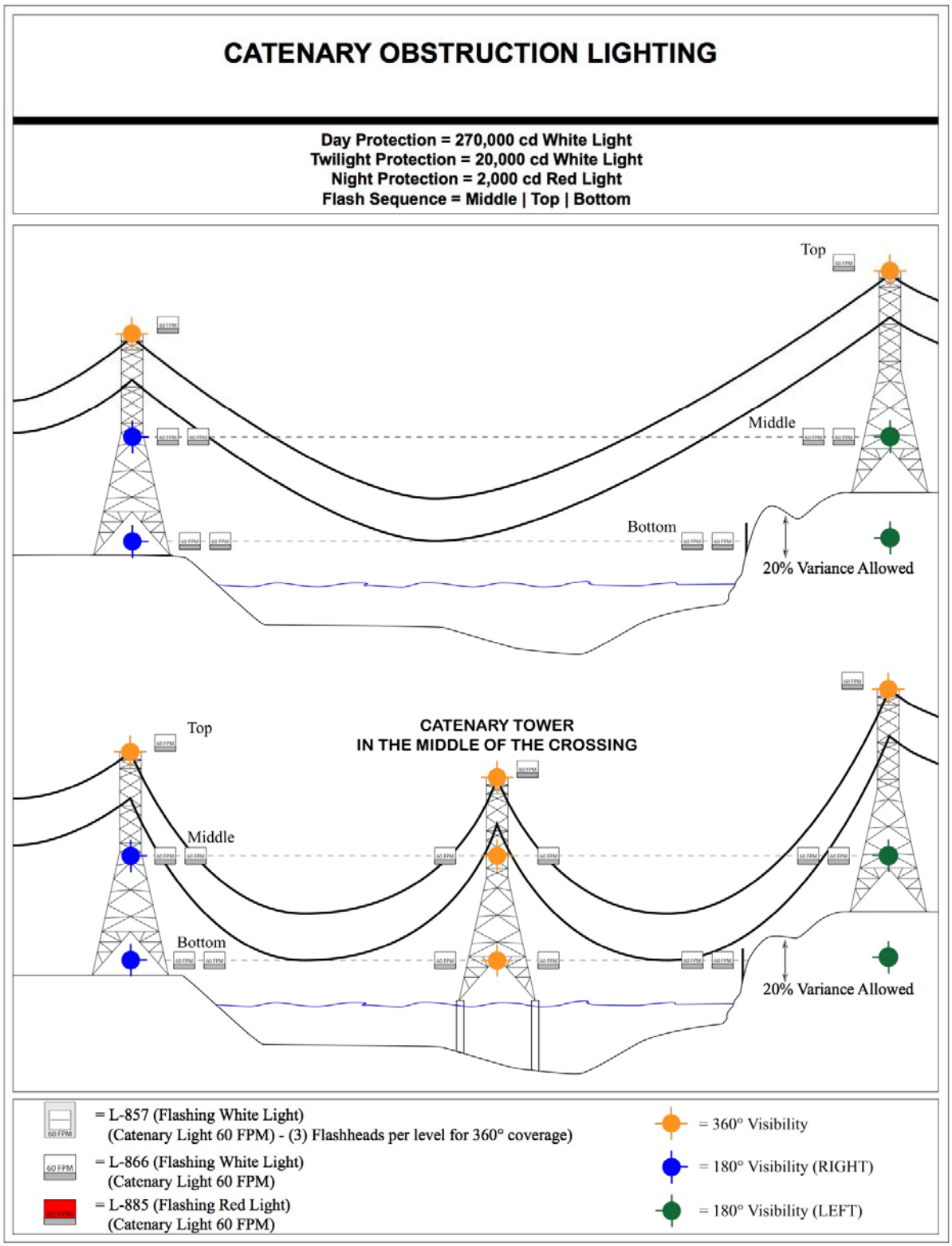


Figure A-4. Catenary Obstruction Lighting

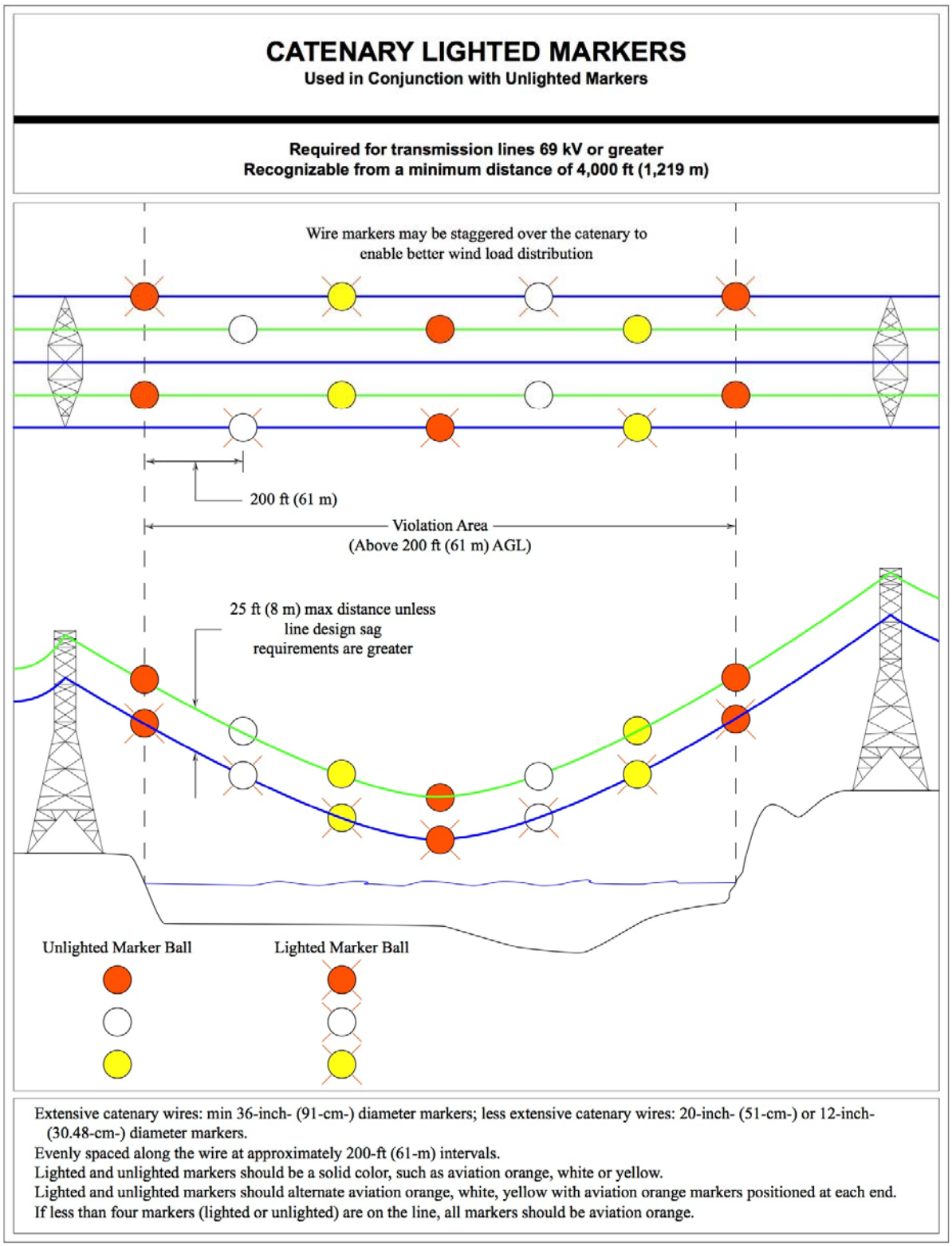


Figure A-5. Catenary Lighted Markers

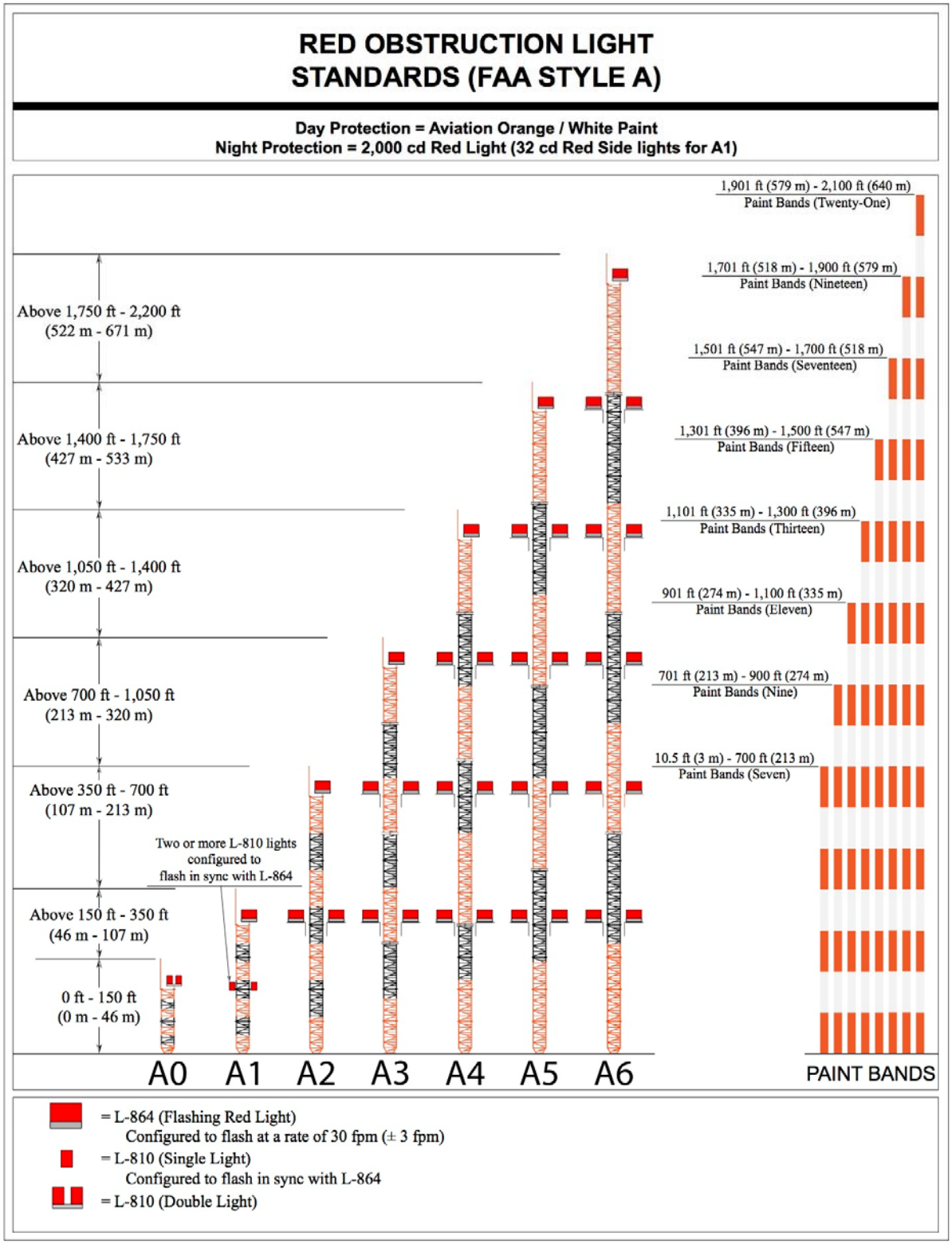


Figure A-6. Red Obstruction Light Standards

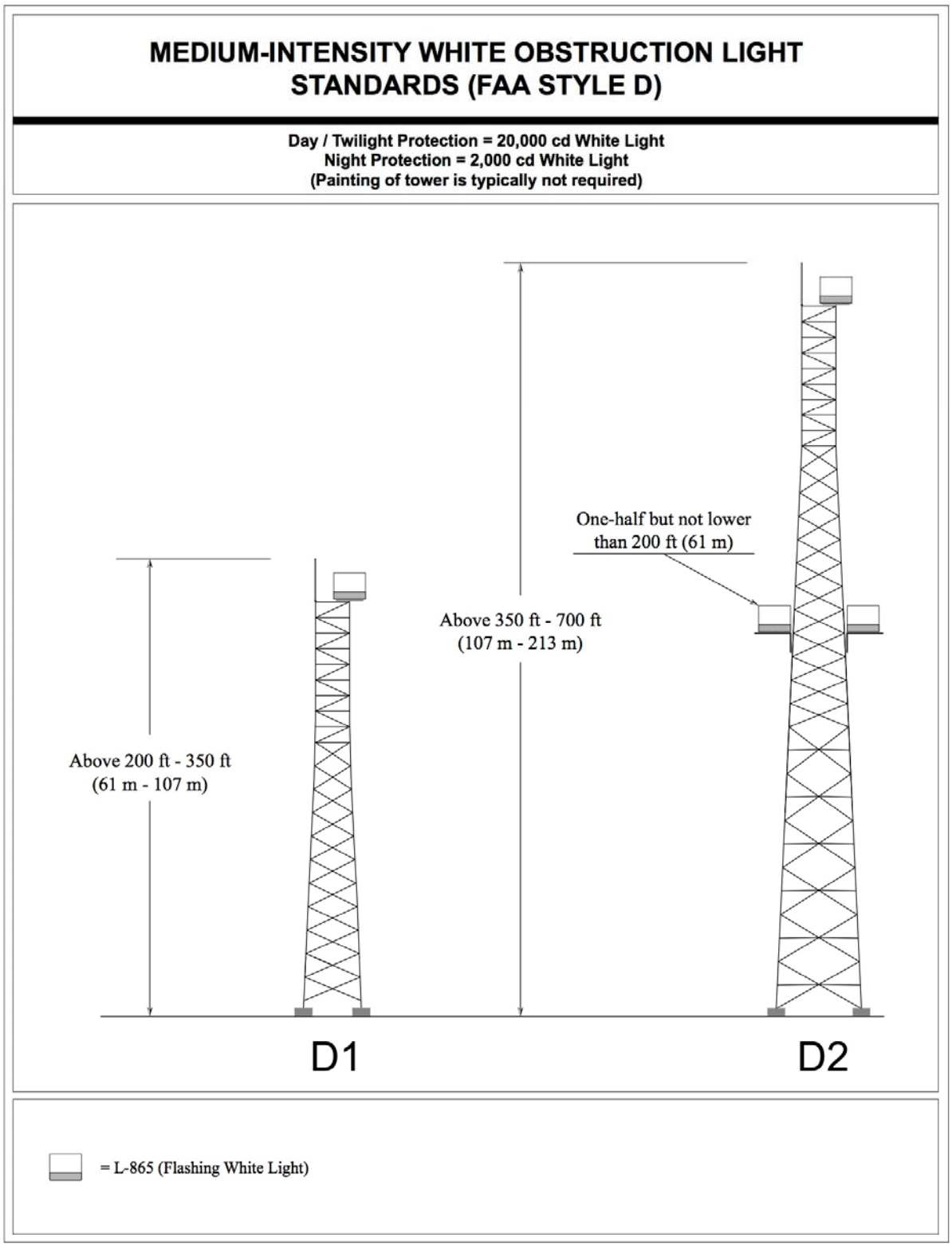


Figure A-7. Medium-Intensity White Obstruction Light Standards

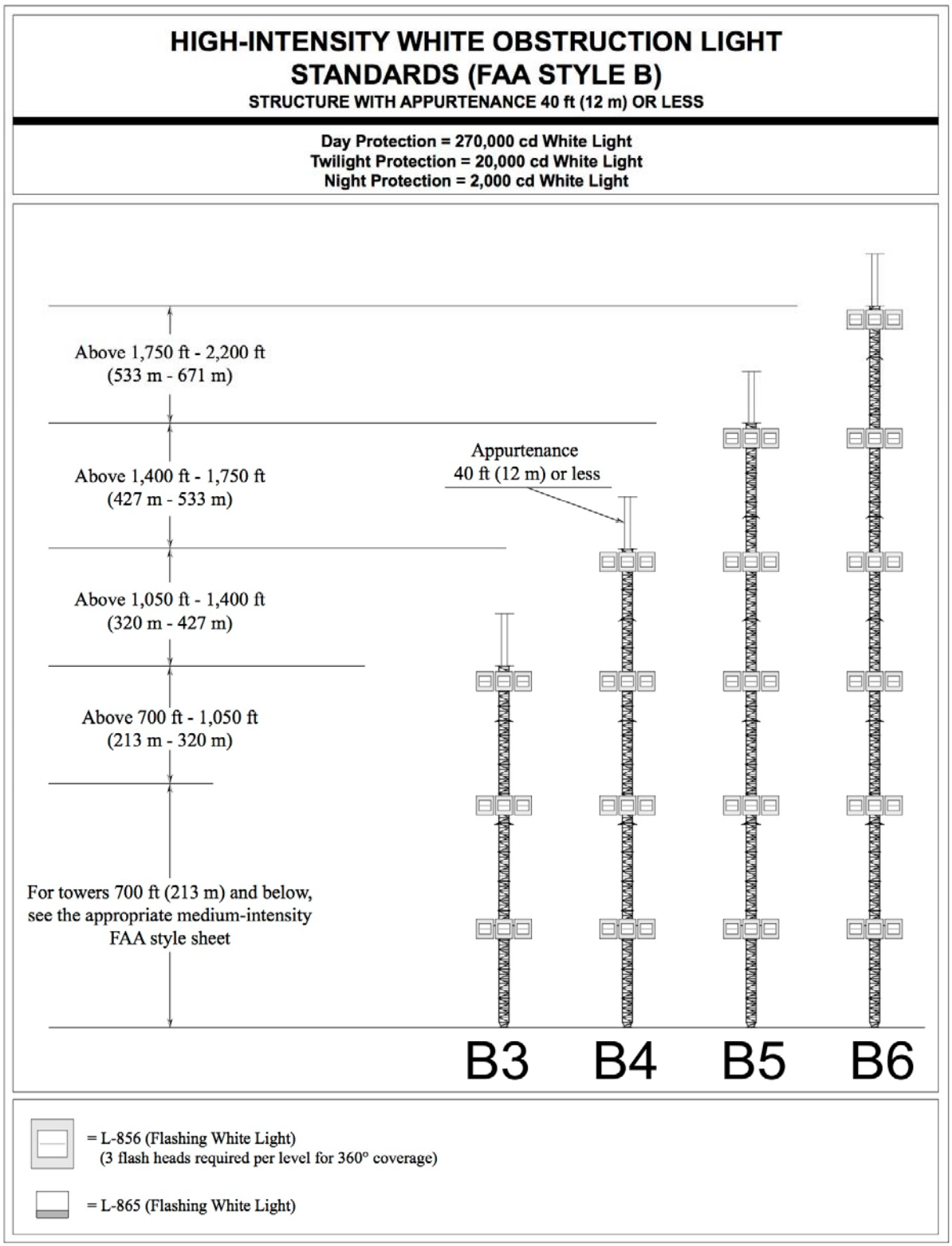


Figure A-8. High-Intensity White Obstruction Light Standards—Structures With Appurtenance 40 Feet or Less

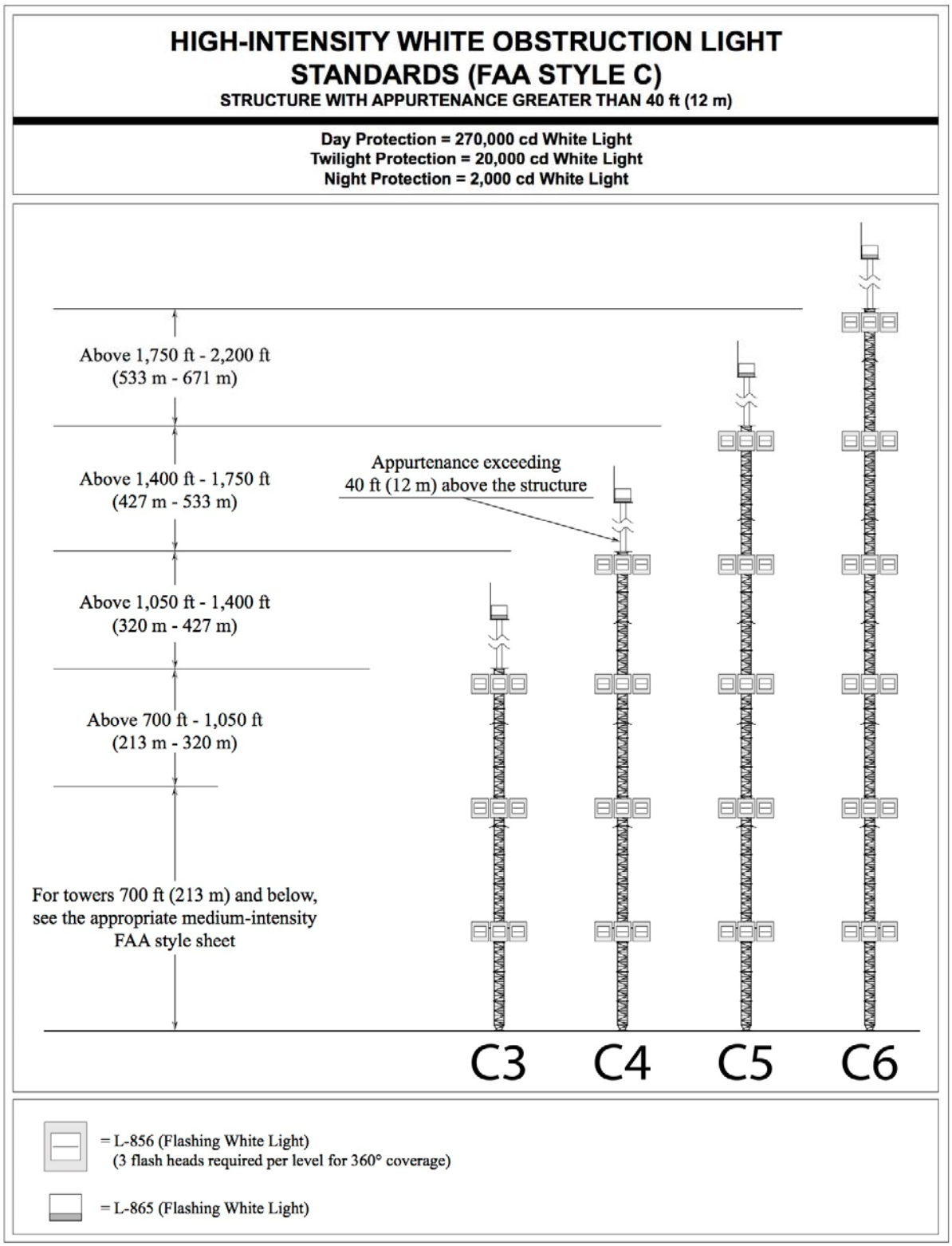


Figure A-9. High-Intensity Obstruction Lighting Standards—Structures With Appurtenance Over 40 Feet High

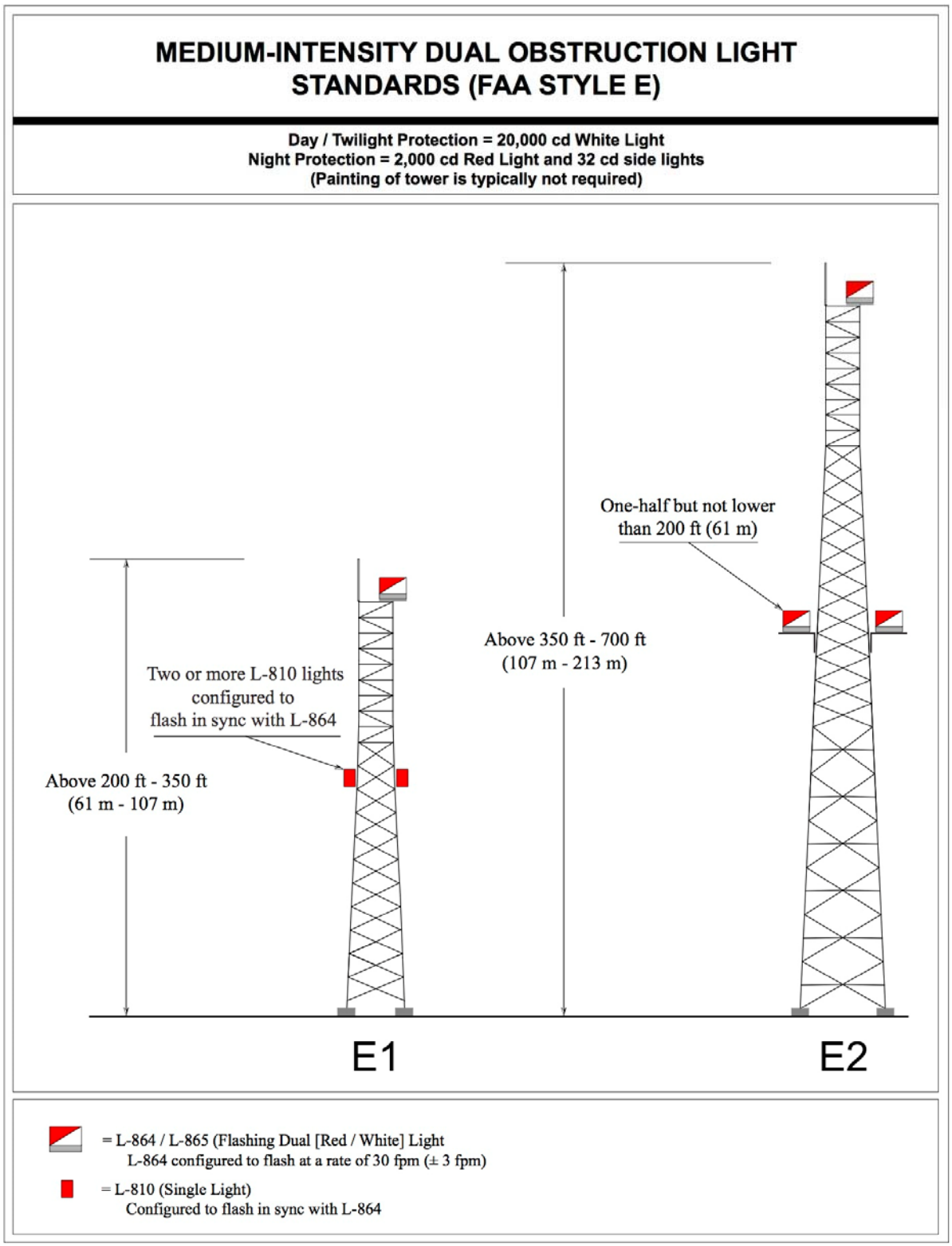


Figure A-10. Medium-Intensity Dual Obstruction Lighting Standards

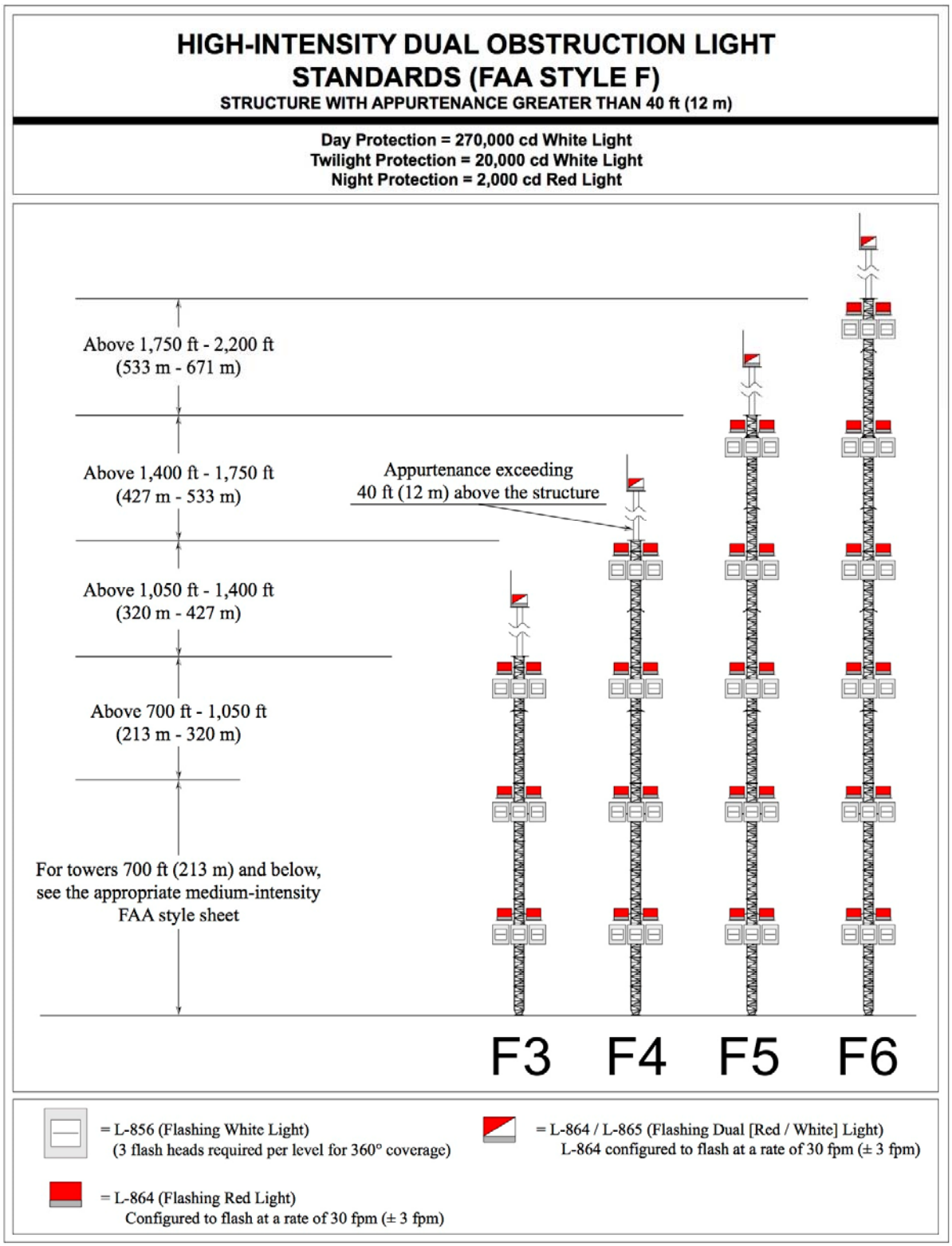


Figure A-11. High-Intensity Dual Obstruction Lighting Standards—Structures With Appurtenance Over 40 Feet High

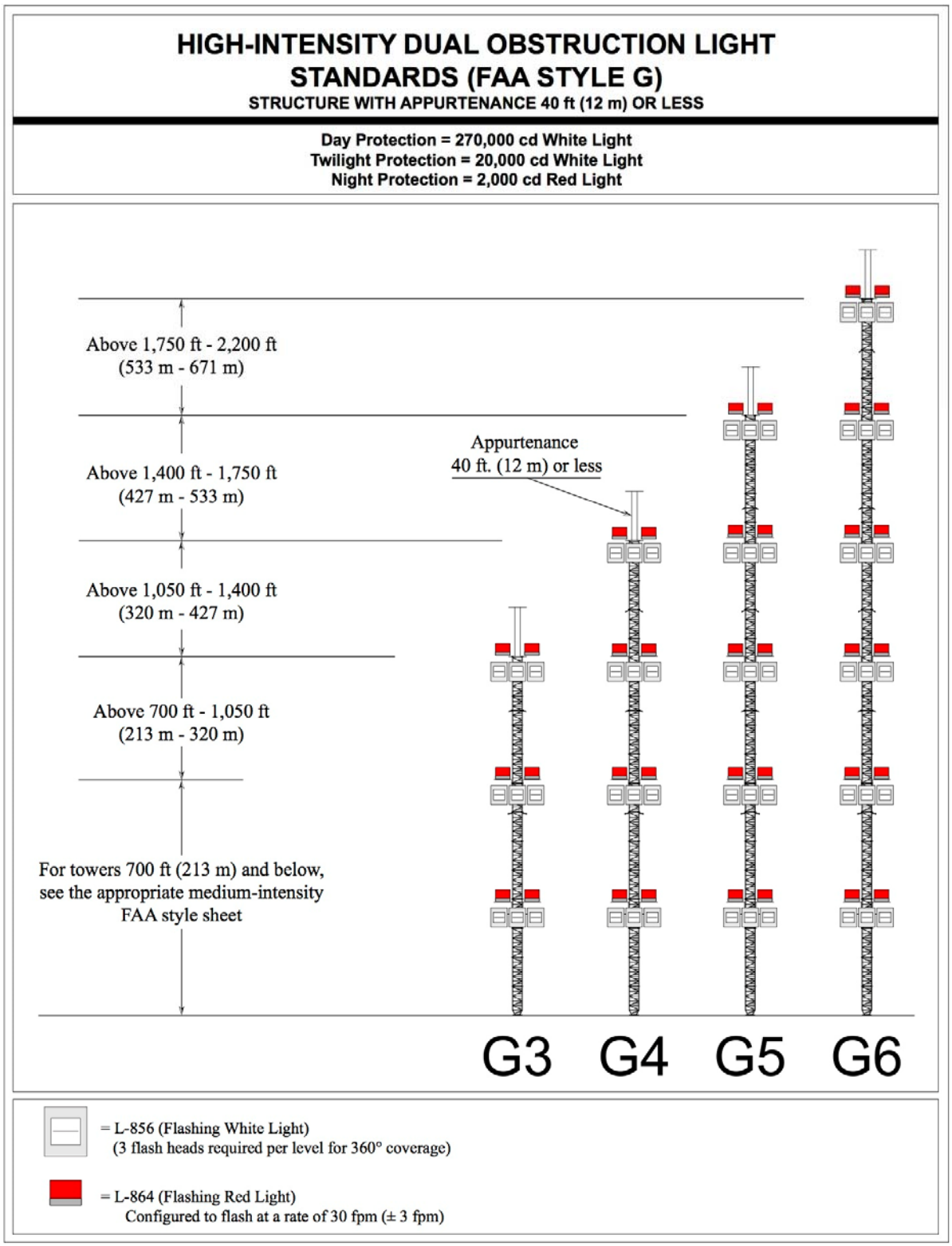


Figure A-12. High-Intensity Dual Obstruction Lighting Standards—Structures With Appurtenance 40 Feet or Less

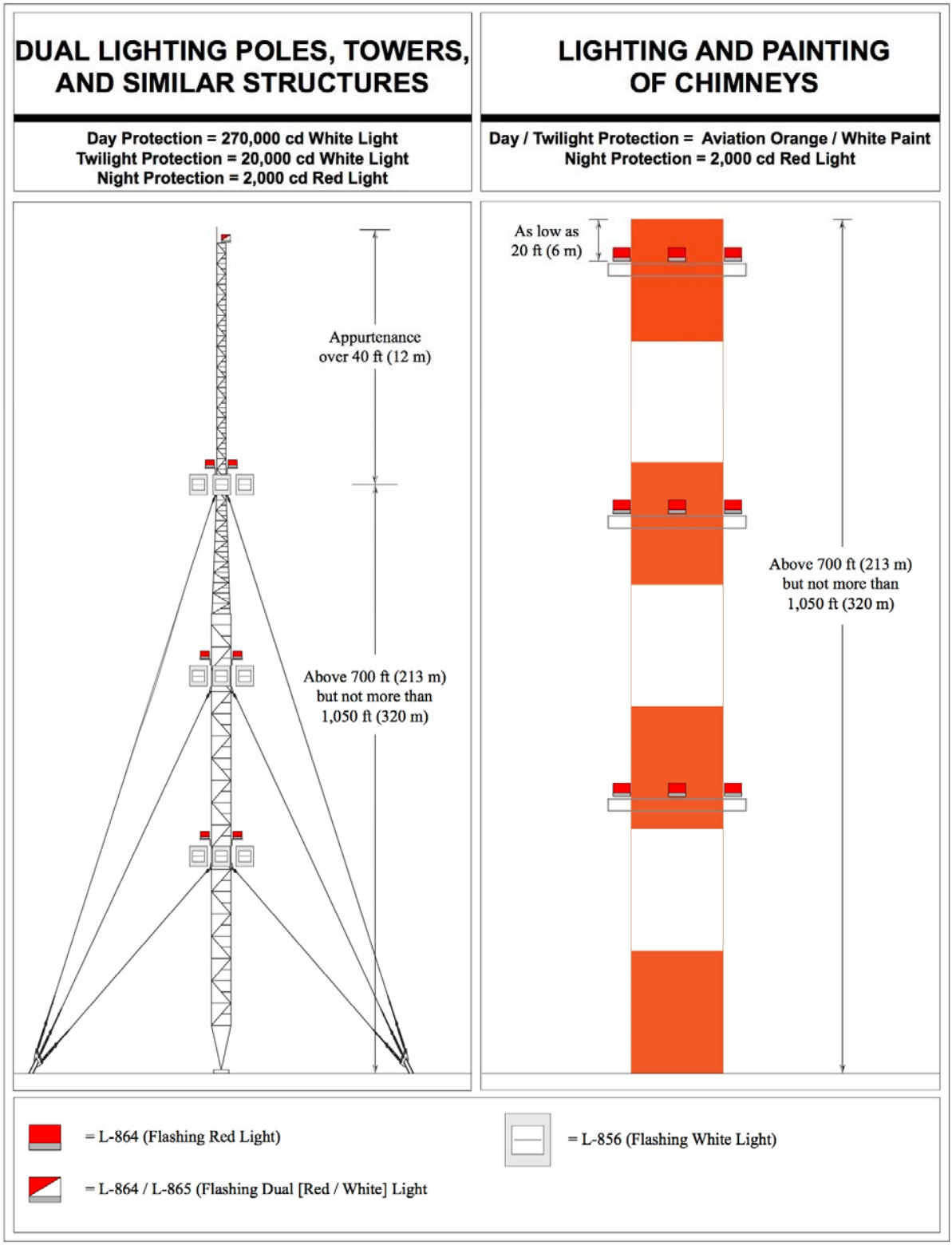


Figure A-13. Painting and/or Dual Lighting of Chimneys, Poles, Towers, and Similar Structures

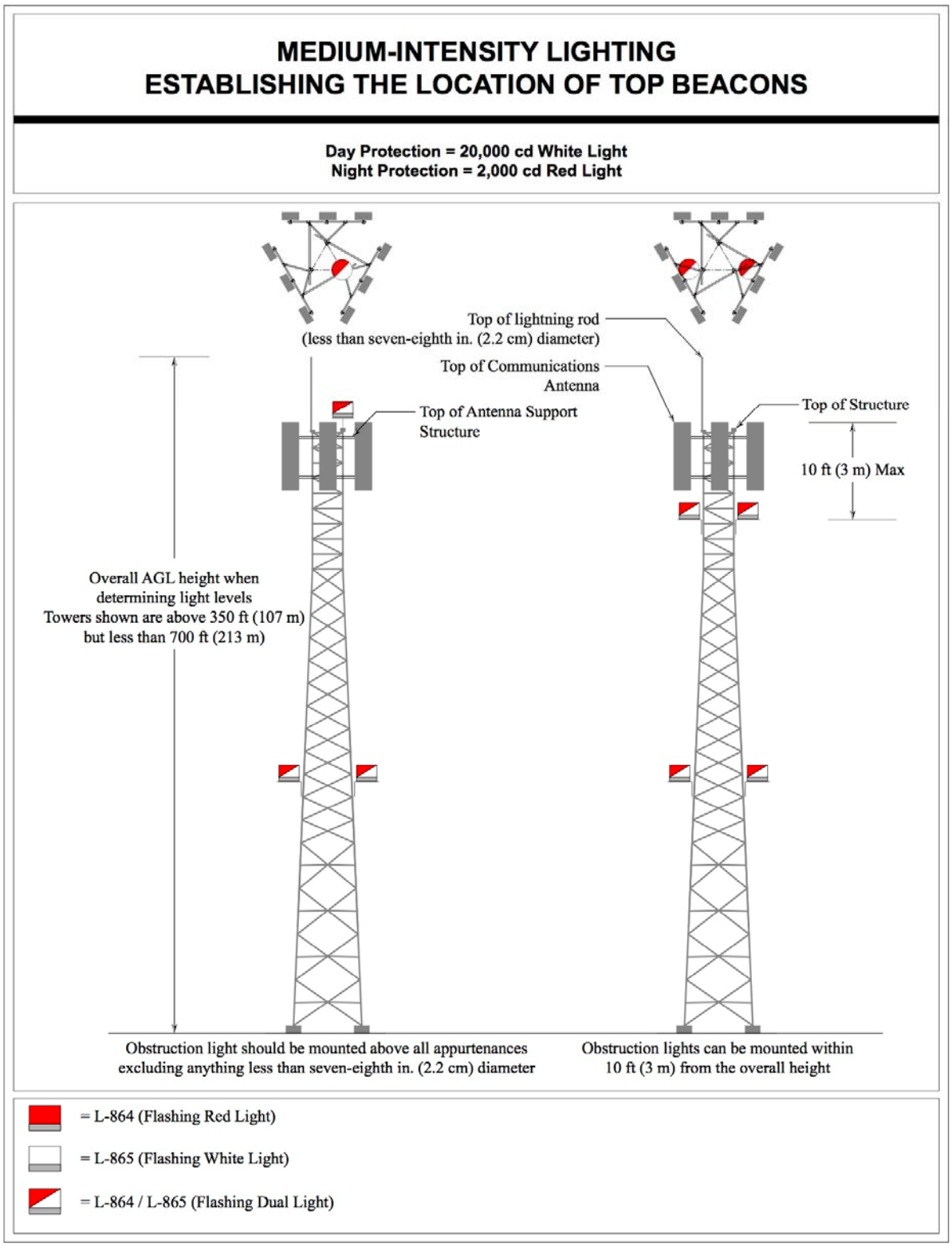


Figure A-14. Medium-Intensity Lighting—Establishing the Location of Top Beacons

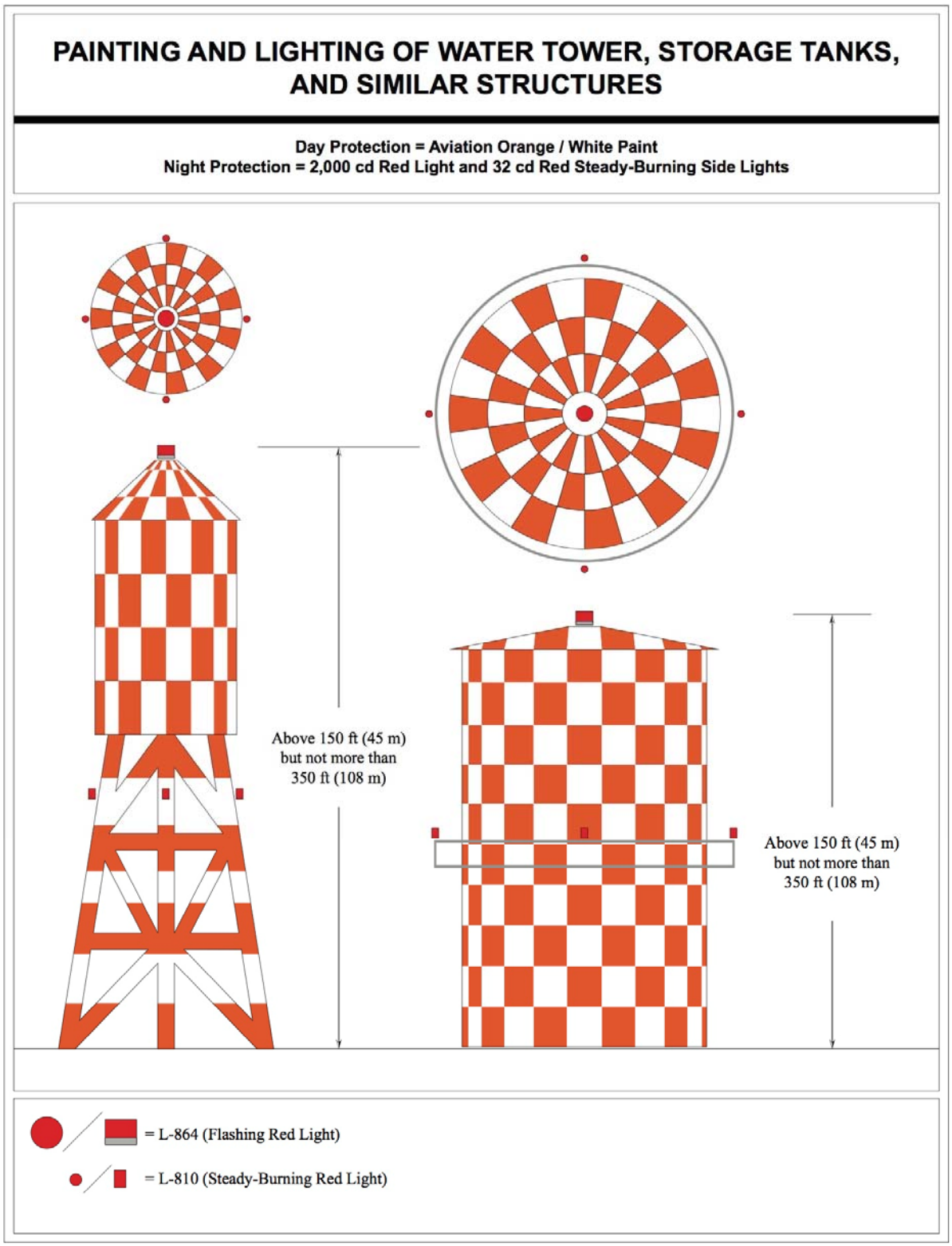


Figure A-15. Painting and Lighting of Water Towers, Storage Tanks, and Similar Structures

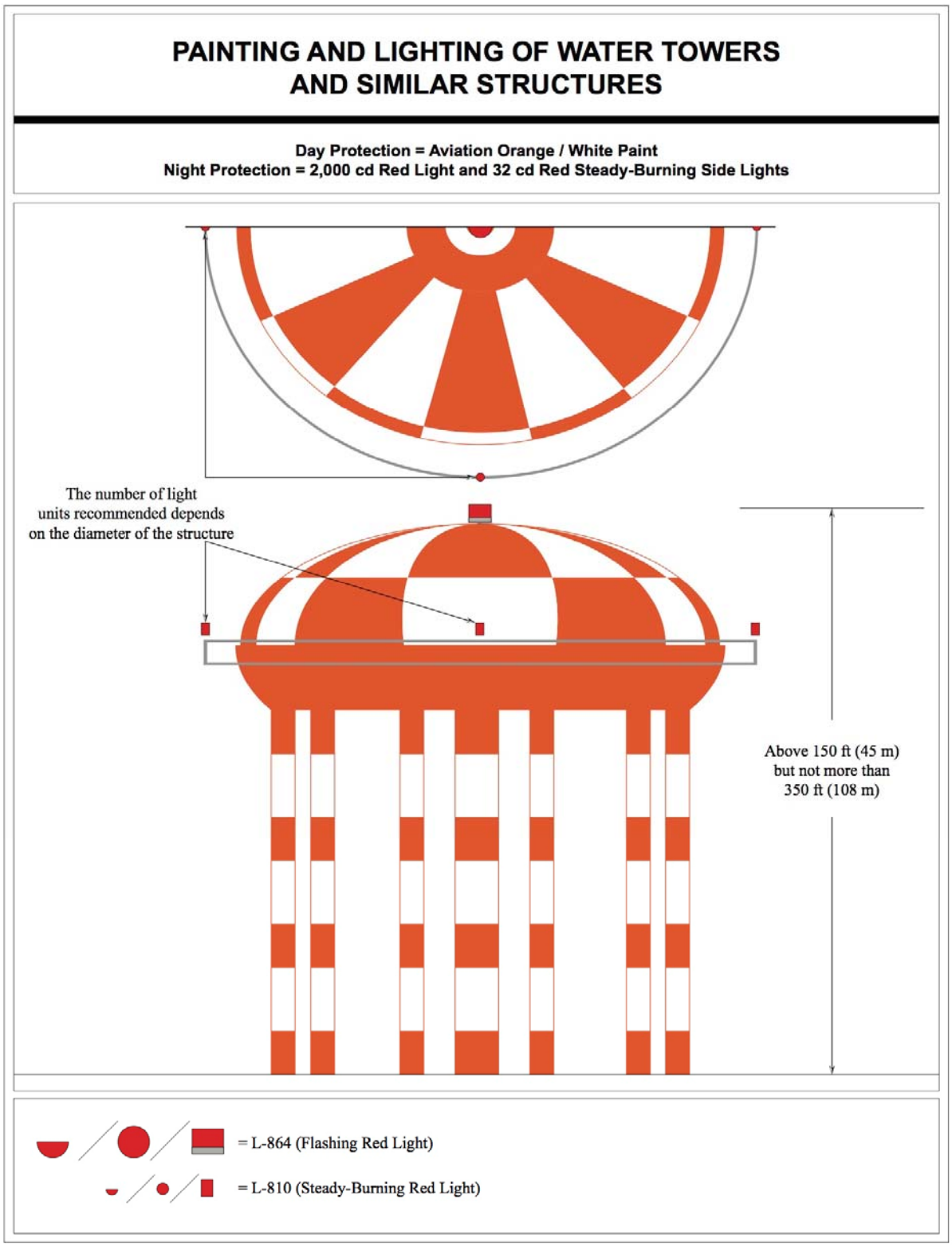


Figure A-16. Painting and Lighting of Water Towers and Similar Structures

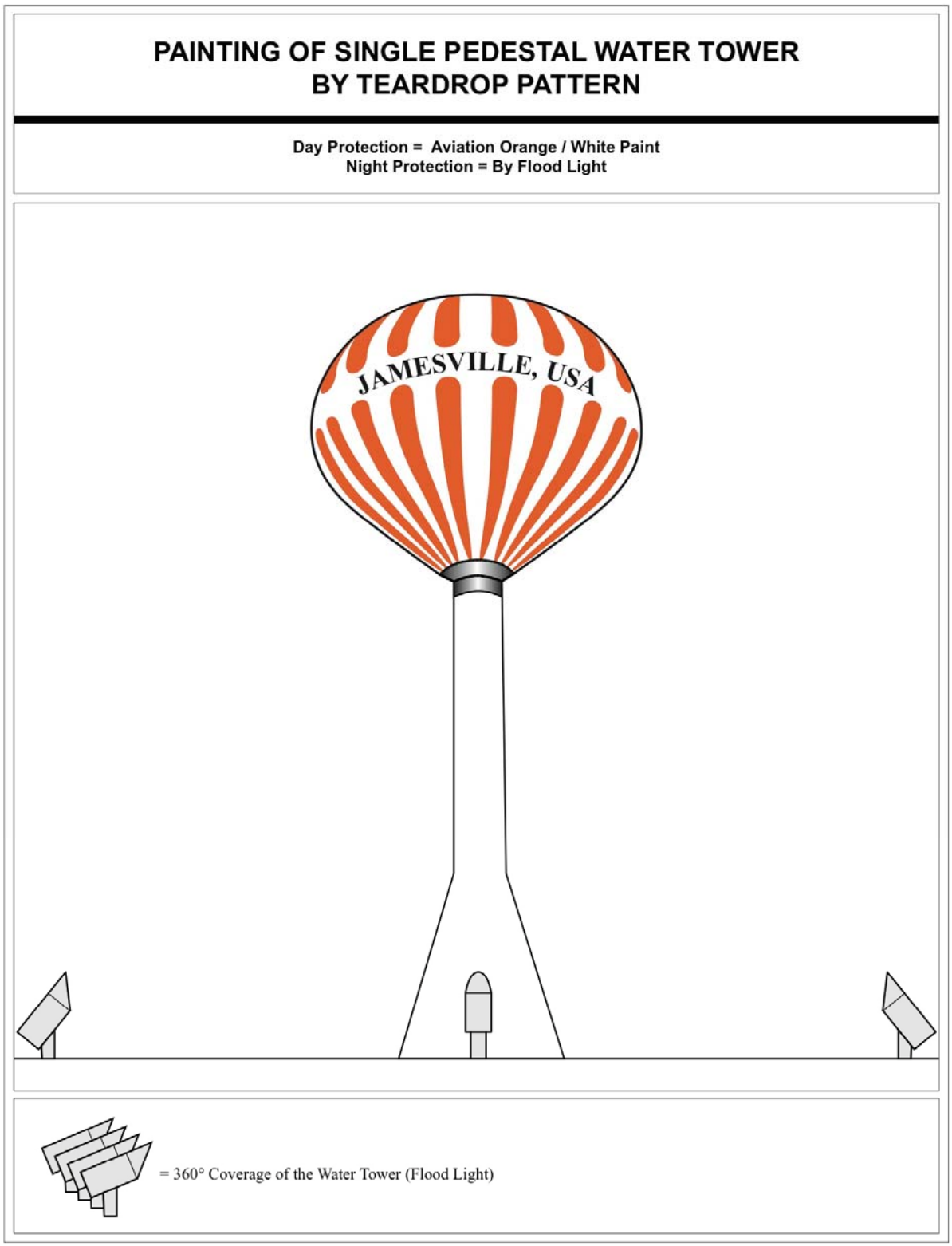


Figure A-17. Painting a Single Pedestal Water Tower Using the Teardrop Pattern

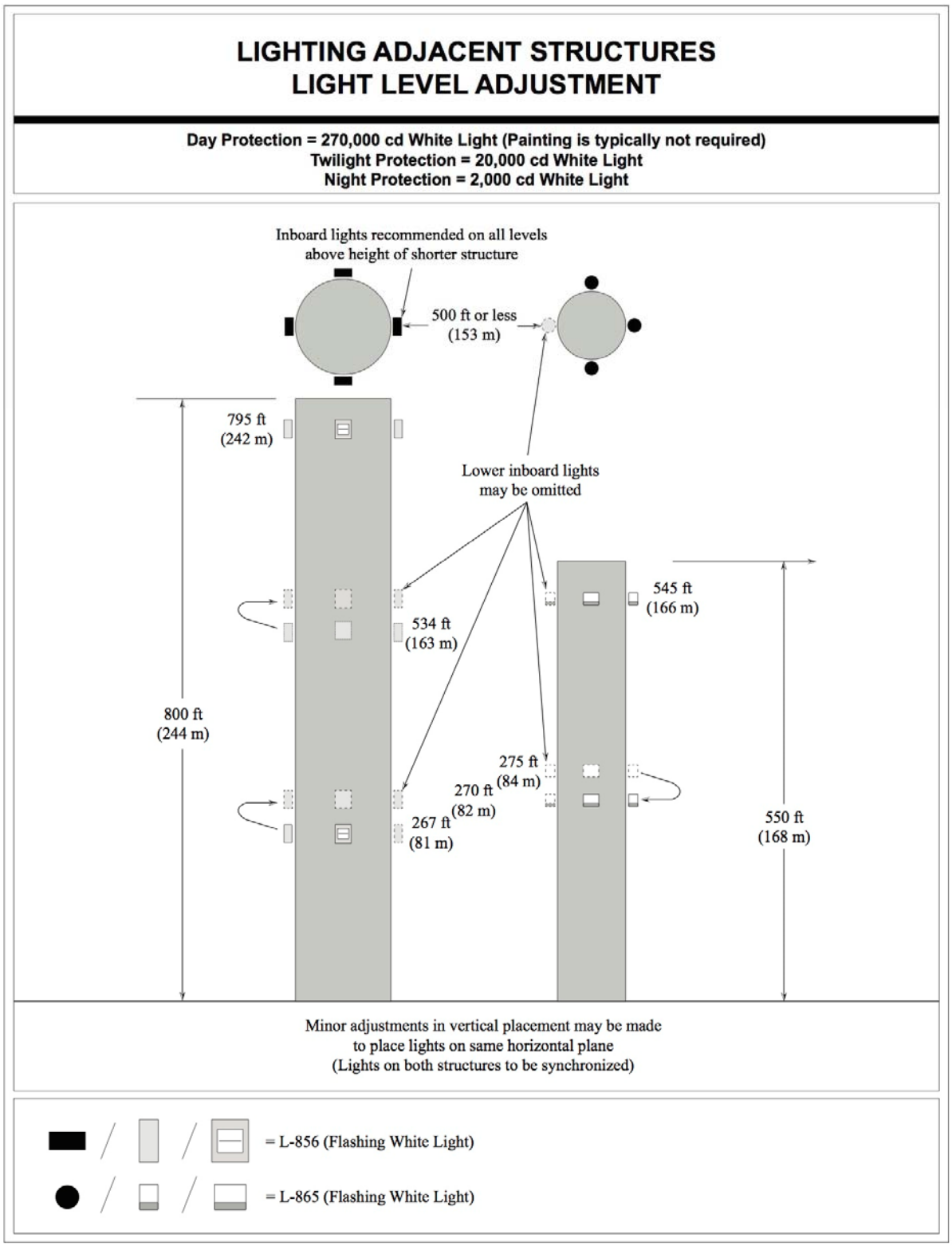


Figure A-18. Lighting Adjacent Structures—Light Level Adjustment

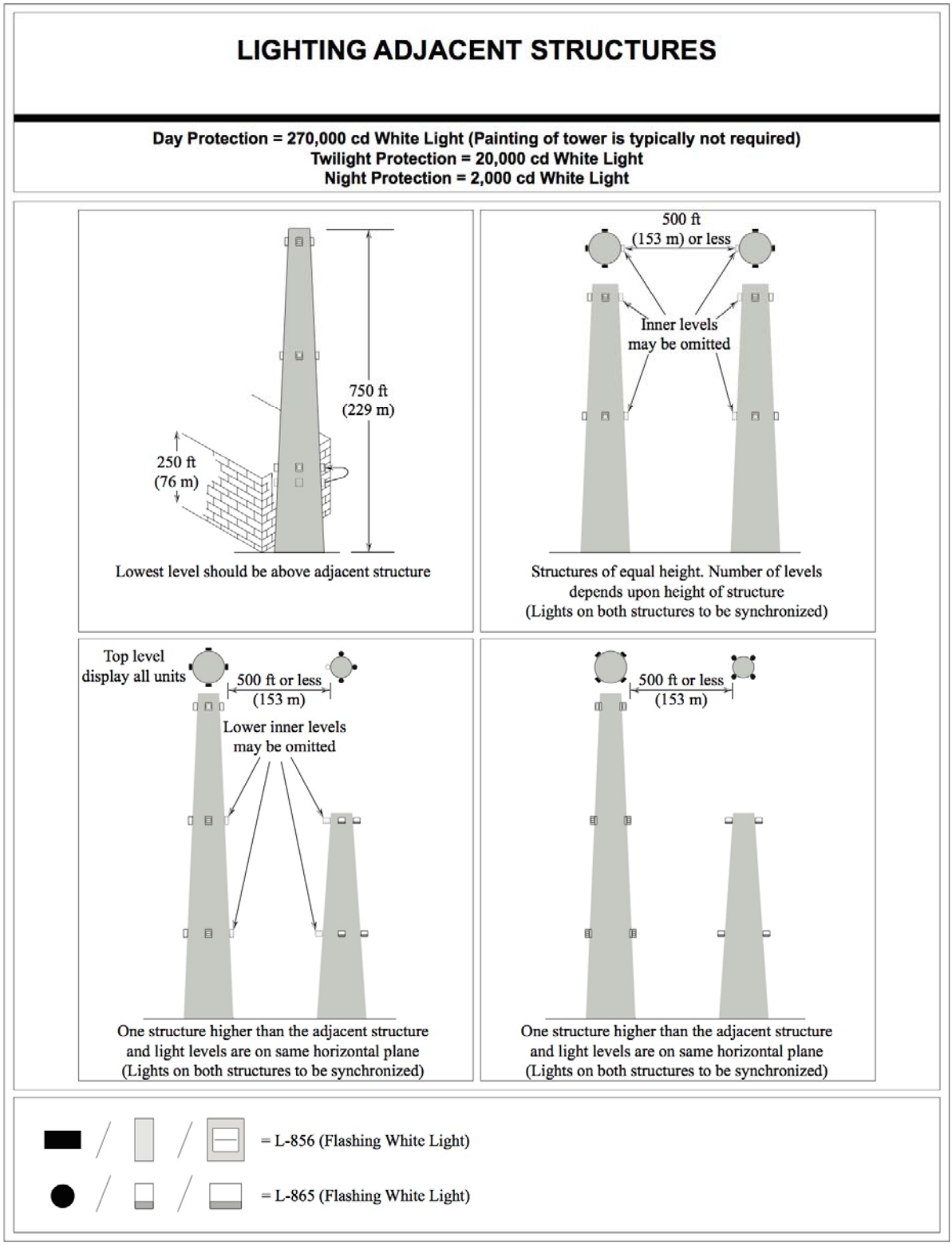


Figure A-19. Lighting Adjacent Structures

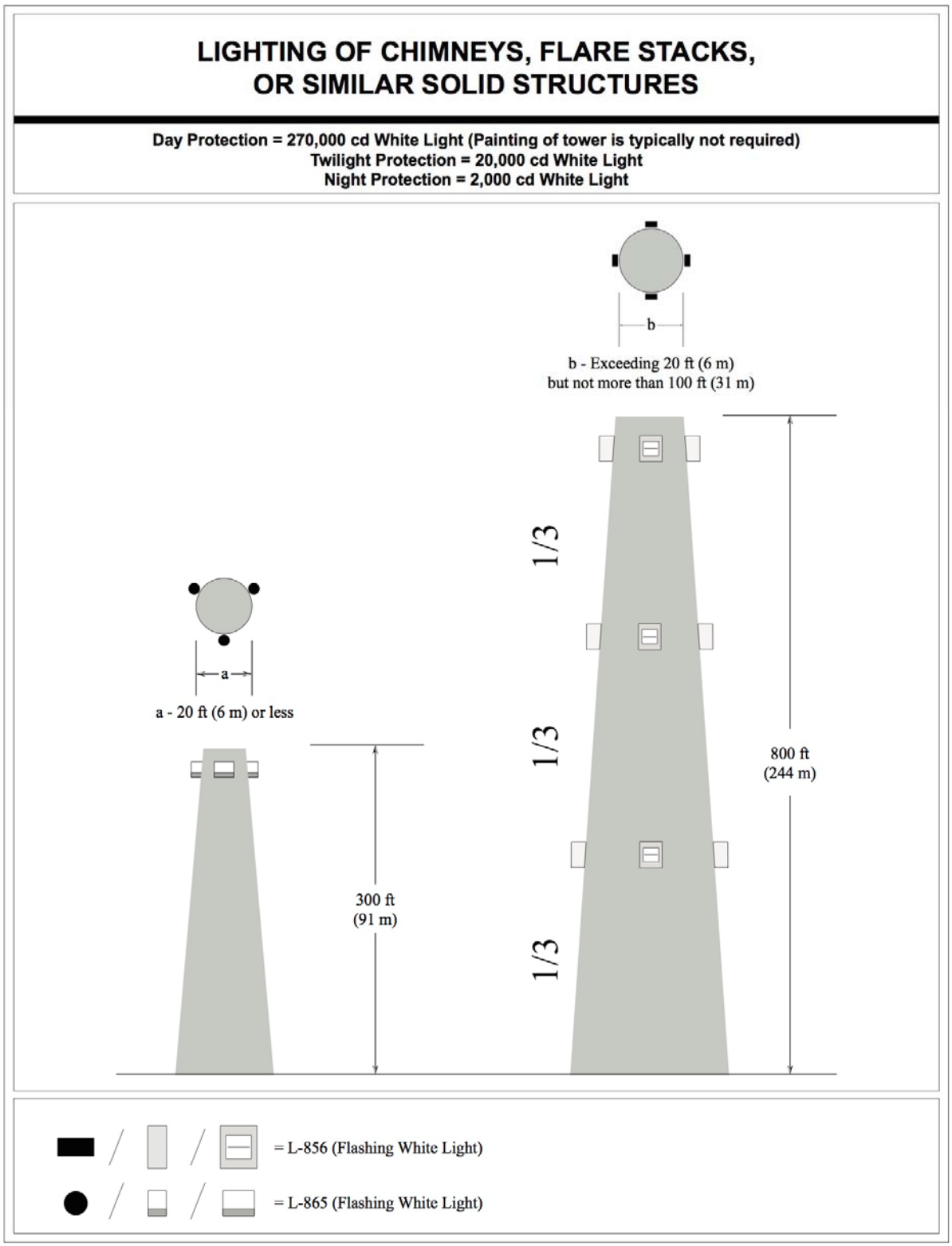


Figure A-20. Lighting of Chimneys, Flare Stacks, or Similar Solid Structures

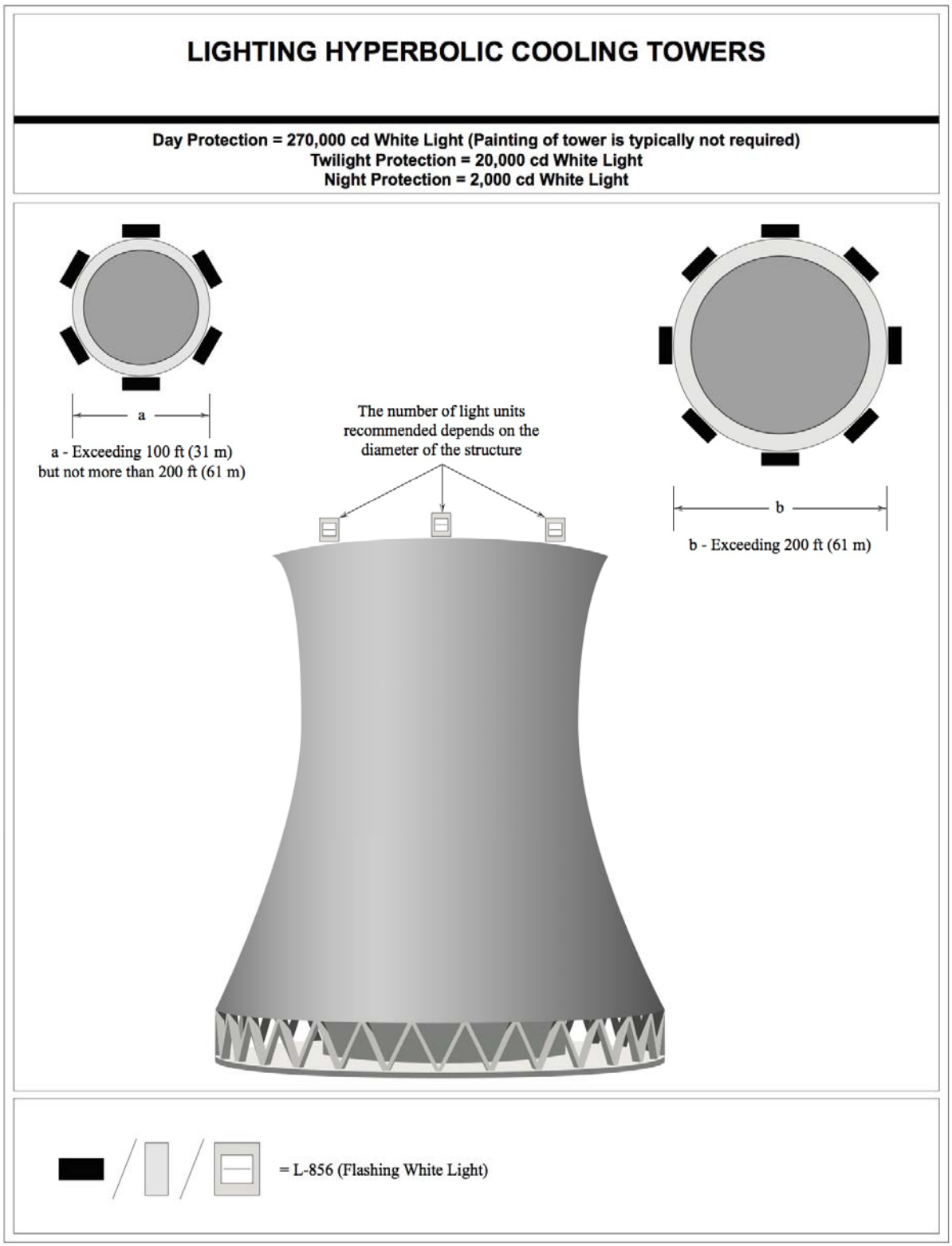


Figure A-21. Hyperbolic Cooling Tower

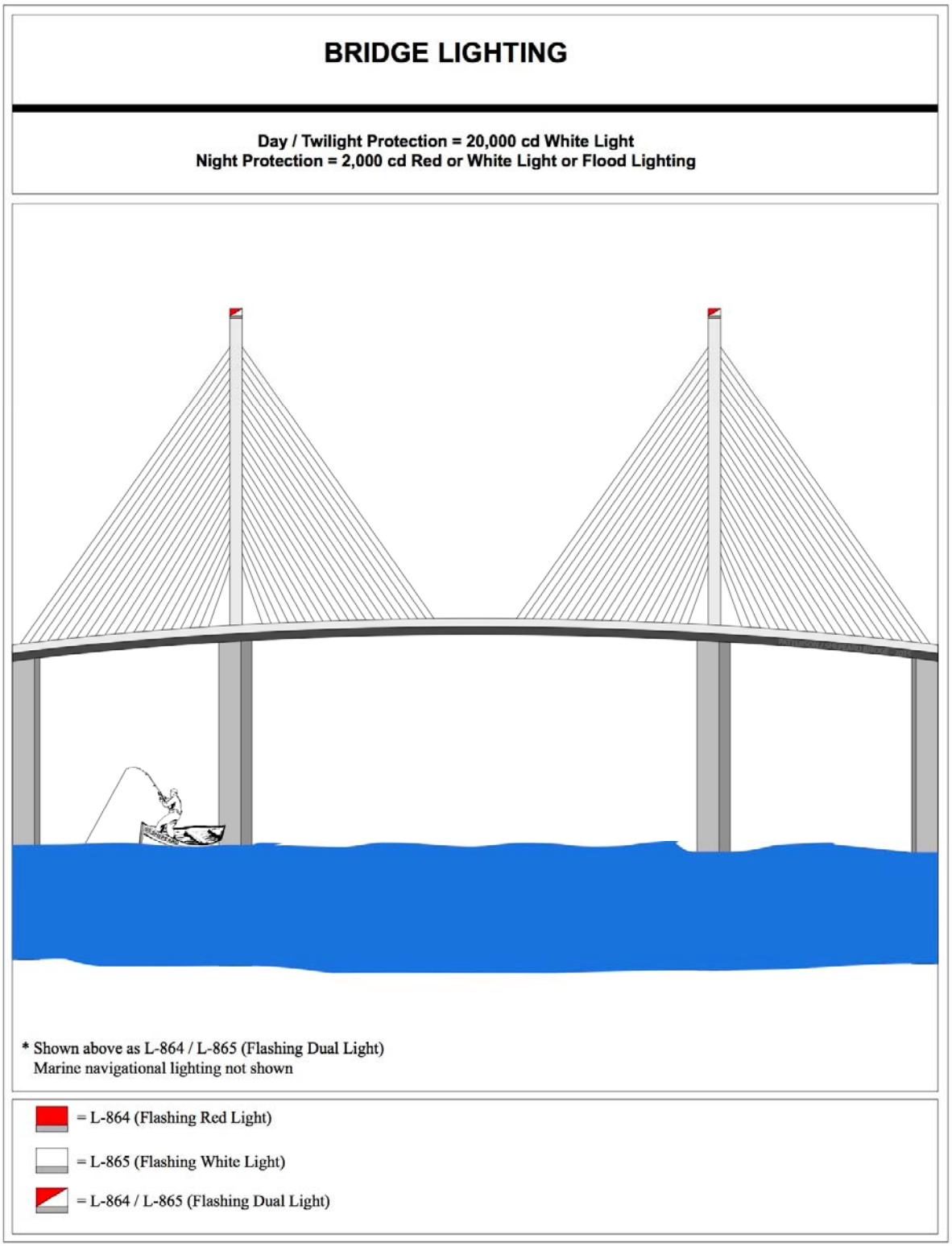


Figure A-22. Bridge Lighting

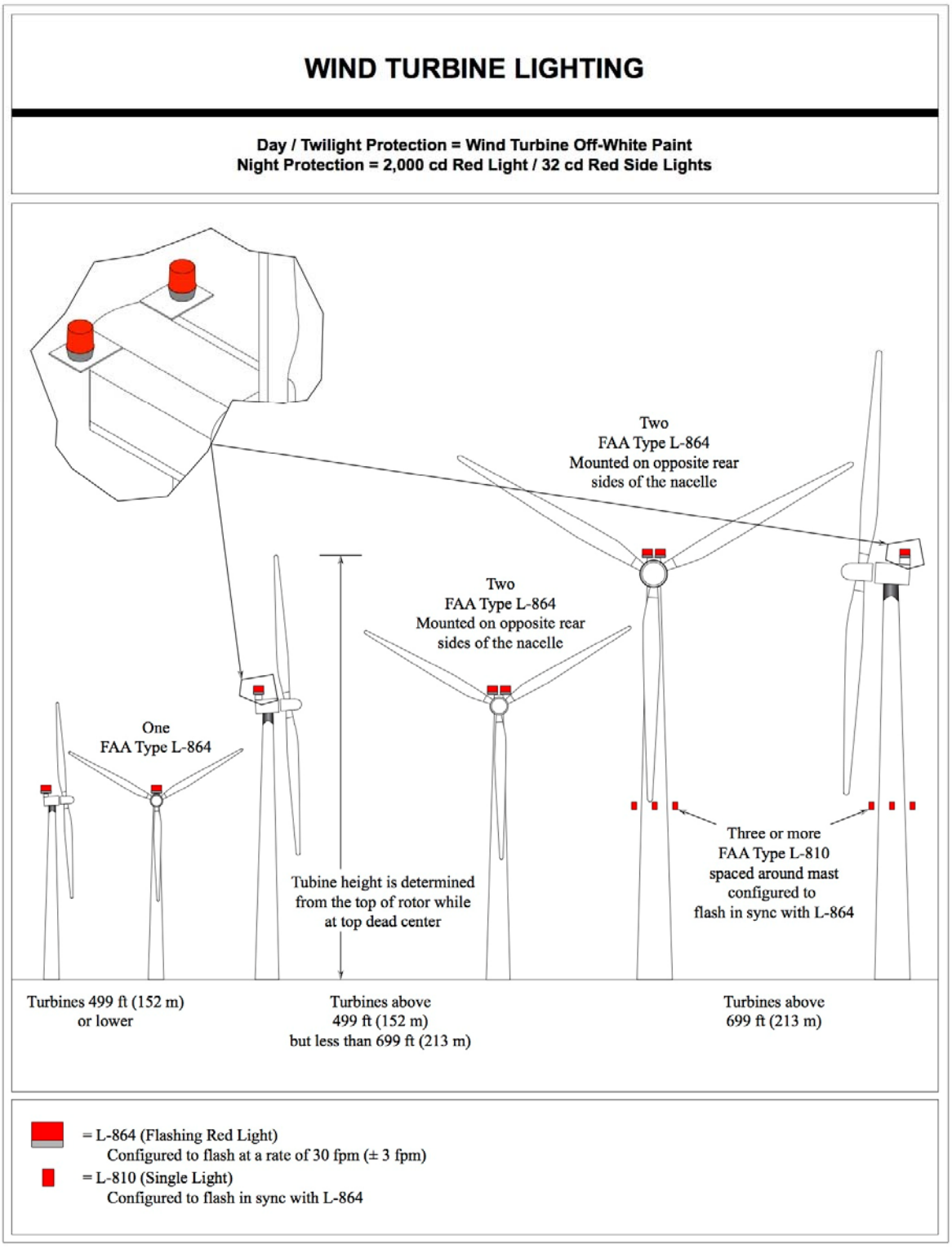


Figure A-23. Wind Turbine Lighting

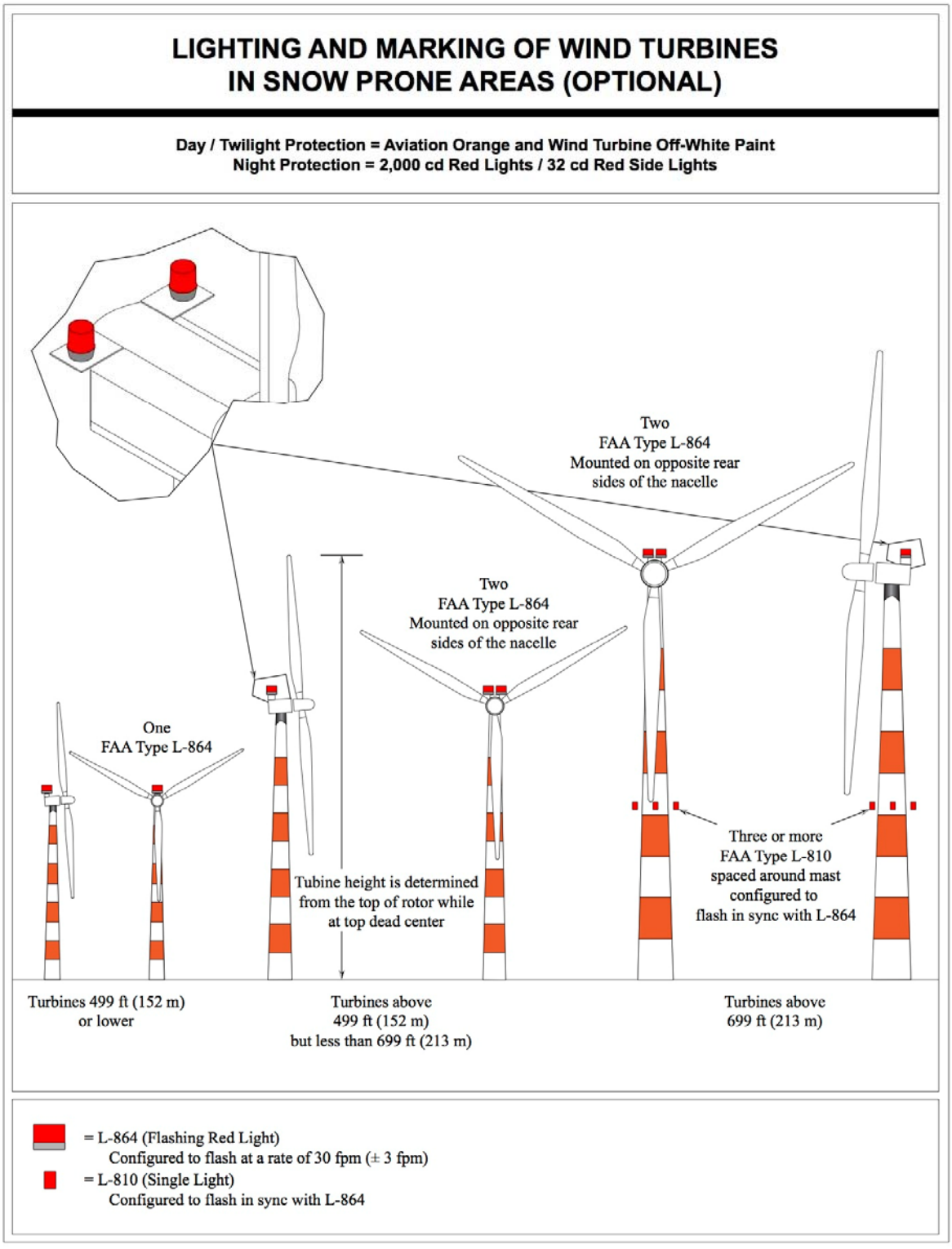


Figure A-24. Wind Turbine Lighting and Marking in Snow Prone Areas (Optional)

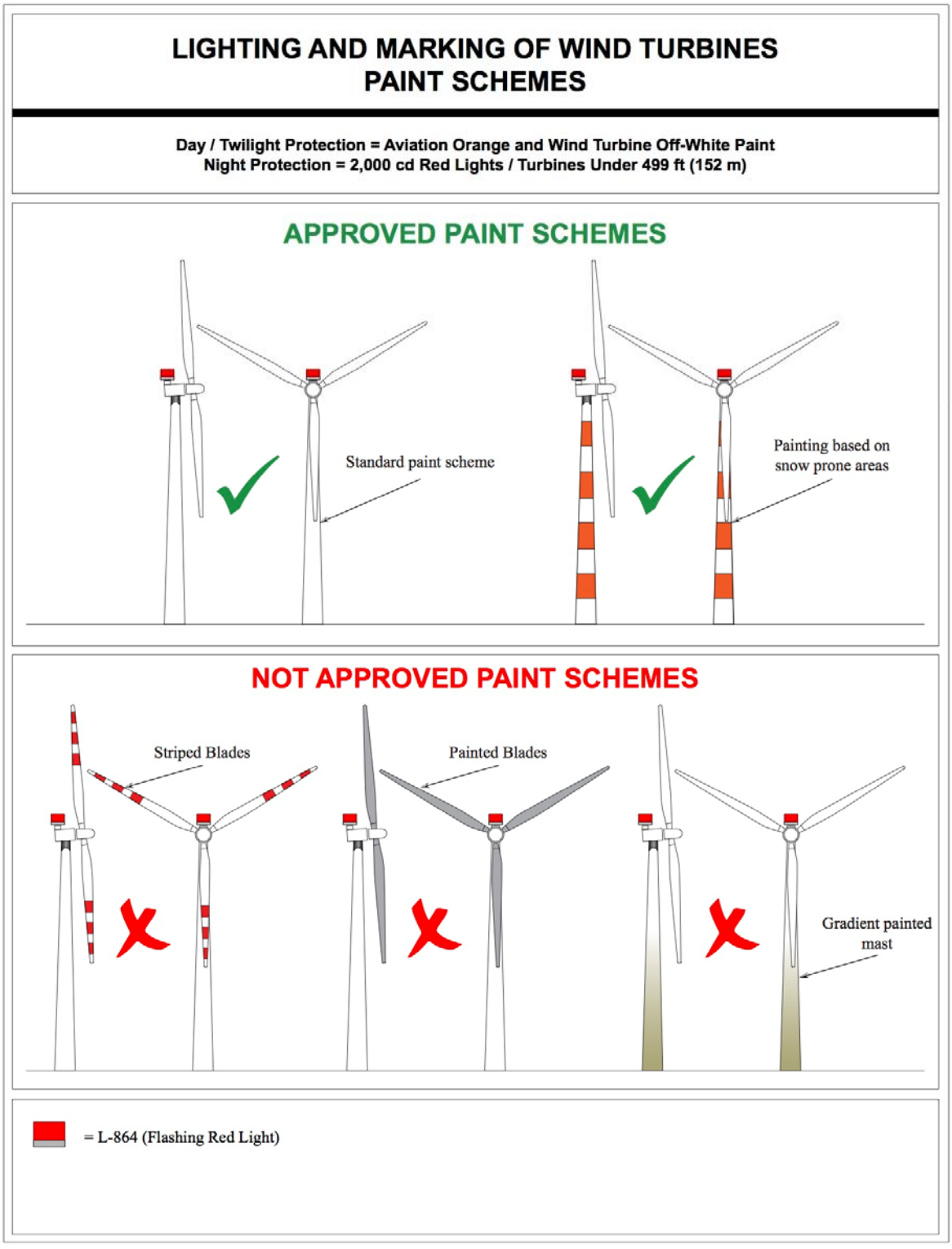


Figure A-25. Lighting and Marking of Wind Turbines – Paint Schemes

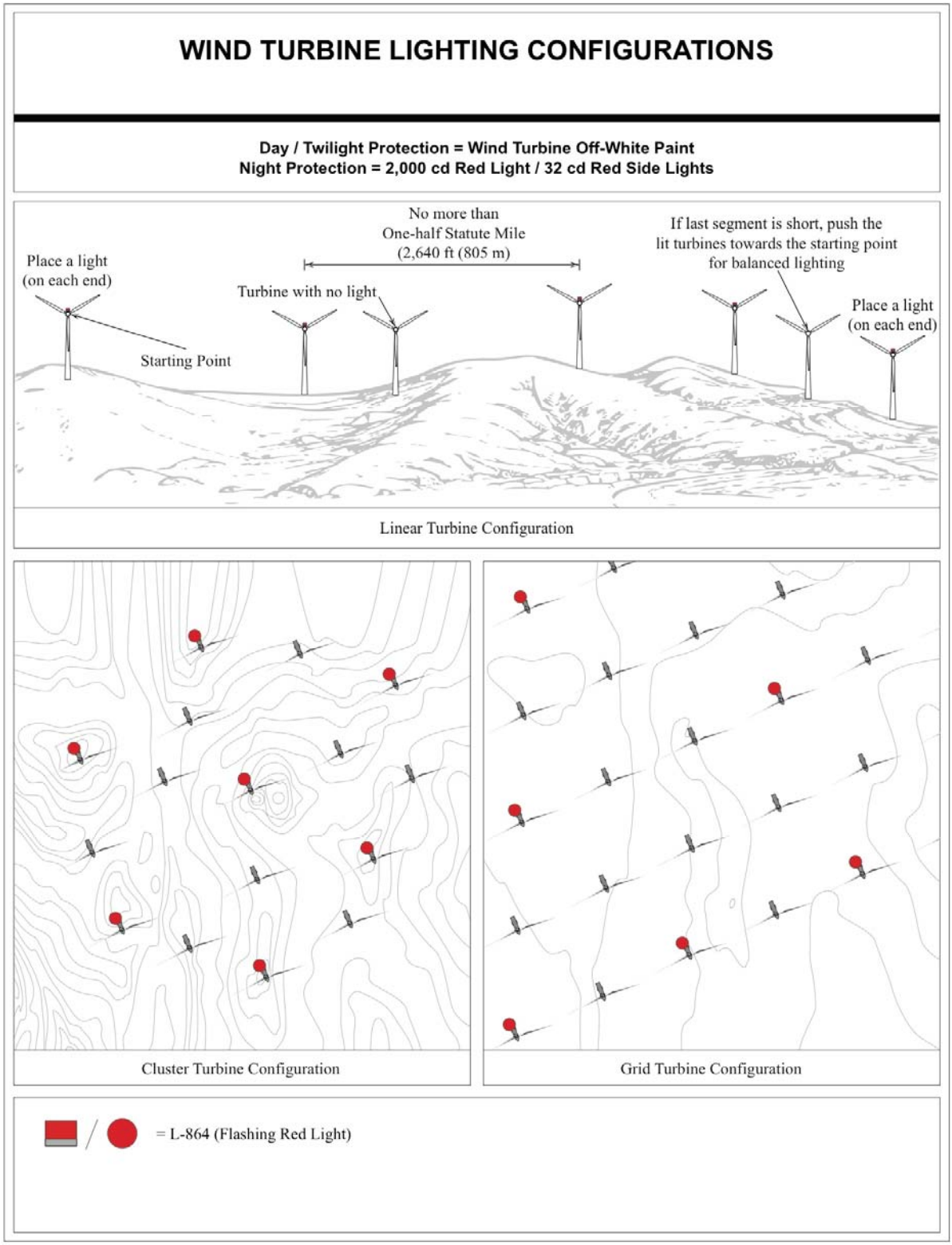


Figure A-26. Wind Turbine Lighting Configurations

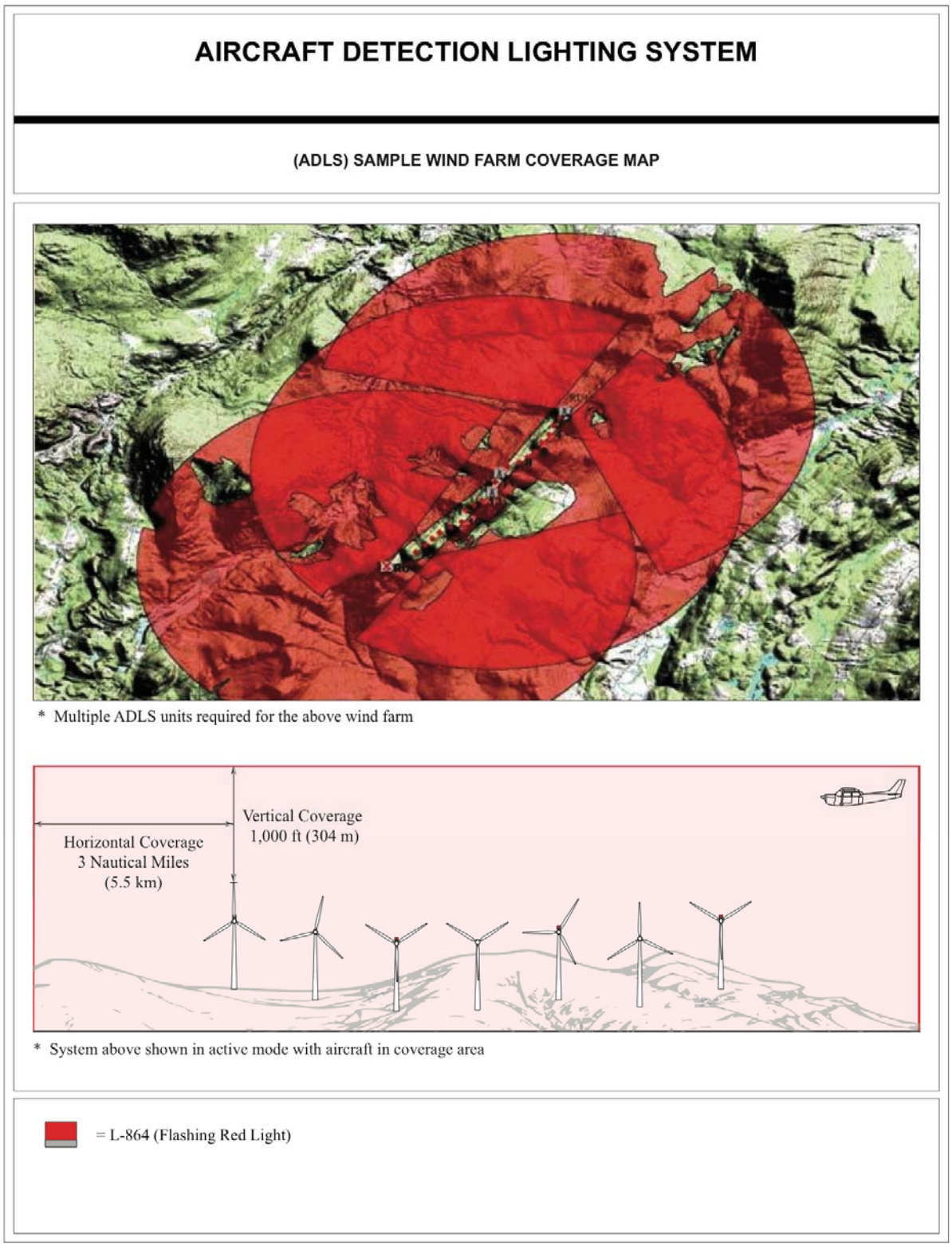


Figure A-27. Sample of Aircraft Detection Lighting System Coverage Map

APPENDIX B: MISCELLANEOUS

B-1 **Rationale for Obstruction Light Intensities**.

Sections 91.117, 91.119 and 91.155 of 14 CFR Part 91, *General Operating and Flight Rules*, prescribe aircraft speed restrictions, minimum safe altitudes, and basic visual flight rules (VFR) weather minimums for governing the operation of aircraft, including helicopters, within the United States.

B-2 **Distance Versus Intensities**.

Table B-1 shows the distance the various intensities are visible under 1 and 3 statute miles meteorological visibilities:

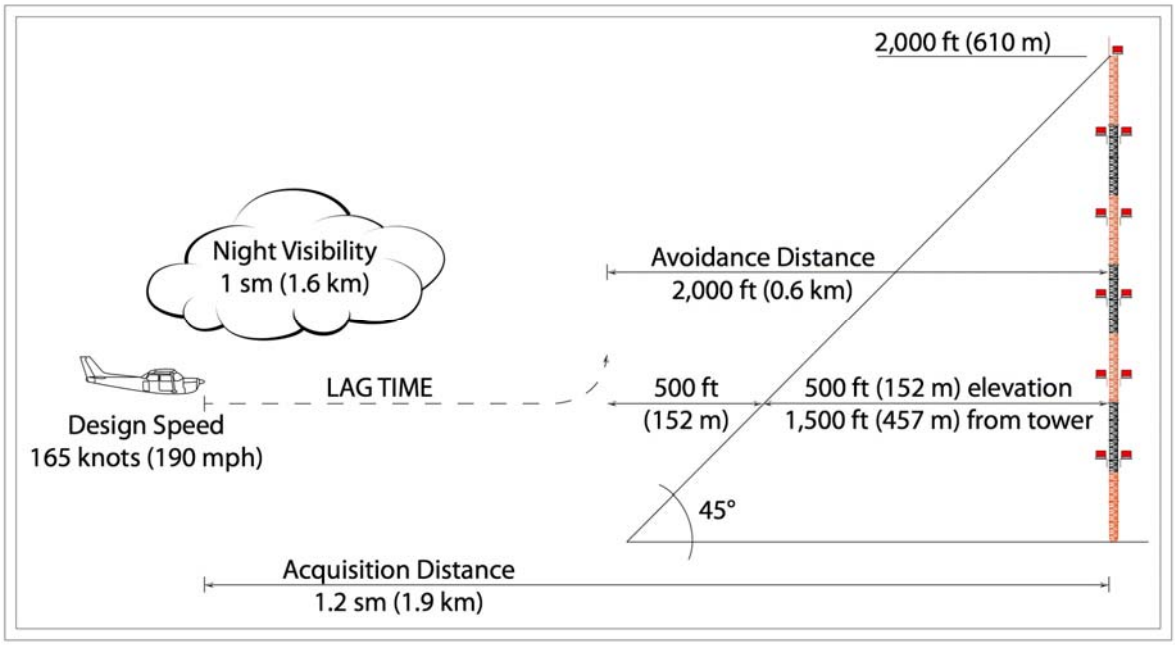
Table B-1. Distance and Intensity

Time Period	Meteorological Visibility Statute Miles	Distance Statute Miles	Intensity Candelas
Night		2.9 (4.7 km)	1,500 (±25%)
	3 (4.8 km)	3.1 (4.9 km)	2,000 (±25%)
		1.4 (2.2 km)	32
Day		1.5 (2.4 km)	200,000
	1 (1.6 km)	1.4 (2.2 km)	100,000
		1.0 (1.6 km)	20,000 (±25%)
Day		3.0 (4.8 km)	200,000
	3 (4.8 km)	2.7 (4.3 km)	100,000
		1.8 (2.9 km)	20,000 (±25%)
Twilight	1 (1.6 km)	1.0 (1.6 km) to 1.5 (2.4 km)	20,000 (±25%)
Twilight	3 (4.8 km)	1.8 (2.9 km) to 4.2 (6.7 km)	20,000 (±25%)

Note: Distance calculated for north sky illuminance.

B-3 **Conclusion**.

Aircraft pilots travelling at 165 kt (190 mph/306 kph) or less should be able to see obstruction lights in sufficient time to avoid the structure by at least 2,000 feet (610 m) horizontally under all conditions of operation, provided the pilot is operating in accordance with 14 CFR Part 91. Pilots operating 250 kt (288 mph/463 kph) aircraft should be able to see the obstruction lights unless the weather deteriorates to 1 statute mile (1.6 km) visibility at night, during which time period 2,000 candelas enables the light to be seen at 1.2 statute miles (1.9 km). To provide an acquisition distance of 1.5 statute miles, a higher intensity of 20,000 candelas would be required. This light, with 3-statute mile visibility at night, could generate a residential annoyance factor. In addition, aircraft at these speeds can normally be expected to operate under instrument flight rules (IFR) at night when the visibility is 1 statute mile (1.6 km).



Note:
The 2,000-foot avoidance distance comes from the guy wires of a 2,000-foot structure. The guy wires at a 45-degree angle would be at a distance of 1,500 feet from the structure at a 500-foot elevation. Since the aircraft is to be 500 feet clear of obstacles (the guy wire), the distance of avoidance from the structure is 1,500 + 500 = 2,000 feet. (See Figure B-1.)

Figure B-1. Illustration of Acquisition Distance Calculation

B-4 **Definitions**.

B-4.1 Flight Visibility.

The average forward horizontal distance, from the cockpit of an aircraft in flight, at which prominent unlighted objects may be seen and identified by day and prominent lighted objects may be seen and identified by night.

Reference: *Airman's Information Manual Pilot/Controller Glossary*.

B-4.2 Meteorological Visibility.

A term that denotes the greatest distance, expressed in statute miles, that selected objects (visibility markers) or lights of moderate intensity (25 candelas) can be seen and identified under specified conditions of observation.

B-5 **Lighting System Configuration**.

1. Configuration A . Red Obstruction Lighting System.
2. Configuration B. High-Intensity White Obstruction Lights for structures with appurtenance 40 feet or less.
3. Configuration C. High-Intensity White Obstruction Lights for structures with appurtenance greater than 40 feet.
4. Configuration D. Medium-Intensity White Obstruction Lights.
5. Configuration E. Medium-Intensity Dual White and Red Obstruction Lights.
6. Configuration F. High-Intensity Dual Obstruction Lights for structures with appurtenance greater than 40 feet.
7. Configuration G. High-Intensity Dual Obstruction Lights for structures with appurtenance 40 feet or less.

Example: "Configuration B 3" denotes a high-intensity lighting system with three levels of light.

Attachment B

April 24, 2020 NDDB Filing

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www.woodplc.com

VIA ELECTRONIC MAIL

April 23, 2020

Ms. Jenny Dickson
Connecticut Department of Energy & Environmental Protection
Natural Diversity Data Base
79 Elm Street
Hartford, CT 06106-5127
Email: deep.nddbrequest@ct.gov

Re: Candlewood Solar LLC
Candlewood Mountain Road, New Milford, CT
New Milford Assessor Map Parcels 26/67.1, 34/15, 9/6, and 34/31.1
NDDB Final Determination No. 201703524 and Determination No. 201911381

Dear Ms. Dickson,

On behalf of Candlewood Solar LLC (Candlewood Solar), this letter is being filed with the Connecticut Department of Energy & Environmental Protection (CT DEEP) Natural Diversity Data Base (NDDB) as a follow up to a conference call that was held between CT DEEP NDDB and members of the Candlewood Solar Project Team on Friday, April 17, 2020. Topics covered during the April 17, 2020 conference call are summarized as follows:

- Construction Schedule
- Bat Acoustic Monitoring
- 5-Year Slimy Salamander Targeted Research Program
- Federal Aviation Administration (FAA) Lighting Requirements

The purpose of this letter is to document the discussions during the April 17, 2020 Candlewood Solar conference call with CT DEEP NDDB and provide the study protocol relative to bat acoustic survey work, the Project construction schedule, and FAA Lighting Requirements. Additionally, as noted in the March 3, 2020 Determination Letter (herein referred to as the "Determination Letter"), Candlewood Solar is requesting the existing bat acoustic data for the Project site and area from CT DEEP NDDB (**Attachment 1**). Pursuant to the Determination Letter, Candlewood Solar is also requesting further communication with CT DEEP NDDB regarding the necessary tree clearing and construction timeline in order to meet the overall Project contractual obligations.

Per the following email communication with CT DEEP NDDB dated December 17, 2019 (**Attachment 1**) and discussions during our January 23, 2020 meeting, Candlewood Solar proceeded with the understanding that there would be flexibility with respect to the tree clearing while protecting bat species.

> *The guidelines for tree clearing to protect bat species, they are designed to protect maternity colonies of bats and there are several options to create flexibility in that timeline which would allow clearing to occur after March 30th if it becomes necessary. Ideally, we prefer to avoid going past the March 30th date, but it is not a proverbial "show stopper."*

The Project is contractually obligated pursuant to the four (4) power purchase agreements with the electric distribution companies (EDCs) to meet a commercial operations date of September 30, 2021 and the expected construction timeline is 18 months. Candlewood Solar has been working cooperatively with CT DEEP NDDB since CT DEEP Stormwater required modifications to the solar array layout and First Light required modifications to the proposed electric interconnection corridor. Candlewood Solar respectfully requests flexibility on the tree clearing be applied by CT DEEP NDDB and as CT DEEP NDDB advised in previous communications and meetings.

Construction Schedule

As noted during the April 17, 2020 conference call, the Project's stormwater application is pending. The stormwater application was originally filed on March 3, 2020, however, due to IT issues with the CT DEEP online ez-file system, the application was not officially received by CT DEEP until March 11, 2020. Candlewood Solar expects to receive feedback from CT DEEP on its stormwater application by the end of April. In the meantime, Candlewood Solar has been working with a tree clearing contractor for tree clearing activities on the Solar Array Parcel only (parcel 26/67.1), including pre-construction environmental and Stormwater Pollution Control Plan (SWPCP) training. Upon CT DEEP approval of the SWPCP and authorization of registration under the General Permit, and Connecticut Siting Council (Council) review and approval of the Development and Management (D&M) Plan updates filed April 14, 2020, Candlewood Solar must be ready to start tree clearing so the Project can meet critical schedule dates.

Bat Acoustic Monitoring

As discussed during the April 17, 2020 conference call, Candlewood Solar has retained EnviroScience to provide bat survey services. As requested by CT DEEP NDDB, included as **Attachment 2**, please find EnviroScience's Qualifications package for Listed Bat Survey Services (Qualifications package). The Qualifications package includes a Company Overview; a summary of Key Staff, their qualifications, and experience by state; a summary of equipment that would be used, and technical experience. Staff resumes are included in Attachment A of the Qualifications package. Project summaries are included in Attachment B and Attachment C contains a copy of EnviroScience's Federal Scientific Collectors Permit from the U.S. Fish and Wildlife Service (USFWS).

Enclosed as **Attachment 3** to this letter, please find Candlewood Solar's proposed acoustic bat survey study plan for the Project. The proposed acoustic bat survey study plan follows the USFWS Range-Wide Indiana Bat Survey Guidelines updated March 2020 (USFWS Guidelines) for presence/absence surveys with the exception of the proposed time of year for conducting the survey. As described in Attachment 2, Candlewood Solar is requesting CT DEEP NDDB approval to conduct survey for 8 detector nights in advance of 15 May.

Finally, as noted above, with this letter, Candlewood Solar is requesting CT DEEP NDDB share existing bat acoustic data for the Project site and area to supplement the proposed survey efforts.

Qualified Herpetologist

During the April 17, 2020 conference call with CT DEEP NDDB, there was also discussion pertaining to the Five Year Slimy Salamander Targeted Research Program required by the Determination Letter. It was noted during this discussion that Candlewood Solar has retained KT Wildlife to serve as the Qualified Herpetologist during work activities in accordance with CT DEEP NDDB's November 15, 2018 Final Determination which states the following under Recommended Protection Strategies for Wood and Box Turtles bullets 1 and 10:

> *Hiring a qualified herpetologist to be onsite to ensure these protection guidelines remain in effect and prevent turtles from being taken when moving heavy equipment. This is especially important in the month of June when turtles are selecting nesting sites.*
>
> *The Contractor and consulting herpetologist will search the work area each morning prior to any work being done.*

(**Attachment 1**)

The resumes of the KT Wildlife biologists performing work on the Candlewood Solar Project are included in **Attachment 4**. KT Wildlife biologists have extensive experience with Wood and Box turtles, including published research noted on the resumes. Previous Connecticut monitoring work for herpetofauna has been conducted in Glastonbury, Mansfield, and Andover, CT. Box turtle monitoring was performed at all of these sites and two of the sites included Wood turtles and spring salamanders as well. KT Wildlife biologists have surveyed for state-listed reptiles and amphibians, including the Slimy Salamander, in Connecticut and other nearby states (e.g., New York and New Jersey) and are major contributors to the New

York and New Jersey Herp Atlas projects, especially for salamanders. KT Wildlife has a current Authorization to Relocate State Listed Species Permit (Permit# 1521001) which pertains to timber rattlesnakes and other state-listed reptiles and amphibians.

FAA Lighting Requirements

The three (3) FAA Determinations of No Hazard to Air Navigation (FAA Determinations or Determinations) that require marking/lighting as a condition of the Determinations are included in **Attachment 5** to this letter. The marking/lighting condition requires the structure "to be marked/lighted in accordance with FAA Advisory circular 70/7460-1 L Change 1, Obstruction Marking and Lighting, red lights – Chapters 4,5(Red),&12." **Attachment 6** contains a copy of FAA Advisory circular 70/7460-1 L Change 1 (FAA Advisory circular). It should be noted that, "If the structure/bridge/extensive obstruction exceeds 150 feet (46 m) horizontally, at least one steady-burning light should be displayed for each 150 feet (46 m), or fraction thereof, of the overall length of the major axis.." (See FAA Advisory circular, Section 5.8.2 Prominent Buildings, Bridges, and Similar Extensive Obstructions.) As such, while the FAA Determinations are associated with 3 points, the northern extent of the array requires obstruction marking/lighting. The lighting fixtures will be mounted on the perimeter fence surrounding the array and will be mounted roughly 10 feet above grade. **Figure 1** shows the approximate locations of the FAA obstruction lighting that will be installed on the perimeter fence. In accordance with FAA requirements, the lights will be steady burning red lights. The lights will be operated by a photocell and will be activated when the ambient light falls below a specific level. Candlewood Solar has not selected the specific lighting manufacturer, however, **Attachment 7** includes the specifications of a typical L-810 Red Obstruction Light. L-810 Red Obstruction lights cast most of their light between approximately 5-10 degrees above the structure (see light blue shading between 5 to 10 deg vertical angle), 360 degrees around the light (see horizontal angle) which is shown on the photometric L810 Isotropic Intensity Chart on the second page of the specification sheet. However, L-810 Red Obstruction lights also cast some light downward (see -5 to – 10 deg vertical angle). The Isotropic Intensity Chart is in Candela (cd), a unit of luminous intensity. The individual lights operate at approximately 35 cd at 0 degrees horizontally. A foot-candle (FC) is the illuminance of a one-candela light source per square foot. For comparison purposes the following table provides illumination under different conditions.

Condition	Illumination (ft cd)
Sunlight	10,000
Full Daylight	1,000
Overcast Day	100
Very Dark Day	10
Twilight	1
Deep Twilight	.1
Full Moon	.01
Quarter Moon	.001
Starlight	.0001
Overcast Night	.00001

Depending on distance from the light, the maximum luminous intensity is approximately 0.05FC (between full moon and deep twilight), approximately 10 feet from the light at a 45 degree angle when the light is approximately 10 feet above ground level. Attached **Figure 2** shows luminous intensity at various angles and distances from the obstruction light.

Should you have any questions, please do not hesitate to contact Mr. Rob Bukowski at (978) 392-5307; rob.bukowski@woodplc.com or Ms. Tricia Foster at (508) 840-9609; tfoster@epsilonassociates.com.

Sincerely,

Wood Environment & Infrastructure Solutions, Inc. and Epsilon Associates, Inc.

Robert J. Bukowski, P.E.
Project Manager

Tricia Foster
Senior Scientist

Attachments:

Figures

Attachment 1. NDDB March 3, 2020 Determination Letter, December 17, 2019 Email Communications, and NDDB November 15, 2018 Final Determination Letter

Attachment 2. EnviroScience Qualifications Package

Attachment 3. Acoustic Bat Survey Study Plan

Attachment 4. KT Wildlife Resumes

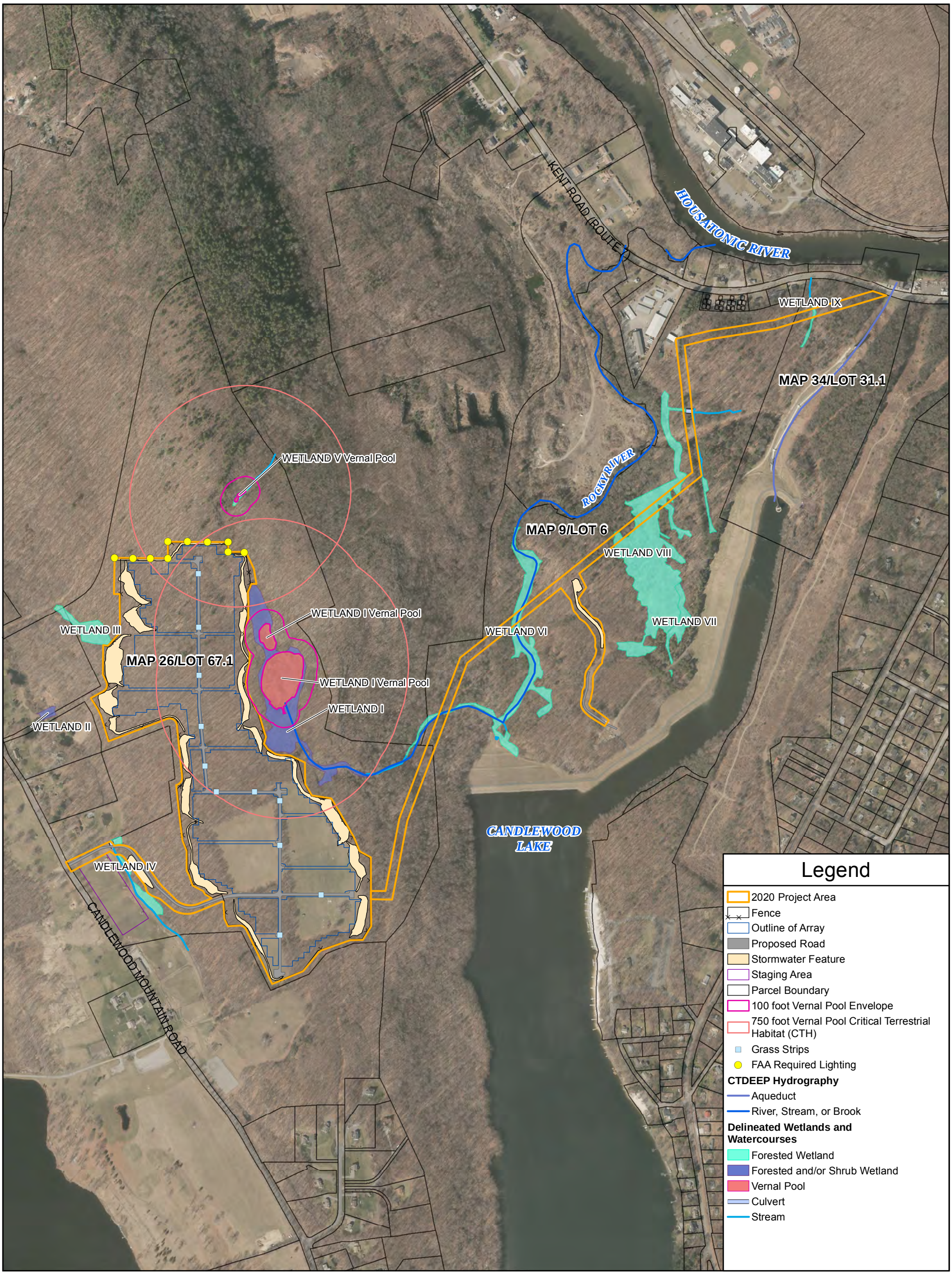
Attachment 5. FAA Determinations of No Hazard to Air Navigation and Extensions

Attachment 6. FAA Advisory circular 70/7460-1 L Change 1

Attachment 7. L-810 Red Obstruction Light

cc: R. Jackson, Candlewood Solar LLC
M. Daigneault, Candlewood Solar LLC
B. Pitreau, Candlewood Solar LLC
J. Willaman, EnviroScience
K. Michell, KT Wildlife

Figures



Location of Site

OVERALL SITE PLAN

Candlewood Solar LLC

Candlewood Solar Project
New Milford, Connecticut

Notes & Sources

Basemap Source: 2016 Connecticut Orthophotography created by the University of Connecticut - Connecticut Environmental Conditions Online (UCONN CTECO), distributed by ArcGIS Online.
Datalayer Sources: Parcel Boundary from CTDEEP GIS website.

0 340 680 Feet

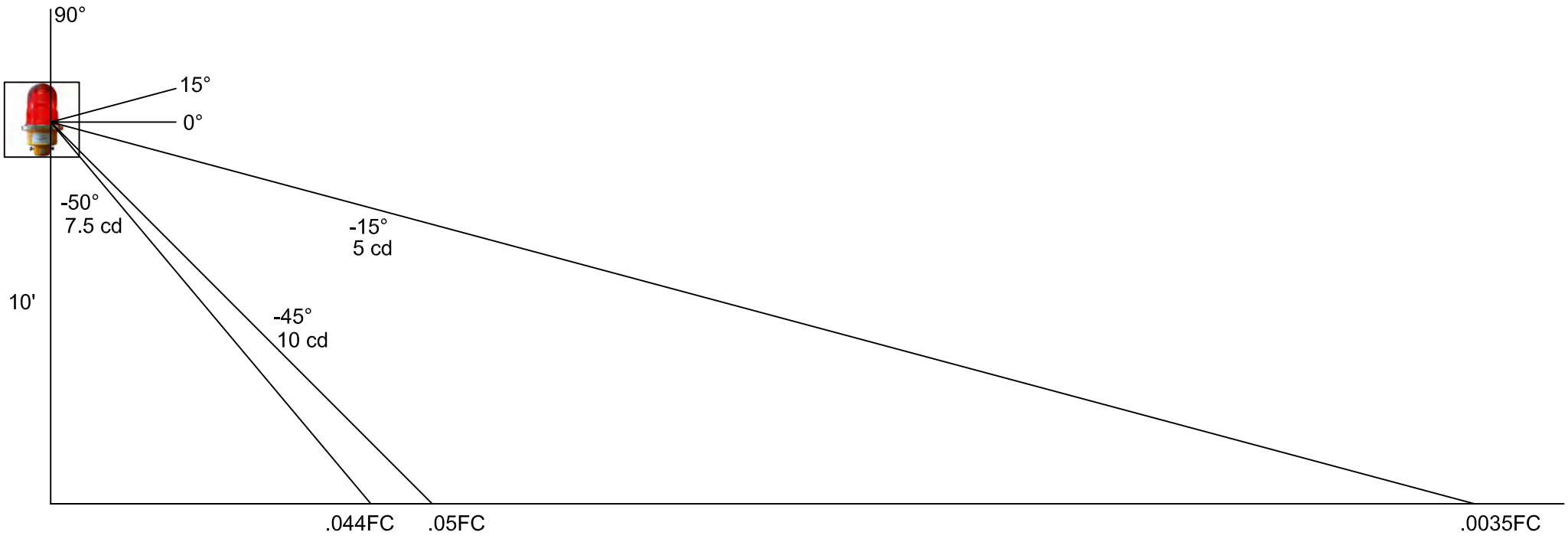
N

FIGURE 1

wood.
Wood Environment & Infrastructure Solutions, Inc.
271 Mill Road
Chelmsford, MA
Phone: (978) 692-9090

Document Path: H:\Ameresco\NewMildford_CT\Task4\MXD\Fig2_OverallSitePlan.mxd

Figure 2.



Attachment 1

NDDB March 3, 2020 Determination Letter,

December 17, 2019 Email Communications, and

NDDB November 15, 2018 Final Determination Letter

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

79 Elm Street • Hartford, CT 06106-5127 www.ct.gov/deep Affirmative Action/Equal Opportunity Employer

March 3, 2020

Tricia Foster
Wood Environment & Infrastructure Solutions, Inc.
271 Mill Road, 3rd Floor
Chemsford, MA 01824
Tricia.foster@woodplc.com

Project: Proposed Candlewood Solar Project with Revised Interconnection Route, Candlewood Mountain road and Kent Road, New Milford, CT
NDDB Determination #201911381

Dear Tricia Foster,

In conjunction with your request for a Natural Diversity Database Determination for the above referenced project, including the Revised Interconnection Route, the following documents were submitted to and reviewed by Wildlife Division staff:

- Habitat Assessment Report for the Candlewood Solar Interconnect Project – November 13, 2019
- Habitat Survey and Mitigation Proposal – Electrical Interconnect Routing Alternative – December 13, 2019

Subsequent to this review, a meeting was held on January 23, 2020 with DEEP Agency staff, Candlewood Solar project representatives, and consulting biologists, in order to discuss and finalize the remaining issues that need addressing.

In response, a Revised Review Request was submitted on February 7, 2020, which included the State Threatened *Plethodon glutinosus* (slimy salamander) Mitigation Plan, February 7, 2020, which provides responses to the issues raised at the January meeting.

This Determination addresses specifically the issues raised by the revised project scope, including the revised interconnection route and the revised conservation easement area as described in the State Threatened *Plethodon glutinosus* (slimy salamander) Mitigation Plan. All remaining measures agreed to and documented in the *Incidental Take Report for the State Threatened Plethodon glutinosus (northern salamander)* and associated amendments and maps, as well as additional conservation measures described in NDDB Determination 201703524 are still applicable and required to be implemented.

Tree Roosting Bats:
NDDB Determination 201703524 indicated that, in order to limit impacts to tree roosting bats, tree clearing should only occur between November 1st and March 30th. Candlewood Solar has proposed extending this window; this was further discussed at the January 23, 2020 meeting, and DEEP is willing to work with Candlewood Solar on this timeline. CT DEEP will share existing data and provide guidance

on additional acoustic monitoring work that may be required in order to appropriately address tree clearing timelines. Per communication between DEEP and Wood Environmental on February 28, 2020, Candlewood Solar understands that they will be responsible for the cost associated with any acoustic survey work undertaken as a requirement for the project. To allow for bat acoustic survey work to be implemented if necessary, further communication on this element will occur during the months of March, April, and May of 2020 or as appropriate based on the adjusted tree clearing and construction timeline.

State Threatened *Plethodon glutinosus* (slimy salamander) Mitigation Plan:
The plan is comprised of three main components:

- Revised conservation easement area – The Plan revises the original 100-acre conservation areas with both removals and additions. Communication between DEEP and Wood Environmental on February 28, 2020 clarifies that the final conservation easement proposed is 120 acres. Program staff have reviewed maps demarcating the revised conservation area and concur that these changes are acceptable.
- Five-year targeted research program – DEEP concurs that the goals and approach to the 5-Year Targeted Research, as outlined in the State Threatened *Plethodon glutinosus* (slimy salamander) Mitigation Plan, February 7, 2020 are appropriate and acceptable. Communication between DEEP and Wood Environmental on February 28, 2020 clarifies that Candlewood will work with DEEP wildlife biologists to develop a detailed research and monitoring plan. The approved plan will be submitted to the NDDB and will be included as part of the project requirements. The plan must be fully developed in time for the first post-construction field season.
- Invasive species control plan – DEEP concurs that the invasive species plan, as proposed in the State Threatened *Plethodon glutinosus* (slimy salamander) Mitigation Plan, February 7, 2020 and revised in communications between DEEP and Wood Environmental on February 28, 2020, are acceptable. Note that the revisions include:
    - A change from the proposed 5 years to 10 years of monitoring and treatment
    - Limiting erosion control blankets to natural fiber only
    - Consultation with DEEP prior to selecting and utilizing chemical herbicides
    - A December 31st due date for submission of annual reports

DEEP concurs that State Threatened *Plethodon glutinosus* (slimy salamander) Mitigation Plan, as submitted on February 7, 2020, with the revisions and clarifications noted above, is acceptable to mitigate for the additional impacts to state listed species stemming from project scope changes, specifically, the interconnection revision.

This NDDB Determination for the Proposed Candlewood Solar Project with Revised Interconnection Route, as described in the submitted information is valid for two years. This determination applies only to the project as described in the submission. Please submit an updated Request for Review if there are additional changes to the project's scope of work and/or timeframe, including if work has not begun by March 3, 2022.

Natural Diversity Database information includes all information regarding listed species available to us at the time of the request. This information is a compilation of data collected over the years by the Department of Energy and Environmental Protection's Natural History Survey and cooperating units of DEEP, land owners, private conservation groups and the scientific community. This information is not necessarily the result of comprehensive or site-specific field investigations. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of

concern, as well as enhance existing data. Such new information is incorporated into the Database and as it becomes available. New information may result in additional review, and new or modified restrictions or conditions may be necessary to remain in compliance with certain state permits.

- During your work listed species may be encountered on site. A report must be submitted by the observer to the Natural Diversity Database promptly and additional review and restrictions or conditions may be necessary to remain in compliance with certain state permits.
- Your project involves the state permit application process or other state involvement, including state agency actions; please note that consultations with your permit analyst or other Agency Divisions may result in additional requirements. In this situation, additional evaluation of the proposal by the DEEP Wildlife Division may be necessary and additional information, including but not limited to species-specific site surveys, may be required. Any additional review may result in specific restrictions or conditions relating to listed species that may be found at or in the vicinity of the site.

Sincerely,

Jenny Dickson
Director, Wildlife Division
(860) 424-3114
Jenny.dickson@ct.gov

Tricia Foster

From: Dickson, Jenny <Jenny.Dickson@ct.gov>
Sent: Tuesday, December 17, 2019 3:54 PM
To: 'Jackson, Robert'; Blum, Robin
Cc: Jacobson, Rick; 'butler@oxbowassociates.com'; Tricia Foster; Bukowski, Rob; Walker, Jim; Daigneault, Michael; Anderson, David
Subject: RE: NDDB Final Determination No.: 201703524 and NDDB Review #2019-11-381 - Candlewood Solar; New Milford, CT - Rare Plant Survey Form

Mr. Jackson:
We are in the process of finalizing our review of the materials you provided. As you are aware, the revision in the proposed alignment from what was originally agreed to, and authorized by the Office of Policy and Management, presents some significant challenges. We are reviewing what has been provided pursuant to that change. We will be in touch with you later this week to schedule either a conference call or a meeting, but our schedule will not allow it to occur before the 20th .

With regard to the guidelines for tree clearing to protect bat species, they are designed to protect maternity colonies of bats and there are several options to create flexibility in that timeline which would allow clearing to occur after March 30th if it becomes necessary. Ideally, we prefer to avoid going past the March 30th date, but it is not a proverbial "show stopper."

I hope this provides some clarification as to where we are in the process.

Jenny Dickson, Director
CT DEEP Wildlife Division
79 Elm Street, 6th Floor
Hartford, CT 06106-5127
P: 860-424-3114 | E: jenny.dickson@ct.gov

From: Jackson, Robert [mailto:rjackson@ameresco.com]
Sent: Tuesday, December 17, 2019 3:26 PM
To: Blum, Robin <Robin.Blum@ct.gov>
Cc: Dickson, Jenny <Jenny.Dickson@ct.gov>; Jacobson, Rick <Rick.Jacobson@ct.gov>; 'butler@oxbowassociates.com' <butler@oxbowassociates.com>; Tricia Foster <tfoster@epsilonassociates.com>; Bukowski, Rob <rob.bukowski@woodplc.com>; Walker, Jim <jawalker@ameresco.com>; Daigneault, Michael <mdaig@ameresco.com>; Anderson, David <danderson@ameresco.com>
Subject: RE: NDDB Final Determination No.: 201703524 and NDDB Review #2019-11-381 - Candlewood Solar; New Milford, CT - Rare Plant Survey Form

Robin,

Good day and I left you a voice mail this afternoon. I am checking on the expected timing of the review of the Oxbow report and if further conversations with our biologists are needed. If yes, I suggest we schedule a conference call or an in person meeting this week.

Unfortunately, we have been advised by NDDB that the Incidental Take Report Addendum cannot be transmitted to NDDB until there is agreement regarding the proposed slimy salamander mitigation along the interconnection corridor. Furthermore, we are unable to transmit the stormwater general permit application until the overall NDDB and OPM review process is complete.

I expect we have mutual interests in avoiding tree clearing outside of the clearing window for bats. As you are aware, we are required by the November 18, 2019 NDDB Final Determination Letter to complete tree clearing during the hibernation or winter range period for bats and tree clearing should be limited to between November 1 and March 30.

We look forward to your response.

AMERESCO
Green • Clean • Sustainable

Robert E. Jackson
Director – Project Development
Utility-Scale Solar PV

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M:+1 978-987-2820

rjackson@ameresco.com

111 Speen St., Suite 410
Framingham, MA 01701
http://www.ameresco.com

 Please print only if necessary.

From: Blum, Robin <Robin.Blum@ct.gov>
Sent: Monday, December 16, 2019 1:33 PM
To: Jackson, Robert <rjackson@ameresco.com>
Cc: Dickson, Jenny <Jenny.Dickson@ct.gov>; Jacobson, Rick <Rick.Jacobson@ct.gov>
Subject: FW: NDDB Final Determination No.: 201703524 and NDDB Review #2019-11-381 - Candlewood Solar; New Milford, CT - Rare Plant Survey Form

Caution - External Email

Thank you Rob, I appreciate your documentation of this information. I continue to sort through the remaining emails received late Friday, including review of the Oxbow report for survey work done on December 5th.
~Robin

Robin Blum
Wildlife Biologist
Wildlife Division
Bureau of Natural Resources
Connecticut Department of Energy and Environmental Protection
209 Hebron Road, Marlborough, CT 06447
P: 860.424.4137 | F: 860.295.8175 | E: robin.blum@ct.gov

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

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Ensuring a clean, affordable, reliable, and sustainable energy supply.

From: Jackson, Robert [mailto:rjackson@ameresco.com]
Sent: Friday, December 13, 2019 3:32 PM
To: DEEP Nddbrequest <DEEP.Nddbrequest@ct.gov>; Tricia Foster <tfoster@epsilonassociates.com>; McKay, Dawn <Dawn.McKay@ct.gov>
Cc: Blum, Robin <Robin.Blum@ct.gov>; Bukowski, Rob <rob.bukowski@woodplc.com>; Walker, Jim <jawalker@ameresco.com>; 'smyers@oxbowassociates.com' <smyers@oxbowassociates.com>; 'butler@oxbowassociates.com' <butler@oxbowassociates.com>; 'matthew@oxbowassociates.com' <matthew@oxbowassociates.com>
Subject: RE: NDDB Final Determination No.: 201703524 and NDDB Review #2019-11-381 - Candlewood Solar; New Milford, CT - Rare Plant Survey Form

Robin,

Good day. Per our phone conversation this afternoon, I will briefly outline our discussion with First Light regarding the alignment of the interconnection corridor over the last several years.

The attached Figure 4 from our Draft Incidental Take Report Addendum (to be transmitted) illustrates the five (5) alternatives for the alignment of the interconnection corridor discussed with First Light. After extensive technical discussions with First Light earlier this year, First Light's engineers are now set on the currently proposed alignment. This is due to First Light's concerns with potential impacts to their dam infrastructure and FERC regulatory and setback requirements. We understand this current alignment is First Light's last and final offer.

Routing the interconnection corridor along Candlewood Mountain Road and/or Route 7 are not financially viable and present extended permitting requirements our project financials and schedule cannot accommodate.

Trish Foster of Epsilon Associates is currently reviewing the draft Oxbow Report outlining the proposed slimy salamander mitigation and will have the report transmitted this afternoon.

AMERESCO
Green • Clean • Sustainable

Robert E. Jackson
Director – Project Development
Utility-Scale Solar PV

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M:+1 978-987-2820

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111 Speen St., Suite 410
Framingham, MA 01701
http://www.ameresco.com

 Please print only if necessary.

From: DEEP Nddbrequest <DEEP.Nddbrequest@ct.gov>
Sent: Friday, December 6, 2019 9:53 AM
To: Tricia Foster <tfoster@epsilonassociates.com>; McKay, Dawn <Dawn.McKay@ct.gov>
Cc: Blum, Robin <Robin.Blum@ct.gov>; Bukowski, Rob <rob.bukowski@woodplc.com>; Jackson, Robert <rjackson@ameresco.com>; Walker, Jim <jawalker@ameresco.com>; 'smyers@oxbowassociates.com' <smyers@oxbowassociates.com>; 'butler@oxbowassociates.com' <butler@oxbowassociates.com>; 'matthew@oxbowassociates.com' <matthew@oxbowassociates.com>
Subject: Re: NDDB Final Determination No.: 201703524 and NDDB Review #2019-11-381 - Candlewood Solar; New Milford, CT - Rare Plant Survey Form

Caution - External Email

Tricia,

Thank you for sending along the special plant form for the *Panax quinquefolius* (American Ginseng). The form helps us keep our data organized in an efficient way for future reference.

Take care,

Dawn

Dawn M. McKay
Wildlife Division
Bureau of Natural Resources
Connecticut Department of Energy and Environmental Protection
79 Elm Street, Hartford, CT 06106-5127
P: 860.424.3592 | E: dawn.mckay@ct.gov

From: Tricia Foster <tfoster@epsilonassociates.com>
Sent: Friday, December 6, 2019 6:42 AM
To: DEEP Nddbrequest; McKay, Dawn
Cc: Blum, Robin; 'Bukowski, Rob'; 'Jackson, Robert'; 'Walker, Jim'; 'smyers@oxbowassociates.com'; 'butler@oxbowassociates.com'; 'matthew@oxbowassociates.com'
Subject: RE: NDDB Final Determination No.: 201703524 and NDDB Review #2019-11-381 - Candlewood Solar; New Milford, CT - Rare Plant Survey Form

December 6, 2019

Dawn,

As you are aware, during the pre-construction northern slimy salamander surveys conducted between June 17 and June 26, 2019 for the Candlewood Solar Project, Oxbow identified one occurrence of the state special concern *Panax quinquefolius* (American Ginseng). Attached please find the NDDB Rare Plant Survey Form documenting the occurrence. If you have any questions please let us know.

Thank you.
Tricia

Tricia Foster | Senior Scientist

Epsilon Associates, Inc.
3 Mill & Main Place, Suite 250
Maynard, Massachusetts 01754
978.897.7100 | 508.840.9609 (mobile)
tfoster@epsilonassociates.com | www.epsilonassociates.com

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Connecticut Department of

ENERGY &
ENVIRONMENTAL
PROTECTION

November 15, 2018

Tricia Foster
Wood Environment & Infrastructure Solutions, Inc.
271 Mill Road, 3rd Floor
Chemsford, MA 01824
Tricia.foster@woodplc.com

Project: Proposed Candlewood Solar Project, between Candlewood Mountain Road and Kent Road in New Milford, Connecticut
NDDB Final Determination No.: 201703524

Dear Tricia Foster,

I have re-reviewed Natural Diversity Data Base maps and files regarding the area delineated on the map provided for a proposed Candlewood Solar Project, between Candlewood Mountain Road and Kent Road in New Milford, Connecticut. As you are aware, according to our records there are extant populations of State Listed Species known to occur within or close to the boundaries of this property. The species include:

Birds
Vermivora chrysoptera (Golden-winged warbler) – State Endangered

Mammals
Myotis lucifugus (Little brown bat) – State Endangered
Lasiurus borealis (Red bat) – State Special Concern
Lasionycteris noctivagans (Silver-haired bat) - State Special Concern
Lasiurus cinereus (Hoary bat) - State Special Concern

Reptiles
Plethodon glutinosus (slimy salamander) – State Threatened
Ambystoma jeffersonianum (Jefferson salamander "complex") - State Special Concern
Glyptemys insculpta (Wood turtle) - State Special Concern
Terrapene carolina carolina (Eastern box turtle) - State Special Concern

State Endangered *Vermivora chrysoptera* (golden-winged warbler):
In Connecticut, the golden-winged warbler breeds in old-field habitat generally 10 or more acres in size. Its breeding season is from May through July. During this time it is most susceptible to disturbances in its feeding and nesting habitat. The habitat assessment your firm completed concluded that suitable breeding habitat for golden-winged warbler is wholly absent from the premises due to a lack of open canopy habitat in a suitable early to mid-successional seral stage

to support the species, and no protective measures were needed. I concur with your conclusion and no further conservation actions is necessary.

Tree Roosting Bat Protection
Tree clearing should be completed during the hibernation or winter range period for bats. Tree clearing should be limited to between November 1 and March 30. The implementation of this measure would be protective of those species of bats identified as well as other bat species. Additionally, large diameter coniferous and deciduous trees and wooded buffers adjacent to wetland areas will be maintained whenever possible. Based on the revised site plan layout, forested buffer areas vary by wetland.

Bat houses should be installed in the area where trees will be removed and will help in the conservation of tree roosting bats. Candlewood Solar will mount between 20 and 30 bat houses on east facing, mature tree trunks, not less than 12 feet from the ground in areas where trees are removed.

State Special Concern *Ambystoma jeffersonianum* (Jefferson salamander "complex")
Thank you for including the vernal pool protection strategies that you will implement. The state special concern Jefferson salamander "complex" will benefit from these conservation measures. I concur with the following conservation measures you submitted to protect the vernal pool:

- No impacts should occur to the vernal pool depressions or 100-foot envelope.
- The total length of roads within the 750-foot critical terrestrial habitat (CTH) will be the minimum required to access the northern portion of the array for maintenance or emergency activities.
- Any ruts or artificial depressions created as part of the project will be refilled to grade to avoid creation of decoy vernal pools.
- Erosion and sediment control BMPs will be implemented per the required Connecticut General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities.
- Impervious surfaces will be minimized within the vernal pool habitat area.
- No artificial lighting should be installed for the project.

Recommended Protection Strategies for Wood and Box Turtles:
The following recommendations will minimize potential impacts to the turtles. These recommendations should be implemented throughout the work area:

- Hiring a qualified herpetologist to be on site to ensure these protection guidelines remain in effect and prevent turtles from being run over when moving heavy equipment. This is especially important in the month of June when turtles are selecting nesting sites.
- Exclusionary practices will be required to prevent any turtle access into construction areas. These measures will need to be installed at the limits of disturbance.
- Exclusionary fencing must be at least 20 in tall and must be secured to and remain in contact with the ground and be regularly maintained (at least bi-weekly and after major weather events) to secure any gaps or openings at ground level that may let animal pass through. Do not use plastic web or netted silt-fence.

- All staging and storage areas, outside of previously paved locations, regardless of the duration of time they will be utilized, must be reviewed to remove individuals and exclude them from re-entry.
- All construction personnel working within the turtle habitat must be apprised of the species description and the possible presence of a listed species, and instructed to relocate turtles found inside work areas or notify the appropriate authorities to relocate individuals.
- Any turtles encountered within the immediate work area shall be carefully moved to an adjacent area outside of the excluded area and fencing should be inspected to identify and remove access point.
- In areas where silt fence is used for exclusion, it shall be removed as soon as the area is stable to allow for reptile and amphibian passage to resume.
- No heavy machinery or vehicles may be parked in any turtle habitat.
- Avoid degradation of wetland habitats including any wet meadows and seasonal pools.
- The Contractor and consulting herpetologist must search the work area each morning prior to any work being done.
- When felling trees adjacent to brooks and streams please cut them to fall away from the waterway and do not drag trees across the waterway or remove stumps from banks.
- Avoid and limit any equipment use within 50 feet of streams and brooks.
- Any confirmed sightings of box, wood or spotted turtles should be reported and documented with the NDDB (nddbrequestdep@ct.gov) on the appropriate special animal form found at (http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323460&depNav_GID=1641)

State Threatened *Plethodon glutinosus* (slimy salamander):
In Connecticut the state threatened slimy salamander is restricted to mature mesic forest habitat with rocky talus slopes, numerous fallen logs along with a thick layer of leaf litter and forest debris. The subject area (this property) was identified as providing suitable habitat for the slimy salamander. With that in mind, on September 11, 2018 The Connecticut Office of Policy and Management (OPM), in consultation with The Connecticut Department of Energy and Environmental Protection (DEEP), determined that that the proposed Installation and Operation of a 20 Megawatt (MW) AC (MWac) Solar Photovoltaic (PV) Electric Generating Facility at 197 Candlewood Mountain Road (Candlewood Solar, LLC) in New Milford, Connecticut would result in an incidental taking of the State Threatened *Plethodon glutinosus* (slimy salamander) pursuant to Section 26-310 of the Connecticut General Statutes (CGS).

Pursuant to CGS Sec. 26-310(d), the Commissioner of Energy and Environmental Protection is required to provide Candlewood Solar, LLC with specific feasible and prudent measures and alternatives that must be implemented as part of the proposed project in order to ensure that the action does not appreciably reduce the likelihood of the recovery of the species. The proposed actions have been planned to avoid, minimize and mitigate impacts to the "take" of northern slimy salamander. These specific measures include:

- Limiting tree clearing impacts and the overall footprint of the project
- Providing a 100-acre conservation easement

- Three-year monitoring and reporting
- Addition of grassy strips to roadways

Tree clearing and grading are required as part of this Solar PV project. The revised plan configuration limits the impact to 1.3 acres (of the 49 +/-acres) of high quality forested salamander habitat. Furthermore, the overall footprint of the Solar PV project was reduced through an alternative design utilizing higher capacity solar panels. The changes to the panels and the reduction of the overall footprint of the project reduced the total amount of tree clearing and work within the prime northern slimy salamander habitat. In addition, the layout of the Solar PV array was shifted away from two wetlands and these changes netted further avoidance of undisturbed northern slimy salamander habitat. This will ultimately increase the size of the undisturbed buffer around cryptic vernal pools in this area as well.

Candlewood Solar, LLC identified a 100-acre area that will be set aside for permanent conservation as mitigation for unavoidable impacts to the northern slimy salamander. Candlewood Solar, LLC will deed this 100-acre parcel to a local conservation trust or similar entity as permanently conserved land. The 100 acres includes contiguous, steep, sloping, mature forest. It also includes wetlands and vernal pools. The conservation easement will outline and limit the types of activities allowed within the mitigation area in order to protect its natural resource value especially for the northern slimy salamander.

Candlewood Solar, LLC will also conduct three years of monitoring for the northern slimy salamander. Surveys will be conducted in the pre-construction period and continue post-construction for two additional years. Reporting will be made to CTDEEP NDDB within 7 days of field surveys and will include survey dates and duration; description and maps of surveyed areas; site photographs; species photographs; species lists; locations of salamanders identified and assessments. There will also be an annual summary report prepared and submitted. Candlewood Solar, LLC will ensure and be responsible for contracting with the qualified herpetologist and their reporting efforts. The qualified herpetologist will obtain and maintain a valid scientific collector's permit to work with northern slimy salamander populations.

The original proposal had many of the access roads being improved with crushed stone and gravel. However, these improved roads would be a barrier to migration or travel by northern slimy salamanders. Candlewood Solar, LLC has agreed to add grassed strips, approximately 20 feet wide, along the proposed project access roadways to mitigate for these improved access roads. The 20 foot wide grassed strips will replace the gravel for the full width of the roadway at the approximate locations. The locations of these grassed strips were based on proximity to forested habitat areas from where the salamanders would presumably be emanating.

The details of these conservation actions (above) are outlined in the 'Incidental Take Report for the State Threatened *Plethodon glutinosus* (northern slimy salamander)' prepared by AMEC Foster Wheeler dated February 9, 2018 and amended with email and maps to include mitigation (adding grass strips) to proposed improved access roads on June 15, 2018. In addition, Candlewood Solar, LLC will work with CTDEEP to ameliorate any problems that may arise.

Failure to comply with conditions set forth in 'Incidental Take Report for the State Threatened *Plethodon glutinosus* (slimy salamander)' prepared by AMEC Foster Wheeler dated February 9,

2018 and amended with email and maps to include mitigation to proposed improved access roads on June 15, 2018 or within this document may result in permit revocation and/or civil penalties levied against the responsible party.

This determination is good for two years. Please re-submit a new NDDB Request for Review if the scope of work changes or if work has not begun on this project by November 15, 2020.

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

Please contact me if you have further questions at (860) 424-3592, or dawn.mckay@ct.gov .
Thank you for consulting the Natural Diversity Data Base.
Sincerely,

Dawn M. McKay

Dawn M. McKay
Environmental Analyst 3

Attachment 2

EnviroScience Qualifications Package

Qualifications:
Listed Bat Survey Services

Prepared for:

Connecticut Department of Energy and Environment Protection (CT DEEP)

and

Wood Environment & Infrastructure Solutions, Inc.

https://www.woodplc.com/

Prepared by:

EnviroScience
Excellence In Any Environment

5070 Stow Rd.
Stow, OH 44224
800-940-4025
www.EnviroScienceInc.com

Date: April 20, 2020

TABLE OF CONTENTS

LIST OF ATTACHMENTS

INTRODUCTION

EnviroScience, Inc. (EnviroScience) is pleased to submit qualifications for bat survey services on the Candlewood Solar Project, through Wood Environment & Infrastructure Solutions, Inc. (Wood). The following includes a company overview and qualifications, key project personnel, and past project summaries.

COMPANY OVERVIEW

EnviroScience was established in 1989 to provide technical services in the environmental field. In our 30+ years of operation, we have supported environmental design and regulatory requirements servicing federal, state, and municipal governments; Departments of Transportation; as well as mining, industrial, engineering, and private sector firms. EnviroScience's reputation for *Excellence in Any Environment* has been built one project at a time using technically sound and proven scientific protocols, understanding current regulatory climates, accurate and detailed reporting, and a commitment to superior client service while remaining cost conscious. EnviroScience is headquartered in Ohio, with additional offices in Nashville, Tennessee and Richmond, Virginia.

EnviroScience's depth of staff and company focus are two key areas that set us apart from the competition. Our staff brings a broad range of environmental, scientific, construction, and project management expertise to the table. EnviroScience is a small business employing over 110 permanent employees, including 94 scientists with Ph.D., M.S., and other advanced degrees and certifications. Together, EnviroScience employees create a network of highly specialized and skilled experts, each bringing a unique interpretation and perspective to problem solving.

EnviroScience is often considered a "niche" environmental consultant due to our ecological consulting focus and nationally recognized environmental services, restoration, and environmental compliance and permitting services. Few firms in the country retain as many ecologists, divers, and environmental scientists under one roof, and most our staff have over 10 years of experience in their respective fields.

EnviroScience has considerable experience with linear projects such as roads, transmission lines, and natural gas pipelines. Typical clients are West Virginia Department of Highways (WVDOH), Ohio Department of Transportation (ODOT), American Electric Power (AEP), and Dominion East Ohio Gas (Dominion). Under our Master Service Agreement with Dominion, EnviroScience is responsible for all environmental coordination required prior to pipeline construction. Individual projects have ranged from 0.25 to 17 miles in length and will total approximately 4,000 miles by the year 2020. Environmental coordination includes wetland delineation, endangered species consultation, nationwide permitting, 401/404 permitting, storm water pollution prevention plan preparation, Ohio Historic Preservation Office desktop review, and city/county coordination for pipeline corridor projects, urban pipeline projects, separation stations, and well pads. EnviroScience has performed ecological surveys and permitting for over 1000 projects since 2010.

EnviroScience has been performing surveys for federally listed bat species for over 20 years including habitat surveys, roost emergence surveys, acoustic monitoring, mist net

presence/absence surveys, hibernacula search and survey, and radio telemetry tracking. Additionally, EnviroScience is experienced in formulation of formal Biological Opinions, Conservation Plans, and all forms of project coordination for Endangered Species Act Section 7 compliance with U.S. Fish and Wildlife Service (USWFS) and state regulatory agencies. EnviroScience bat surveys have ranged in size and scope depending on the project needs and have included extensive efforts for military facilities, utility corridors, large mining sites, the railroad industry, the oil and gas industry, and private development.

EnviroScience biologists have completed surveys in many states, including Alabama, Arkansas, Illinois, Indiana, Iowa, Kentucky, Missouri, New York, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia. Our biologists have the ability and experience to complete bat surveys throughout the full range the federally protected Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), and gray bat (*Myotis grisescens).* EnviroScience uses the most current equipment and agency protocols as well as strictly adhering to the recommended decontamination procedures to prevent the spread of White Nose Syndrome. All efforts are documented with reporting including mapping, site and species data and photographs, and fully completed field data forms.

KEY STAFF

EnviroScience has assembled a team of expert biologists and ecologists to conduct the proposed services. The team has extensive past experience working on large scale ecological investigations throughout the United States as well as broad knowledge and experience with services identified in the Scope of Work for this proposal. Staff resumes are included in Attachment A.

List of Key Personnel

Key Personnel	Qualifications	Bat Survey Experience in Following States
Jamie Willaman	Project Manager, Bat Biologist, Agency Coordination Specialist.	Ohio, Indiana, Illinois, Missouri, Kentucky, Pennsylvania, and West Virginia
Mary Gilmore	Federally permitted bat biologist. Qualified Bat Habitat, Identification, and Acoustic Surveyor.	Alabama, Illinois, Indiana, Kentucky, Missouri, New York, Ohio, Pennsylvania, Tennessee, West Virginia, Virginia
Dan Cox	Federally Permitted Bat Biologist. Qualified Bat Habitat, Identification, and Acoustic Surveyor.	Arkansas, Illinois, Indiana, Iowa, Kentucky, Missouri, New York, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia
Sean Kline	Field Survey Leader. Qualified Bat Habitat, Identification, and Acoustic Surveyor.	Kentucky, New York, Ohio, Pennsylvania, West Virginia

Ms. Jamie Willaman will be the project manager for the bat surveys. Ms. Willaman is a senior member of the Natural Resources group specializing in Federally Listed Bats and Wetland/Stream delineations and permitting. As an endangered bat biologist, she has in-depth USFWS Section 7 consulting experience, knowledge of North American bats and their habitat, and 15 years of field survey practice including habitat tree identification, mist-net surveys, acoustic monitoring surveys, hibernacula search and survey, and radio telemetry**.** Jamie graduated from Kent State University with a Bachelor of Science in Conservation and one in Secondary Science Education in 2002. She has been working as a wetland delineator for over twenty years and began managing endangered bat surveys fourteen years ago. Mrs. Willaman manages EnviroScience endangered bat surveys including mist-net surveys, emergent surveys, habitat surveys, and she has been trained in using AnaBat and SonoBat for acoustical monitoring of populations. Jamie has had extensive training with Bat Conservation International (BCI), Bat Conservation and Management, and Bat Sense/BCID. Ms. Willaman is a member of the Northeast Bat Working Group, the Midwest Bat Working Group, the Southern Bat Diversity Network, the Ohio Bat Working Group and has attended several bat blitz events. Her range of bat projects have included large parcels for energy and government clients, linear corridors for energy and transportation clients, and she has composed multiple Biological Assessment and Conservation Plan coordination documents, as well as mitigation agreements.

Ms. Mary Gilmore will be the technical field lead for the bat surveys. Ms. Gilmore is a member of the EnviroScience team specializing in Threatened and Endangered Bats and Wetland/Stream delineating and permitting. As an endangered bat biologist, Ms. Gilmore has over 10 years' experience conducting threatened and endangered habitat assessments and bat surveys of all types, including acoustic, mist net, radiotelemetry, and hibernacula surveys (Attachment C). Ms. Gilmore has a USFWS Indiana bat recovery permit through the extent on the bat's range and is a Qualified Bat Surveyor in both Kentucky and Tennessee. She has extensive field experience leading mist net surveys, conducting radiotelemetry, and knowledge of threatened and endangered bats and their habitat. She is proficient in using Global Positioning Systems (GPS) to map ecological features. Ms. Gilmore has led threatened and endangered bat mist net surveys and habitat assessments throughout the eastern U.S., including Alabama, Illinois, Indiana, Kentucky, Michigan, Missouri, New York, Ohio, Pennsylvania, Tennessee, West Virginia, and Virginia. She has completed the Acoustic Techniques and Analysis course and the AnalookW Analysis Course provided by Titley Scientific. Ms. Gilmore can visually identify most Midwestern bat calls using standard bat acoustic techniques and is proficient with automated acoustic software. She has placed radio transmitters on approximately 60 bats consisting of four species (Indiana bat, northern long-eared bat, little brown bat, and big brown bat). She is a member of the Ohio Bat Working Group, Kentucky Bat Working Group, Tennessee Bat Working Group, Midwest Bat Working Group, and the Southern Bat Diversity Network.

Mr. Dan Cox is an ecologist with 14 years' professional experience. He holds a USFWS recovery permit (TE43605A-2; Attachment C) with twelve years' experience surveying and researching rare bat species, which has provided him with a working–knowledge of scientific publications, field data, and survey reports of monitored bat species. Mr. Cox has experience conducting threatened and endangered habitat assessments and bat surveys of all types, including acoustic, mist net, radiotelemetry, and hibernacula surveys. He has led threatened and endangered bat mist net surveys and habitat assessments throughout the eastern U.S., including Arkansas, Illinois, Indiana, Kentucky, Michigan, Missouri, New York, Ohio, Pennsylvania, Tennessee, West Virginia, and Virginia. Mr. Cox has in-depth experience with acoustic call identification, USFWS coordination and all forms of bat survey on various size properties for many industries.

Mr. Sean Kline will lead the field effort for acoustics, habitat survey, and will construct and install the bat houses. As a bat ecologist, Mr. Kline has 5 years' experience conducting threatened and endangered wildlife surveys. He has extensive field experience in performing mist net, cave portal, and acoustic surveys; radio telemetry; and identification of T&E bats and their habitat. Mr. Kline has conducted ecological work throughout Ohio, West Virginia, Pennsylvania, Kentucky, and New York. Additionally, Sean has 5 years' experience designing, constructing, installing, and monitoring artificial bat roosts.

EQUIPMENT AND TECHNOLOGICAL EXPERIENCE

EnviroScience uses up to date and industry accepted equipment, materials, and methods to accomplish survey tasks.

For acoustic bat monitoring, ES uses SD-2 AnaBat detectors, housed in custom weatherproof cases and mounted on either a tripod system or direct to the landscape. All acoustic detectors are set in landscape level, selected sites and are set up in accordance with the *USFWS Rangewide Indiana Bat Survey Guidance* (Phase II- Steps5-7 and Appendix C), to maximize the detection ability.

All recorded bat calls are downloaded the morning following survey and are processed through the USFWS Approved bat call identification software Kaleidoscope Pro, to attain quantitative species identification results of all bat calls recorded. In the case where a call is identified as possibly indeterminate between two species, or a call is identified as a listed species, ES biologists Mary Gilmore or Dan Cox have the experience and qualifications to "vet" the call and qualitatively identify the bat species.

Additionally, all ES field personnel are highly experienced with GPS, photo documentation, mapping, and scientific data logging.

ENVIROSCIENCE BAT SURVEY EXPERIENCE MATRIX

DATE	LOCATION	SELECTED PROJECTS WITH SIMILAR ELEMENTS	Large Site	Linear Site	Habitat Survey	Mist Net Bat Survey	Acoustic Survey	Radio telemetry	Hibernacula/ Portal Surveys	Informal Consultation	Formal Consultation	Conservation Plan/ BA
2019	West Virginia	Equitrans Multiple Gas Pipelines		●	●	●			●		●	●
2018-19	Pennsylvania	PA Turnpike Mon-Fayette Transportation Project	●	●	●	●	●	●	●		●	●
2016, 2019	Ohio	NASA Glen/ Plumbrook Research Centers	●		●	●	●			●		●
2018	West Virginia	WVDOH US33 Transportation Project	●	●		●			●		●	
2018	Indiana	CSXT Fort Wayne Rail Line		●		●				●		
2018	Tennessee	TDOT Batson and Sam Ridley Parkways		●	●	●	●		●	●		
2017	Ohio	AOA Scioto Preserve Mitigation Site	●		●	●	●		●	●		●
2015	Virginia	CSXT Arkendale Main Line		●		●				●		
2015-16	Ohio	Camp James A. Garfield Joint Military Training Center	●		●	●		●		●		
2013	MS, IL	AEP Fabius Island Transmission Line	●		●	●		●		●		
2011	Ohio	ODOT Portsmouth Bypass	●		●	●	●	●		●	●	●
2011	IL, IN, MO, OH	Surveys at various US Army Training Facilities	●		●	●		●		●		
2011	New York	Fort Drum Army Bat Survey	●		●	●	●	●		●		
2012-2014	Tennessee	TDOT Multi-county Indiana Bat Mist Net Surveys	●		●	●	●	●	●	●		
2011-2012	Illinois	Acoustic Monitoring for Windfarm Development			●		●			●		
2011, 2014	Kentucky	White Nose Hibernacula Cave Surveys			●				●	●		
2005-2019	AL, AR, IL, IN, KY, MO, NY, OH, PA, SC, TN, WV, VA	Various natural gas pipeline projects	●	●	●	●	●	●	●	●	●	●
2005-2018	IN, KY, MO, OH, PA, WV	Indiana bat surveys Large coal mining sites	●		●	●	●		●	●	●	●

Attachment A. Employee Resumes

JAMIE WILLAMAN

Ecological Operations Manager / Senior Bat Ecologist / Senior Wetland Biologist

Ms. Willaman is the EnviroScience Midwest Operations Manager. As operations manager she is responsible for project planning and tracking, the companywide work pipeline, process efficiency and policy, personnel, equipment, and vehicle scheduling, perspective employee interviews and is manager of the resource staff consisting of over 75 employees. In addition, Ms. Willaman is a senior member of the Natural Resources group specializing in the Federally Listed Bats and Wetland/Stream delineation and permitting. As an endangered bat biologist, she has in-depth USFWS Section 7 consulting experience, knowledge of northeastern bats and their habitat, and 13 years of field survey practice including habitat tree identification, mist-net surveys, acoustic monitoring surveys, and radio telemetry. Jamie graduated from Kent State University with a Bachelor of Science in Conservation and one in Secondary Science Education in 2002. She has been working as a wetland delineator for over sixteen years and began managing endangered bat surveys twelve years ago. Jamie has had extensive training with Bat Conservation International (BCI), Bat Conservation and Management, and Bat Sense/BCID. Ms. Willaman is a member of the Northeast Bat Working Group, the Midwest Bat Working Group, the Southern Bat Diversity Network, and the Ohio Bat Working Group and has attended several bat blitz events. Her range of bat projects have included large parcels for energy and government clients, linear corridors for energy and transportation clients, and she has composed two Biological Assessment coordination documents for the NLEB.

EDUCATION

B.S. Conservation / Natural Resources, Minor Biology, Kent State University, 2002

B.S. Secondary Education, Comprehensive Science, Minor Geology, Kent State University, 2002

CERTIFICATIONS

38 Hour Army Corps of Engineers Wetland Delineation, Richard Chinn 2005

OEPA Certified Data Collector Level 2, 2010

SCUBA Certification: Open Water, SSI 2005

MSHA Surface Mining

FRA Rail Safety

E-Rail Safe

AutoCAD

First Aid / CPR

YEARS OF EXPERIENCE

EnviroScience, Inc.: 15

Flickinger Wetland Service Group: 3

SEMINARS & TRAINING

Ohio Rapid Assessment Method (ORAM), OEPA Workshop 2001, 2002

Qualitative Habitat Evaluation Index (QHEI) and Biocriteria Assessment, OEPA 2003

Headwater Habitat Evaluation Index (HHEI), OEPA Workshop 2003

SELECTED PROJECT EXPERIENCE

Natural Resource and Endangered Species Compliance, Kokosing Construction, 2009-2018. Assessment, delineation, and habitat evaluation for over fifty sites throughout Ohio to assist the Kokosing Construction Company, Transportation Division, with natural resource compliance for design build highway construction projects. Projects have involved ODOT Section 107.1 assessments, jurisdictional delineations, stream assessments, endangered species surveys, and permitting with the USFWS, ODNR, OHPO, OEPA, and USACE.

Natural Resources Management Surveys and Plan, NASA, 2016-2017. Project manager for the inventory of species at both the Plum Brook Station and Lewis Field facilities of the NASA Glen Research Center. Inventories were completed to update the facilities Natural Research Management Plan. Scheduled, coordinated, and managed field survey efforts for rare plant, plant community, bird, fish, bat,

Mrs. Willaman has been the project manager of several large multi-year projects involving in-depth field surveys and agency coordination efforts.

SEMINARS & TRAINING (CONT'D)

Project Development Process (PDP), ODOT Seminar 2005

Waterway Permits Training, ODOT 2005

Ecological Training, ODOT 2005

Waterways Permitting, ODOT 2005

U.S. Fish and Wildlife Consultant Training, USFWS 2005

Vegetative Index of Biotic Integrity (VIBI)Training, OEPA 2005

Amphibians of NE Ohio, OEPA 2007

Jurisdictional Determination, Post-Rapanos, USACE 2007

Bat Conservation and Management Training, BCM 2008

Bat Conservation and Management Training, BCI 2008

Bat Conservation Acoustic Monitoring Training, BCI 2010

Bat Conservation Advanced Capture Training, BCI 201 1

Acoustic Techniques and Analook Analysis Course, Bat Sense 2014

PROFESSIONAL AFFILIATIONS

Society of Wetland Scientists

Nature Conservancy Volunteer, White Pine Bog Preserve

Southern Bat Diversity Network Member and Bat Blitz Participant, 2011-2013

Midwest Bat Working Group Member

Northeast Bat Working Group Member

Ohio Bat Working Group Member

Bat Conservation International

lepidopteran, and reptile and amphibian surveys and reporting. Compilation of a site wide management plan update.

Bat Hibernacula Search and Survey, Pennsylvania Turnpike Commission, 2016. Project manager for a survey of a 14-mile proposed highway corridor and buffer area for the presence of winter bat habitat. Potential habitat was documented and trapped to determine the presence of hibernating bats. Project involved in-depth coordination with USFWS and PA Game Commission, logistics and scheduling, and the creation of a results report to submit to agencies for further compliance coordination.

Camp Ravenna Planning Level Bat Survey. Ravenna, Ohio 2015-16. Coordinated with USFWS for site specific authorization of a mist net survey of a 25,000-acre National Guard Training facility. Analyzed past capture data, past acoustic data, and aerial and natural resource mapping to determine the approximate location of 180 mist net locations. Assisted mist net surveys targeting Northern Long-eared bats, including bat handling, species ID and data logging, radio telemetry, and emergence counts.

Camp Ravenna INRMP Update. Ravenna, Ohio 2013-15. Project manager and technical writer for an update of the Camp Ravenna Integrated Natural Resource Management Plan (INRMP), in accordance with the methods, procedure and requirements of the Sikes Act. Update involved in-depth coordination with Ohio Army National Guard personnel, hosting agency meetings and coordination, integration of over 5 years of Planning Level Survey (PLS) species and land data, composition of separate PLS reports, update of military mission and range additions, integration of new listed species and management, recommendations of management practices, reformatting the document, and creation of 22 GIS maps.

Northern Long-eared bat Biological Assessment, Dominion, OH 2015. Lead writer of a Biological Assessment (BA) regarding the impacts of the Western Access Pipeline Project on the Federally Threatened Northern Long-eared Bat. Researched the most current available literature on the life history of the bat species and analyzed the impact all phases of pipeline construction will have on the species. Compiled appropriate mitigation measures for incidental take. The completed BA was coordinated the USFWS and a Biological Opinion for the project was issued.

Indiana bat and Northern Long-eared bat Biological Assessment, ODOT, OH 2014. Lead writer of a Biological Assessment (BA) regarding the impacts of the ODOT/Federal Highway Administration Portsmouth Bypass Project on the Federally Endangered Indiana Bat and the Proposed Endangered Northern Long-eared Bat. Researched the most current available literature on the life history of the bat species

MARY GILMORE

Senior Bat Ecologist

Ms. Gilmore is a senior member of the EnviroScience team specializing in threatened and endangered bats and wetland/stream delineating and permitting. As an endangered bat biologist, Ms. Gilmore has over 10 years' experience conducting threatened and endangered habitat assessments and bat surveys. Ms. Gilmore has a USFWS Indiana bat recovery permit through the extent on the bat's range and is a Qualified Bat Surveyor with the State of West Virginia and the Commonwealth of Pennsylvania. She has extensive field experience leading mist-net surveys, conducting radio telemetry, and knowledge of threatened and endangered bats and their habitat. Ms. Gilmore has conducted ecological work throughout IL, IN, KS, KY, MI, MO, NY, OH, OK, PA, TN, WV, and VA.

EDUCATION

B.S. Forestry and Wildlife Management, Ohio State University, 2008

RELEVANT TRAINING

Acoustic Techniques Analysis Course, Titley Scientific

AnalookW Analysis Course, Titley Scientific

Evaluating Acoustic Bat Surveys for ESA Compliance (May 2020)

USFWS Indiana bat Recovery Permit

RELEVANT EXPERIENCE

Threatened and Endangered Bats

Endangered Habitat Assessments

Acoustic Bat Surveys and all analysis

Mist Net Surveys

Radio Telemetry

Bat Hibernacula Surveys

SELECTED PROJECT EXPERIENCE

Mist-net, Portal search, and Wetland Delineation, Burgess & Niple / West Virginia Division of Highways, 2018. Surveyed 4.6-mile proposed highway corridor for endangered bats and potential bat portals. A total of 70 net-nights were completed and two northern long-eared bats were captured during mist-net surveys. Completed a routine wetland delineation within the proposed highway corridor.

Habitat Assessments and Conservation Planning, Appalachian Ohio Alliance / Ohio Department of Transportation, 2018. Assessed properties for suitability of potential bat habitat and assisted with drafting habitat assessment reporting and conservation planning. Properties were selected as part of a bat mitigation project. Conducted acoustic surveys and mist net surveys at selected properties.

Tennessee Department of Transportation, Various Counties TN, 2012, 2014, and 2018. Conducted Indiana bat mist-net and acoustic surveys for several new alignments and road widening projects throughout the state of TN.

Acoustic and Mist Net Inventory, Leidos Inc., NASA Plum Brook Station and Lewis Field, (John Glenn Research Center), Ohio, 2016. Conducted facility-wide biological survey at NASA John Glenn Research Center to assist in the development of a threatened and endangered species management plan. Indiana bat mist-net and acoustic surveys for several new alignments and road widening projects throughout the state of TN.

Mist-net Surveys, Virginia Department of Transportation, Various Counties in VA, 2015-2016. Project Manager for various presence/absence bat mist-net surveys throughout Virginia targeting northern long-eared and Indiana bats.

Bat Inventory Surveys, NASA, 2016 and Camp Ravenna Bat Survey. Ravenna, Ohio 2015-16. Utilized mist-net surveys and radio telemetry techniques to document the spatial and temporal use and distribution of bats within both the Plum Brook Station and Lewis Field facilities of the NASA Glen Research Center, and the 25,000-acre National Guard Training facility targeting rare/endagnered bats.

Bat Hibernacula Search and Survey, Pennsylvania Turnpike Commission, 2016. Searched for potential hibernacula and conducted fall portal surveys for Indiana bats and northern long-eared bats using mist nets, harp traps, and acoustic detectors for a proposed interstate bypass.

Indiana bat Acoustic and Mist Net Survey. Johnson County, Missouri. Conducted Indiana bat mist net surveys for a proposed 6 mile natural gas pipeline replacement project. Responsible for selecting and managing mist net site locations and collecting acoustic bat call data and analyzing data through software.

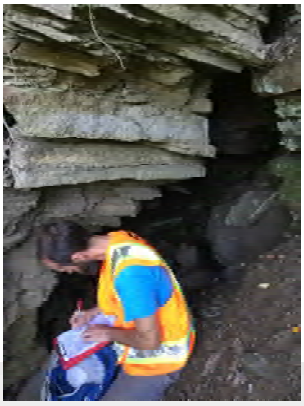
Kentucky Division of Fish and Wildlife Resources, White Nose Surveys, Various Counties, 2011 and 2014. Assisted with hibernacula white nose surveys at various counties through Kentucky.

Hibernacula Surveys, Pennsylvania Department of Transportation, Summerset County, PA, 2013. Assisted Qualified Indiana Bat Surveyor in conducting bat harp trap surveys on caves/abandoned mine portals. Utilized acoustic monitoring in conjunction with harp traps.

Pre-Construction Acoustic Monitoring for Proposed Windfarm Development. Logan County, IL. 2011, 2012. Assisted with deployment of acoustic monitoring detectors, and with establishing remote data collection and solar charging panels on unit.

Fort Drum, Jackson and Lewis Counties, NY, 2011. Contracted by Jackson Consulting to utilize mist-net surveys and radio telemetry techniques to document the spatial and temporal use and distribution of bats within Fort Drum Military Base. Assisted with acoustic surveying.

Indiana Bat Foraging Research, Pickaway County, Ohio, 2008 and 2010. Assisted a graduate student studying the foraging patterns of Indiana bats. Approximately 34 Indiana bats were tracked to collect day roosting behavior and foraging behavior for the life of their transmitter.



Dan Cox

Senior Bat Ecologist

Mr. Cox has seventeen years professional experience as an ecologist. He has surveyed bat communities throughout the eastern United States since 2006. As a research associate at the University of Kentucky, Mr. Cox's research focused on the effects of prescribed burning on two federally listed species of bats (Myotis sodalis and M. septentrionalis). He has extensive experience conducting regulatory surveys for endangered species of bats on proposed natural gas pipelines, proposed coal mines, DoD facilities, Federal Highway Administration projects, state-owned conservation lands, and state DOT projects. Mr. Cox's experience not only includes surveying various rare species of flora and fauna, but also includes writing management plans for those species and implementing habitat management. He is proficient in a variety of field techniques, including mist netting, Harp trapping, acoustic surveys, cave surveys, live-trapping, pit fall trapping, attaching transmitters to bats, habitat management, avian surveys, herpetofauna surveys, and aerial/ground radio telemetry. Mr. Cox has completed surveys in IL, IN, IA, MI, AR, TN, OH, KY, SC, VA, PA, and NY..

EDUCATION

B.S. Zoology, Minor in Chemistry, Eastern Illinois University, 2001

M.S. Biological Sciences, Eastern Illinois University, 2005

Graduate Certificate, Applied Statistics, University of Kentucky, 2007

Training

AnaBat Techniques Workshop, Northtronics USA

USFWS Indiana bat Recovery Permit

RELEVANT EXPERIENCE

Threatened and Endangered Bats

Acoustic Bat Survey and Data Analysis

Mist Net Survey

Endangered Habitat Assessments

Radio Telemetry

Bat Hibernacula Surveys

SELECTED PROJECT EXPERIENCE

Mist-net, Portal search, and Wetland Delineation, Burgess & Niple / West Virginia Division of Highways, 2018. Surveyed 4.6-mile proposed highway corridor for endangered bats and potential bat portals. A total of 70 net-nights were completed and two northern long-eared bats were captured during mist-net surveys. Completed a routine wetland delineation within the proposed highway corridor.

EnviroScience, Inc., 2019. Confidential client and project location. Conducted an acoustic survey to determine bat species diversity within the project area.

borealis Biological, 2018. Prologis Industrial Park, Illinois. Conducted a rare bat acoustic survey for a 201-acre area of a proposed industrial park. The acoustic data was first analyzed using Kaleidoscope Pro and then manually vetted to confirm species presence/absence.

EnviroScience, Inc., 2016. Mon/Fayette Expressway, Pennsylvania. Searched for potential hibernacula and conducted fall portal surveys for Indiana bats and northern long-eared bats using mist nets, harp traps, and acoustic detectors for a proposed interstate bypass.

KY State Nature Preserves Commission (August 2011 - March 2014). As the Eastern Regional Preserves Manager, I bioinventoried approximately 6,000 acres of public lands distributed amongst 16 conservation areas. Acoustic monitors were used to determine bat species diversity during bioinventories. I analyzed and manually vetted the acoustic data.

Mr. Cox has over 17 years of experience conducting biological surveys, threatened and endangered habitat assessments and bat surveys.

Jackson Environmental, 2011. Fort Drum Military Installation, New York. Coordinated a multi-year, ongoing research project on bat population dynamics. Duties included crew supervision, mist netting, acoustic sampling, data management, and ground and aerial radiotelemetry. I reviewed, summarized, and regularly coordinated results of acoustic surveys with military personnel.

Jackson Environmental, 2010. Midland Wind Resource Area, Henry County, Illinois, Iberdrola Renewables. Assessed habitat and surveyed approximately 25,793 acres for Indiana bats (Myotis sodalis). Additional duties included coordination with regulatory agencies, data analysis, AnaBat acoustic monitoring, and report preparation.

Jackson Environmental, 2010. Effects of Blasting on Bat Hibernaculum, Clark County, Kentucky, Palmer Engineering Company Inc. Conducted AnaBat acoustic surveys for presence of bats and determined effects of blasting on hibernating bats. Duties included acoustic monitoring, report preparation, data analysis, and coordination with regulatory agencies.

Environmental Solutions and Innovations, 2009. The Conservation Fund. Manually vetted and interpreted data collected during AnaBat studies completed across the eastern range of the Indiana bat in nine states.

Environmental Solutions and Innovations, 2008. Equitrans, Ranger Pipeline. Participated in field surveys for the endangered Indiana bat along a proposed 70-mile, natural gas pipeline in Martin and Floyd counties, Kentucky. Responsible for AnaBat site selection, data collection and analysis, mist net surveys and habitat assessments.

SEAN KLINE

Bat Ecologist / Wetland and Stream Scientist

Mr. Kline is a wildlife biologist with EnviroScience Inc. specializing in threatened and endangered (T&E) wildlife surveys and wetland/stream delineation. As a bat ecologist, Mr. Kline has 4 years' experience conducting threatened and endangered wildlife surveys. He has extensive field experience in performing mist net, cave portal, and acoustic surveys; radio telemetry; and identification of T&E bats and their habitat. As a wetland/stream scientist, Mr. Kline has >4 years' experience conducting wetland and stream delineations, construction, erosion and sediment control/construction compliance monitoring, and project reporting and permitting in both Ohio and West Virginia. Mr. Kline has conducted ecological work throughout Ohio, West Virginia, Pennsylvania, Kentucky, and New York.

EDUCATION

B.S. Wildlife and Fisheries Management, Minor in Conservation Ecology, West Virginia University, 2016

A.S. Wildlife Sciences and Fisheries Management and Aquaculture, Hocking College, 2014

CERTIFICATIONS

Combined Field Survey Techniques for Bats, Bat Survey Solutions, LLC

Ohio Rapid Assessment Method (ORAM), The Ohio EPA

Qualitative Habitat Evaluation Index (QHEI), The Ohio EPA

Headwater Habitat Evaluation Index (HHEI), The Midwest Biodiversity Institute

Wetland Delineation Training, Swamp School, LLC.

Wildland Firefighter, 2014

CPR, 2017

YEARS OF EXPERIENCE

EnviroScience, Inc.: >1

AllStar Ecology, LLC.: 3

RELEVANT EXPERIENCE

Threatened and Endangered Bats

Wetland / Stream Delineating and Permitting

AutoCAD, GPS, and GIS

Habitat Assessments

Mist Net Surveys

Cave Portal Surveys

Radio Telemetry

SELECTED PROJECT EXPERIENCE

Endangered and Threatened Bat Species Presence/Absence Surveys, Undisclosed Clients, West Virginia, Ohio, and Pennsylvania 2016-2019. Conducted mist net surveys for proposed associated pipeline construction activities and road construction/widening throughout West Virginia, Pennsylvania, and Ohio. Responsibilities included agency coordination, transportation of crews to mist net sites, location of suitable habitat, mist net implementation, bat capture and identification, radio telemetry, mapping, and report generation.

Potential Bat Roost Tree and Hibernacula Surveys and Rocket Box Installation/Monitoring. Undisclosed Clients, West Virginia, 2016-2018. Surveyed hundreds of acres across West Virginia for T&E bat species suitable summer habitat, including potential roost trees and hibernacula. Led survey field crews as well as mapped habitat types and generated reports for various clients and agencies. Based on results of surveys, mitigation of habitat losses by way of rocket box installation onsite or off. Led crews for in-house construction of rocket boxes and led field crews in the installation process and position of boxes onsite. Monitoring of rocket box occupancy continued two years after installation and included daytime presence/absence surveys, netting/capturing bats, identifying species, collecting morphological data, and implementation of White Nose Syndrome (WNS) protocols.

Wetland and Stream Delineations, Project Reporting and Permitting, Undisclosed Clients, throughout Ohio and West Virginia, 2016-2020. Completed many wetland and stream delineations and project reporting and permitting throughout Ohio and West Virginia. Utilizing training using QHEI, HHEI, and ORAM assessment methods to quickly and accurately delineate streams and wetlands.

Attachment B. Project Summaries

Marsha Gunder Schneider Preserve

Circleville, Ohio

Northern Long-eared bat with radio transmitter, ready for tracking.

Client
Appalachia Ohio Alliance

ES Project No. 9826

Key Services Provided
- Bat Survey
- Acoustic Monitoring
- Mist Net Survey
- Radio Telemetry Tracking
- Emergence Survey

Contact
Steve Fleegal
(334) 399-2345

Project Duration
June to September 2017

ES Project Cost
$25,000

ES Key Staff
Neal Hess
Jamie Willaman
Mary Gilmore

Appalachia Ohio Alliance (AOA) contracted EnviroScience, Inc. to conduct acoustic and mist-net surveys for bats within their Marsha Gunder Schneider Preserve (the Preserve) located near Circleville, Pickaway County, Ohio. The principle objective of the summer bat surveys was to learn about bat activity within the Preserve, specifically targeting the Indiana bat (*Myotis sodalis*; Federally Endangered) and the northern long-eared bat (*Myotis septentrionalis*; Federally Threatened).

The Preserve is approximately 295 acres in size and contains open fielded areas intermixed with forested corridors along site streams, including the Scioto River and Davenport Pond.

EnviroScience conducted acoustic monitoring for 8 detector nights at the Preserve in July of 2017, using AnaBat SD2 detectors. The recorded calls were processed using Kaleidoscope Pro Version 4.3.1 to identify calls to species. In total, over 1,700 calls from 11 bat species were recorded, including both Indiana and northern long-eared bats. This data allowed AOA to determine that the Preserve was being heavily utilized by bats.

To further investigate the use of the Preserve by listed bats, EnviroScience performed a 14 net night, mist net survey in August of 2017. The survey resulted in the capture of 40 bats of 8 species, including two female northern long-eared bats. Both northern long-eared bats were fitted with radio transmitters and radio telemetry was used to track the bats to their diurnal roosts. Two roost trees were identified during three days of tracking and an emergence survey was performed on each tree.

Overall this survey was highly successful in helping AOA prove the Preserve was being utilized as summer habitat for multiple bat species, including both the Indiana bat and the northern long-eared bat.

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WINTER BAT SURVEY FOR PENNSYLVANIA TURNPIKE TRANSPORTATION PROJECT

Allegheny County, Pennsylvania

Client
Pennsylvania Turnpike
c/o McCormick Taylor

Key Services Provided
- USFWS/PGC Coordination
- Bat Winter Habitat Survey and Mapping
- Hibernacula Netting Survey
- Acoustic Monitoring
- Full Reporting

Contact
Angela M. Schreffler
(717) 540-6040

Project Duration
June - November 2016

EnviroScience Key Staff
Jamie Willaman
Mary Gilmore
Greg Hocevar

Harp trap and acoustic monitor at entrance of bat hibernacula.

EnviroScience, Inc. assisted the PA Turnpike Commission (PTC) with listed bat coordination and compliance for the proposed Mon/Fayette Transportation Project, which is a fourteen mile, four-lane, tolled expressway between PA Route 51 in Jefferson Hills, PA and the Parkway East (I-376) in Monroeville, PA. The proposed project is in the range of the federally endangered Indiana bat (*Myotis sodalis*) and federally threatened Northern long eared bat (NLEB) (*Myotis septentrionalis*).

EnviroScience biologists assisted coordination with the United States Fish and Wildlife Service (USFWS) and the Pennsylvania Game Commission (PGC) to determine which surveys would be required and a timeline of surveys for the project.

EnviroScience performed a winter hibernacula habitat assessment on the approximately 79,400 linear foot study area (5,513-acres). This assessment was accomplished using a desktop determination to identify potential habitat areas and a pedestrian field survey to search the project area, in accordance with *The Pennsylvania Game Commission and United States Fish and Wildlife Service Protocol for Assessing Bat Use of Potential Hibernacula* (2012).

The desktop review resulted in approximately 2,940 acres of potential habitat that needed surveyed. The field survey resulted in the documentation 37 potential cave/portal openings within the project area. Of the 37 identified openings, 15 openings were found to possess the qualities and characteristics that would warrant further investigation as a potential hibernaculum through seasonal trapping.

The 15 identified potential hibernacula were further assessed by netting and acoustic monitoring. The netting/trapping survey resulted in the capture of one Tricolored bat *(Perimyotis subflavus*).

The PTC was able to conclude that no federally listed bats had winter habitat that would be affected by the proposed project.

EnviroScience
EnviroScienceInc.com

ACOUSTIC SURVEY FOR WIDENING OF SAM RIDLEY PARKWAY AND REALIGNMENT OF CHANEY ROAD PROJECT

Smyrna, Rutherford County, Tennessee

EnviroScience Inc. preformed a habitat assessment and acoustic monitoring probable presence/absence survey for the Tennessee Department of Transportation (TDOT) proposed widening of Sam Ridley Parkway and Chaney Road realignment project located in Smyrna, Tennessee. The survey was conducted in accordance with the United States Fish and Wildlife (USFWS) *Range-wide Indiana Bat Summer Survey Guidelines* (April 2018).

The linear project was approximately 1.47-miles long, with approximately 1.3 acres of forested habitat. In order to determine the effort required to properly perform a presence/absence survey on the site, as well as determine optimal placement locations for an acoustic monitoring recorder, EnviroScience first performed a desktop evaluation of the site. The evaluation determined that the site would need two detector nights within the forested habitat. EnviroScience used an AnaBat SD2 recorder and recorded bat calls for two consecutive nights. All recorded calls were processed using Kaleidoscope Pro Version 4.2.0 to identify calls to species

A total of 84 bat calls were recorded over two nights of survey. Calls were qualitatively analyzed by Mary Gilmore to determine their validity. The survey resulted in the likely absence of listed bats within the proposed project area. EnviroScience coordinated concurrence with the USFWS.

Client
Tennessee Department of Transportation, under contract with Gresham Smith Partners

ES Project No. 10420

Key Services Provided
- USFWS Coordination
- Habitat Assessment
- Acoustic Survey
- Acoustic Bat Call Analysis
- Technical Reporting

Contact
Sandy Layne-Sclafani
(615) 770-8255

Project Duration
2018

ES Project Cost
$7,400

ES Key Staff
Chad Armour
Mary Gilmore

EnviroScience
EnviroScienceInc.com

ECOLOGICAL SURVEYS AT PLUM BROOK STATION & LEWIS FIELD

Sandusky, Ohio & Cleveland, Ohio

Client
NASA, under contract with Leidos

Key Services Provided
- Avian Surveys
- Bat Surveys
- Rare Plant Surveys
- Reptile/Amphibian Surveys
- Fish Surveys
- Plant Community Survey
- Species Management Plan

Contact
Jen Thomas
(330) 761-8910

Project Cost
$300,000

Project Duration
April 2016- March 2017

ES Key Staff
Jamie Willaman
Michael Liptak, Ph.D.
Tim Walters, Ph.D.
Mary Gilmore
Brian Slaby
Nathan Knowles
Brooke Harrison
Ann Gilmore
Teal Richards-Dimitrie
Paul Anderson
Brad Bartelme
Alex Valigosky
Ben Little
Lisa Regula Meyer
Lois Terveen
Mike Gilligan
Jerry Weidmann

NASA facilities are required to maintain current records of species protected by the Endangered Species Act (ESA), and develop programs for the management of any protected species and their critical habitat where present on NASA property. To facilitate NASA Glenn Research Center's (GRC) compliance with the ESA and NASA policies, EnviroScience, Inc. and Leidos, Inc. proposed a strategy for the identification and management of protected species at the following facilities: Lewis Field, approximately 350 acres in Cleveland, and Plum Brook Station (PBS), approximately 6,400 acres in Sandusky, Ohio.

The strategy consists of three interrelated tasks:

1) Perform biological surveys at Lewis Field and PBS to provide current records of protected species at these facilities
2) Update geographic information system (GIS) data layers identifying terrestrial plant communities and aquatic habitats, and incorporating locations of protected species at each facility
3) Update the management plan for the protected species, utilizing the GIS data as a management tool

Throughout 2016, EnviroScience biologists performed surveys of multiple taxa groups at both facilities. Surveys were performed to document birds, bats, reptiles/amphibians, fish, rare plants, butterflies, moths, and vegetative communities at each site, and technical reports were prepared for each survey. In addition, EnviroScience made recommendations for site management to maintain and improve habitat for protected species and important communities. These surveys and recommendations were compiled into a multi-volume technical report for NASA to use in its future management of natural areas on both properties.

EnviroScience
EnviroScienceInc.com

Attachment C. Federal Scientific Collectors Permits

DEPARTMENT OF THE INTERIOR
U.S. FISH & WILDLIFE SERVICE
Endangered Species Permit Office
5600 American Boulevard, West, Suite 990
Bloomington, MN 55437-1458
permitsR3ES@fws.gov

FEDERAL FISH AND WILDLIFE PERMIT

1. PERMITTEE

MARY BRIGID GILMORE
5070 STOW ROAD
STOW, OH 44224
U.S.A.

2. AUTHORITY-STATUTES
16 USC 1539(a)
16 USC 1533(d)

REGULATIONS
50 CFR 17.22
50 CFR 17.32

50 CFR 13

3. NUMBER
TE62311A-4 AMENDMENT

4. RENEWABLE
☒ YES
☐ NO

5. MAY COPY
☒ YES
☐ NO

6. EFFECTIVE
09/06/2016

7. EXPIRES
12/31/2021

8. NAME AND TITLE OF PRINCIPAL OFFICER *(If #1 is a business)*

9. TYPE OF PERMIT
NATIVE ENDANGERED & THREATENED SP. RECOVERY - E & T WILDLIFE

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED
ON LANDS SPECIFIED WITHIN THE ATTACHED SPECIAL TERMS AND CONDITIONS

11. CONDITIONS AND AUTHORIZATIONS:

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL, TRIBAL, OR OTHER FEDERAL LAW.

C. VALID FOR USE BY PERMITTEE NAMED ABOVE.

C.1. VALID FOR USE BY MARY B. GILMORE. UNNAMED ASSISTANTS MAY WORK UNDER THE AUTHORITY OF THIS PERMIT ONLY UNDER THE ON-SITE SUPERVISION OF MARY GILMORE. MS. GILMORE MUST REMAIN PRESENT AT MIST NET SITE WHILE IT IS BEING OPERATED.

D. ACCEPTANCE OF THIS PERMIT SERVES AS EVIDENCE THAT THE PERMITTEE AND ITS AUTHORIZED AGENTS UNDERSTAND AND AGREE TO ABIDE BY THE TERMS OF THIS PERMIT AND ALL SECTIONS OF TITLE 50 CODE OF FEDERAL REGULATIONS, PARTS 13 AND 17, PERTINENT TO ISSUED PERMITS (https://www.fws.gov/permits/ltr/ltr.html). SECTION 11 OF THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED, PROVIDES FOR CIVIL AND CRIMINAL PENALTIES FOR FAILURE TO COMPLY WITH PERMIT CONDITIONS.

E. Permittee is authorized to take (capture, handle, radio-tag, and release) Indiana bat (*Myotis sodalis*) and northern long-eared bat (*M. septentrionalis*) for scientific research aimed at recovery of the species: presence/absence surveys, studies to document habitat use, population monitoring, and to evaluate potential impacts. This permit does not authorize the collection of voucher specimens.

F. Activities are authorized at the following locations:

F.1. Location within Region 2 of the USFWS: Oklahoma, upon receipt of written concurrence from the Field Supervisor, and upon coordination with Ozark Plateau National Wildlife Refuge prior to (1) surveys of caves known to be used by federally-listed bats, and (2) examinations of caves suspected of containing federally-listed bat species (some

☒ ADDITIONAL CONDITIONS AND AUTHORIZATIONS ALSO APPLY

12. REPORTING REQUIREMENTS
ANNUAL REPORT DUE: 01/31

ISSUED BY	TITLE	DATE
Thomas Shull	CHIEF - ENDANGERED SPECIES	09/06/2016

presence/absence surveys may require the presence of a U.S. Fish and Wildlife Biologist), and as outlined in Condition G.

F.2. Locations within Region 3 of the USFWS: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin upon receipt of written concurrence from the Field Supervisor, as outlined in Condition G.

F.3. Locations within Region 4 of the USFWS: Alabama, Arkansas, Florida, Georgia, Kentucky, Mississippi, North Carolina, and Tennessee, upon receipt of written concurrence from the Field Supervisor, as outlined in Condition G.

F.4. Locations within Region 5 of the USFWS: Maryland, New Jersey, New York, Pennsylvania, Vermont, Virginia and West Virginia, upon receipt of written concurrence from the Field Supervisor, as outlined in Condition G.

F.5. Locations within Region 6 of the USFWS: Kansas, Montana, Nebraska, North Dakota, South Dakota, and Wyoming, upon receipt of written concurrence from the Field Supervisor, as outlined in Condition G.

G. Permittee shall notify the USFWS Field Supervisor for the state in which activities are proposed to occur at least 15 days prior to conducting any activities. Contact information is available at: https://www.fws.gov/midwest/endangered/permits/index.html. Your request for this site-specific approval must be in writing and must indicate:

G.1. Species for which proposed activities are being conducted.

G.2. Location of proposed activities, including project site, county, and state.

G.3. A description of the activities (i.e., surveys, radio-telemetry studies, etc.).

G.4. Dates when the project is proposed to take place.

G.5. Evidence that Permittee has received any required contracts to complete the activities.

G.6. Whether all annual reporting requirements have been fulfilled.

G.7. You may proceed with activities only upon receipt of written concurrence from the applicable USFWS Field Supervisor. *Your concurrence letter must be carried with this permit to authorize site-specific activities.*

H. Permittee shall adhere to the following conditions involving capture and handling of bats:

H.1. Bats may be captured with mist nets following the protocol included in the Range-wide Indiana Bat Summer Survey Guidelines. Guidelines are available at: http://www.fws.gov/midwest/endangered/mammals/inba/inbasummersurveyguidance.html. Note that you must use the most up-to-date version of the Summer Survey Guidelines, available on the USFWS website page, for your summer surveys. The monitoring interval for mist nets is +/- 10 minutes and may not exceed 15 minutes. Captured bats may be held for a maximum of 30 minutes, unless injured. In extenuating circumstances, bats shall be held for no longer than 45 minutes.

H.2. Bats may be captured with harp traps with written concurrence from the Field Supervisor in the state in which trapping is proposed. Harp traps must be continually monitored. Captured bats may be held for a maximum of 30 minutes, unless injured. In extenuating circumstances, bats shall be held for no longer than 45 minutes.

H.3. Permittees shall carry out non-intrusive measurements on all captured bats. Data shall be recorded for all bats captured and include, but not be limited to, the data requested in any automated or species specific data sheet provided by the USFWS (e.g., Bat Reporting Spreadsheet). Handling should be limited to the maximum extent practicable and should cease immediately at signs of undue stress (e.g., bat becoming unresponsive, etc.). Bats that appear stressed from handling should be placed in a dark, quiet location away from activity where it can safely fly away after recovery, and should be checked to ensure successful recovery before leaving the study site. Photographs of the identifying characteristics for each individual federally-listed species captured are encouraged. The Permittee may be requested to provide individual photographs after submittal of annual reporting data.

H.4. Lipped metal bands having a unique identifier may be applied to the forearm of captured bats prior to release. No more than one band per bat may be used. Bands should be applied to the forearm of captured bats prior to release. Position the band on the wing so that when the bat is hanging upside down, the band numbers are right-side up. A single band should be placed on the right forearm of each male and the left forearm of each female bat.

H.5. Radio transmitters may be applied during summer roosting period via nontoxic skin bond adhesive. The total weight of the transmitter may not exceed 5% of the bat's body weight and the total weight of the package (transmitter and adhesive) may not exceed 6% of the bat's body weight. The lightest package (both transmitter and adhesive) capable of accomplishing the required task should be used, especially with pregnant females and newly volant juveniles. Bats carrying transmitters must be monitored daily for at least three days, or until the transmitter falls off, whichever occurs first.

H.6. No trapping activities shall occur within 20 meters of a known Indiana bat maternity roost site, either natural or artificial roosts, unless Permittee receives prior written approval from the U.S. Fish and Wildlife Service Field Supervisor for the state in which the activities are proposed to occur.

H.7. Permittee may collect dorsal hair samples, wing biopsy tissue samples, fungal lift tape and swab samples from captured bats for scientific study. Hair samples shall be obtained via clipping fur from between scapula from females and juvenile males. The clipped area is the same area frequently clipped for radio transmitter attachment. Wing tissue samples may be taken using a new, sterile biopsy punch (2mm) for each endangered and threatened bat sampled. No more than two samples, one from each wing, may be obtained per individual. All boards and equipment used to obtain samples must be disinfected according to the protocol cited in Condition H.8.

H.8. Equipment used to capture and handle bats shall be cleaned and decontaminated, including personal gear such as boots and gloves, using products cited in decontamination guidelines and in compliance with label directions. The most recent decontamination guidance is found on the web at: https://www.whitenosesyndrome.org/topics/decontamination.

H.9. Caves, mines, or other suitable hibernation sites may be quietly searched in a manner that minimizes disturbance by utilizing the minimum number of people and time required to complete the survey. Surveys should not be repeated more often than once every other year in any given hibernaculum that is occupied by endangered and threatened bats. Where hibernacula area and safety conditions allow, individuals entering caves are recommended to utilize night vision goggles or red-filtered light and to remain in the cave no more than 90 minutes to complete the work

I. Upon determination that endangered or threatened bats are present at previously undocumented sites, Permittee shall notify the following offices within 48 hours: the U.S. Fish and Wildlife Service Region 3 Office (Condition L.), and the U.S. Fish and Wildlife Service Field Office within the geographic location of study areas (https://www.fws.gov/midwest/endangered/permits/index.html).

J. Accidental mortality may not exceed two specimens. In the event that this number is met, all activities must cease. Any bat mortality or serious injury must be reported within 5 calendar days to the applicable U.S. Fish and Wildlife Service office based on location of mortality event and to the nearest U.S. Fish and Wildlife Service Law Enforcement, Special Agent Office (http://www.fws.gov/offices). Dead or moribund bats may be retained for further study only with the written permission of the U.S. Fish and Wildlife Service. Any bats that are not authorized for retention are to be chilled and promptly transferred to the U.S. Fish and Wildlife Service for potential necropsy and/or contaminants analysis (Condition L.6.).

K. An annual report of all activities conducted under the authority of this permit is due by January 31 following each year this permit is in effect. In addition, copies of all publications and reports resulting from work conducted under this permit must be submitted as they become available. Failure to furnish any reports required by this permit is cause for permit revocation and/or denial of future permit applications. At a minimum, your report shall include:

K.1. The date, time, geographic locations (including datum and projection information), species, age, sex, and weight of all bats encountered.

K.2. A description of locations surveyed where no bats were encountered.

K.3. Band numbers of all bats banded.

K.4. Information on any injuries and/or mortalities and disposition of specimens.

K.5. Location and characteristics of roost trees and bat colonies.

K.6. Copies of any separate reports and/or publications resulting from work conducted under the authority of this permit.

K.7. A completed data collection sheet as found on the Range-wide Indiana Bat Summer Survey Guidelines website page, cited in Condition H.1.

K.8. Data shall be submitted for all bats captured and include, but not be limited to, the data requested in any automated or species-specific data sheet provided by the USFWS (e.g., the data collection sheets found on the current Rangewide Indiana Bat Summer Survey Guidelines website page cited in Condition H.1., or other species specific data sheets). Photographs of the identifying characteristics for each individual federally-listed species captured are encouraged. The Permittee may be requested to provide individual photographs after submittal of annual reporting data.

K.9. Copies of all site specific authorization letters required under Condition G.

If no activities occurred over the course of the year, indication of such shall be submitted as an annual report.

L. Copies of your reports shall be sent to the offices listed below. When possible, electronic copies shall be submitted in lieu of hard copies in MS Word, Portable Document Format, Rich Text Format, or other file format that is compatible with the receiving office.

L.1. Regional Recovery Permits Coordinator
U.S. Fish and Wildlife Service - Midwest Region (Region 3)
Ecological Services - Endangered Species
5600 American Blvd. W., Suite 990
Bloomington, Minnesota 55437-1458
(612/713-5343; fax 612/713-5292)
permitsR3ES@fws.gov

L.2. Regional Recovery Permits Coordinator
U.S. Fish and Wildlife Service - Southwest Region (Region 2)
Endangered Species Permits Office
P.O. Box 1306
Albuquerque, New Mexico 87103-1306
(505/248-6649; fax 505/248-6788)
permitsR2ES@fws.gov

L.3. Regional Recovery Permits Coordinator
U.S. Fish and Wildlife Service - Southeast Region (Region 4)
Endangered Species Permits Office
1875 Century Blvd., Suite 200
Atlanta, Georgia 30345-3301
(404/679-7140; fax 404/679-7081)
permitsR4ES@fws.gov

L.4. Regional Recovery Permits Coordinator
U.S. Fish and Wildlife Service - Northeast Region (Region 5)
Endangered Species Division
300 Westgate Center Drive
Hadley, Massachusetts 01035-9589
(703/358-2402; fax 413/253-8482)
permitsR5ES@fws.gov

L.5. ESA Assistant Recovery Coordinator & Permit Coordinator
U.S. Fish and Wildlife Service - Mountain-Prairie Region (Region 6)
Endangered Species Permits Office
Denver Federal Center, P.O. Box 25486
Denver, Colorado 80225-0489
(719/628-2670; fax 303/236-0027)
permitsR6ES@fws.gov

L.6. Lori Pruitt
Endangered Species Coordinator
U.S. Fish and Wildlife Service
Ecological Services Field Office
620 S. Walker Street
Bloomington, Indiana 47403-2121
(812/334-4261 x1213; fax 812/334-4273)

M. Additionally, based on geographic area, reports and publications shall be submitted to the offices listed under Field Office Contact Information at: https://www.fws.gov/midwest/endangered/permits/index.html

cc: FWS/Regions 2, 4, 5 and 6 (Attn: Regional Recovery Permit Coordinator)
FWS, TE Coordinators: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin
DNR/DOC, TE Administrator/Coordinators: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin

END

NATIVE ENDANGERED & THREATENED SP. RECOVERY
ENDANGERED & THREATENED WILDLIFE

Permit Number: TE43605A-4

Effective: 01/23/2020 Expires: 12/31/2025

Issuing Office:

Department of the Interior
U.S. FISH & WILDLIFE SERVICE
Endangered Species Permit Office
5600 American Boulevard, West, Suite 990
Bloomington, MN 55437-1458
permitsR3ES@fws.gov

CHIEF - ENDANGERED SPECIES

Permittee:

DANIEL R COX
616 SOUTH ILLINOIS ST.
STREATOR, IL 61364
U.S.A.

Authority: Statutes and Regulations: 16 USC 1539(a), 16 USC 1533(d); 50 CFR 17.22, 50 CFR 17.32, 50 CFR 13.

Location where authorized activity may be conducted:

Locations: Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming.

Reporting requirements:

ANNUAL REPORT DUE: 01/31
See permit conditions for reporting requirements

Authorizations and Conditions:

A. General Conditions set out in Subpart B of 50 CFR 13, and specific Conditions contained in Federal regulations cited above, are hereby made a part of this permit. All activities authorized herein must be carried out in accord with and for the purposes described in the application submitted. Continued validity, or renewal of this permit is subject to complete and timely compliance with all applicable Conditions, including the filing of all required information and reports.

B. The validity of this permit is also conditioned upon strict observance of all applicable foreign, state, local, tribal, or other Federal law.

C. Valid for use by Daniel Cox.

C.1. Unnamed assistants may work on permitted activities only under the direct and on-site supervision of Daniel Cox. "On-site supervision" is defined as having the Permittee at a distance close enough to enable immediate assistance to a supervised individual, as needed, while the supervised individual conducts an authorized activity. **At least one named Permittee must remain present at each mist-net and harp trap site while it is being operated.**

D. Acceptance of this permit serves as evidence that the Permittee and its authorized agents understand and agree to abide by the terms of this permit and all sections of Title 50 Code of Federal Regulations (CFR), Parts 13 and 17, pertinent to issued permits (https://www.fws.gov/permits/ltr/ltr.html). Section 11 of the Endangered Species Act of 1973, as amended, provides for civil and criminal penalties for failure to comply with permit conditions.

A request for permit renewal using Application Form 3-200-55 and the $100 application processing fee must be received **at least 30 days prior to the expiration date** of this permit to continue conducting authorized activities under the expired permit while your application is being processed (subject to compliance with 50 CFR, Parts 13.21 and 13.22: <https://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=a1d34199d1ab36c8b78ecd06a7fa5180&tpl=/ecfrbrowse/Title50/50cfr13_main_02.tpl>). When these requirements are not met, this permit becomes invalid on the expiration date. *Unless otherwise instructed within the Authorizations and Conditions*, **annual reports** are due by January 31 following each year your permit is in effect and shall be submitted to all offices identified in the permit Conditions, as appropriate. The following website link provides the permit application Form 3-200-55 and the mailing address to the Midwest Region (Region 3), U.S. Fish and Wildlife Service, Endangered Species Permit Office: <https://www.fws.gov/endangered/permits/how-to-apply.html>.

E. Permittee is authorized to take (capture, handle, radio-tag, and release) the Indiana bat (*Myotis sodalis*), northern long-eared bat (*M. septentrionalis*), and gray bat (*Myotis grisescens*) for scientific research aimed at recovery of the species: presence/absence surveys, studies to document habitat use, population monitoring, and to evaluate potential impacts. This permit does **not** authorize the collection of voucher specimens.

F. Activities are authorized at the following locations:

F.1. Location within Region 2 of the USFWS: Oklahoma, upon receipt of written concurrence from the Field Supervisor, and upon coordination with Ozark Plateau National Wildlife Refuge prior to (1) surveys of caves known to be used by federally-listed bats, and (2) examinations of caves suspected of containing federally-listed bat species (some presence/absence surveys may require the presence of a U.S. Fish and Wildlife Biologist), and as outlined in Condition G.

F.2. Locations within Region 3 of the USFWS: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin, upon receipt of written concurrence from the Field Supervisor, as outlined in Condition G.

F.3. Locations within Region 4 of the USFWS: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee, upon receipt of written concurrence from the Field Supervisor, as outlined in Condition G.

F.4. Locations within Region 5 of the USFWS: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia, upon receipt of written concurrence from the Field Supervisor, as outlined in Condition G.

F.5. Locations within Region 6 of the USFWS: Kansas, Montana, Nebraska, North Dakota, South Dakota, and Wyoming, upon receipt of written concurrence from the Field Supervisor, as outlined in Condition G.

G. Permittee shall notify and request approval from the USFWS Field Supervisor for the state in which activities are proposed to occur at least 15 days prior to conducting any activities. Contact information is available at: https://www.fws.gov/midwest/endangered/permits/index.html. Your request for this site-specific approval must be in writing and must indicate:

G.1. Species for which proposed activities are being conducted.

G.2. Location of proposed activities, including project site, county, and state.

G.3. A complete description of activities (i.e., proposed project plan, including purpose and need, surveys, methods, etc.). If the purpose includes collection of wing biopsies, hair samples, fungal lift tape, or swab samples, a copy of the specific study proposal must be included.

G.4. Dates when the project is proposed to take place.

G.5. Evidence that Permittee has received any required contracts to complete the activities.

G.6. Whether all annual reporting requirements have been fulfilled.

You may proceed with activities only upon receipt of written concurrence from the applicable USFWS Field Supervisor. ***Your concurrence letter must be carried with this permit to authorize site-specific activities.***

H. Permittee shall adhere to following conditions involving capture and handling of bats:

H.1. Bats may be captured with mist nets following the protocol included in the Range-wide Indiana Bat Summer Survey Guidelines. Guidelines are available at: <http://www.fws.gov/midwest/endangered/mammals/inba/inbasummersurveyguidance.html>. Note that you must use the most up-to-date version of the Summer Survey Guidelines, available on the USFWS website page, for your summer surveys. The monitoring interval for mist nets is +/- 10 minutes and may not exceed 15 minutes. Captured bats may be held for a maximum of 30 minutes, unless injured. In extenuating circumstances, bats shall be held for no longer than 45 minutes.

H.2. Bats may only be captured with harp traps with written concurrence from the Field Supervisor in the state in which trapping is proposed. Harp traps must be continually monitored. Captured bats may be held for a maximum of 30 minutes, unless injured. In extenuating circumstances, bats shall be held for no longer than 45 minutes.

H.3. Permittee shall carry out non-intrusive measurements on all captured bats. Data shall be recorded for all bats captured and include, but not be limited to, the data requested in any automated or species specific data sheet provided by the USFWS (e.g., Bat Reporting Spreadsheet). Handling should be limited to the maximum extent practicable and should cease immediately at signs of undue stress (e.g., bat becoming unresponsive, etc.). Bats that appear stressed from handling should be placed in a dark, quiet location away from activity where it can safely fly away after recovery, and should be checked to ensure successful recovery before leaving the study site. Photographs of the identifying characteristics for each individual federally-listed species captured are encouraged. The Permittee may be requested to provide individual photographs after submittal of annual reporting data.

H.4. Lipped metal bands having a unique identifier may be applied to the forearm of captured bats prior to release. No more than one band per bat may be used. Bands should be applied to the forearm of captured bats prior to release. Position the band on the wing so that when the bat is hanging upside down, the band numbers are right-side up. A single band should be placed on the right forearm of each male and the left forearm of each female bat.

H.5. Radio transmitters may be applied during summer roosting period via nontoxic skin bond adhesive. The total weight of the transmitter may not exceed 5% of the bat's body weight and the total weight of the package (transmitter and adhesive) may not exceed 6% of the bat's body weight. The lightest package (both transmitter and adhesive) capable of accomplishing the required task should be used, especially with pregnant females and newly volant juveniles. Bats carrying transmitters must be monitored daily for at least three days, or until the transmitter falls off, whichever occurs first. ***Although not required as a condition of this permit, in order to gather needed information to promote the conservation of the northern long-eared bat, it is recommended that the permittee radio-track female and juvenile northern long-eared bats captured when conducting mist-netting and radio-tracking of Indiana bats within the white-nose syndrome (WNS) zone of the range of the northern long-eared bat. Specifics on the number of females and juvenile bats to be tracked will be determined in coordination with the appropriate Field Office, as specified in Condition G.***

H.6. No trapping activities shall occur within 20 meters of a known Indiana bat maternity roost site, either natural or artificial roosts, unless Permittee receives prior written approval from the U.S. Fish and Wildlife Service Field Supervisor for the state in which the activities are proposed to occur.

H.7. Permittee may collect dorsal hair samples, wing biopsy tissue samples, fungal lift tape and swab samples from captured bats for scientific study. Hair samples shall be obtained via clipping fur from between scapula from females and juvenile males. The clipped area is the same area frequently clipped for radio transmitter attachment. Wing tissue samples may be taken using a new, sterile biopsy punch (2mm) for each endangered and threatened bat sampled. No more than two samples, one from each wing, may be obtained per individual. All boards and equipment used to obtain samples must be disinfected according to the protocol cited in Condition H.8.

H.8. Equipment used to capture and handle bats shall be cleaned and decontaminated, including personal gear such as

boots and gloves, using products cited in decontamination guidelines and in compliance with label directions. The most recent decontamination guidance is found on the web at: https://www.whitenosesyndrome.org/topics/decontamination.

H.9. For the Ozark big-eared bat (*Corynorhinus townsendii ingens*) and Virginia big-eared bat (*C. townsendii virginianus*), the USFWS acknowledges that incidental (unintentional) capture of these co-occurring listed bat species may potentially occur while conducting lawful survey activities directed at authorized bat species. This permit does not authorize any activities for the specific purpose of capture of Ozark or Virginia big-eared bats. Permittee shall be observant and cautious to eliminate or minimize "take" of co-occurring listed species to the maximum extent practicable. In the event of incidental (unintentional) capture of Ozark or Virginia big-eared bat, you shall document the capture with a photograph and immediately release at the capture site. Within 48 hours, you must notify the USFWS in the state in which you are working of the incidental capture (see https://www.fws.gov/midwest/endangered/permits/index.html).

I. Upon determination that endangered or threatened bats are present at previously undocumented sites, Permittee shall notify the following offices within 48 hours: the USFWS Region 3 Office (Condition L.), the Species Recovery Lead (Condition M.), and the USFWS Field Office within the geographic location of study areas (https://www.fws.gov/midwest/endangered/permits/index.html).

J. Accidental injury or mortality may not exceed two (2) specimens. In the event that any accidental injury or mortality occurs, all activities must cease. The Permittee must report any bat mortality or serious injury within 24 hours to the applicable USFWS Field Office in the state in which the incident occurred (contact information provided at: https://www.fws.gov/midwest/endangered/permits/index.html). Written notification must also be made within 48 hours to the Region 3 Regional Permit Coordinator (see Condition L.) and the Species Recovery Lead (Condition M.). The Permittee's statement must document the cause of the injury or mortality, and identify all remedial measures employed by the Permittee to eliminate future mortality or injury events. Based on consultation between the USFWS offices, decisions will be made regarding remedial measures that will be implemented and whether and/or when any of the authorized activities may continue. The Species Recovery Lead Office will provide a decision within five (5) business days concerning the disposition of any injured or dead specimen. Dead or moribund bats may be retained for further study only with the written permission of the USFWS. Any bats that are not authorized for retention are to be chilled and promptly transferred to the USFWS Species Recovery Lead for potential necropsy and/or contaminants analysis. Permitted activities may resume upon receipt of written approval from the Species Recovery Lead Office.

K. An annual report of all activities conducted under the authority of this permit is due by January 31 following each year this permit is in effect. In addition, copies of all publications and reports resulting from work conducted under this permit must be submitted as they become available. Failure to furnish any reports required by this permit is cause for permit revocation and/or denial of future permit applications. At a minimum, your report shall include:

K.1. The date, time, geographic locations (including datum and projection information), species, age, sex, and weight of all bats encountered.

K.2. A description of locations surveyed where no bats were encountered.

K.3. Band numbers of all bats banded.

K.4. Information on any injuries and/or mortalities and disposition of specimens.

K.5. Location and characteristics of roost trees and bat colonies.

K.6. Copies of any separate reports and/or publications resulting from work conducted under the authority of this permit.

K.7. A completed data collection sheet as found in the Survey Guidelines, cited in Condition H.1.

K.8. Data shall be submitted for all bats captured and include, but not be limited to, the data requested in any automated or species-specific data sheet provided by the USFWS (e.g., the reporting spreadsheets found on the current Rangewide Indiana Bat Summer Survey Guidelines website cited in Condition H.1., or other species specific data

sheets). Photographs of the identifying characteristics for each individual federally-listed species captured are encouraged. The Permittee may be requested to provide individual photographs after submittal of annual reporting data.

K.9. Copies of all site specific authorization letters required under Condition G.

If no activities occurred over the course of the year, indication of such shall be submitted as an annual report.

L. Copies of your reports shall be sent to the offices listed below. When possible, electronic copies shall be submitted in lieu of hard copies in MS Word, Portable Document Format, Rich Text Format, or other file format that is compatible with the receiving office.

L.1. Regional Recovery Permits Coordinator
U.S. Fish and Wildlife Service - Region 3
Ecological Services - Endangered Species
5600 American Blvd. W., Suite 990
Bloomington, Minnesota 55437-1458
(612/713-5343; fax 612/713-5292)
permitsR3ES@fws.gov

L.2. Regional Recovery Permit Coordinator
U.S. Fish and Wildlife Service - Region 2
Endangered Species Permits Office
P.O. Box 1306
Albuquerque, New Mexico 87103-1306
(505/248-6420; fax 505/248-6788)
permitsR2ES@fws.gov

L.3. Regional Recovery Permit Coordinator
U.S. Fish and Wildlife Service - Region 4
Endangered Species Permits Office
1875 Century Blvd.
Atlanta, Georgia 30345-3301
(404/679-7097; fax 404/679-7081)
permitsR4ES@fws.gov

L.4. Regional Recovery Permit Coordinator
U.S. Fish and Wildlife Service - Region 5
Endangered Species Division
300 Westgate Center Drive
Hadley, Massachusetts 01035-9589
(413/253-8212; fax 413/253-8482)
permitsR5ES@fws.gov

L.5. Regional Recovery Permit Coordinator
U.S. Fish and Wildlife Service - Region 6
Endangered Species Permits Office
Denver Federal Center, P.O. Box 25486
Denver, Colorado 80225-0489
(303/236-4224; fax 303/236-0027)
permitsR6ES@fws.gov

M. Additionally, based on species, reports and publications shall be submitted to the following:

M.1. ***For studies involving gray bat:***
Vona Kuczynska
U.S. Fish and Wildlife Service

Missouri Field Office
101 Park DeVille Drive, Suite A
Columbia, Missouri 65203-0007
(573/234-2132; fax 573/234-2181)

M.2. ***For studies involving Indiana bat:***
Lori Pruitt
U.S. Fish and Wildlife Service
Indiana Field Office
620 S. Walker Street
Bloomington, Indiana 47403-2121
(812/334-4261; fax 812/334-4273)

M.3. ***For studies involving northern long-eared bat:***
Jill Utrup
U.S. Fish and Wildlife Service
Minnesota-Wisconsin Field Office
4101 American Blvd. E.
Bloomington, Minnesota 55425-1665
(952/252-0092; fax 952/646-2873)

N. Additionally, based on geographic area, **reports and publications shall be submitted to** the applicable offices under "For Fish and Wildlife Permit Holders" at: https://www.fws.gov/midwest/endangered/permits/index.html.

cc: FWS/Region 2, 4, 5, and 6 (Attn: Regional Recovery Permit Coordinator)
FWS, TE Coordinators: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin
DNR/DOC, TE Coordinators: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin

END

Attachment 3

Acoustic Bat Survey Study Plan

Study Plan:

Acoustic Bat Survey
Candlewood Solar Project
New Milford, Litchfield County, Connecticut

Prepared for:

Wood Environment &

Infrastructure Solutions, Inc.

271 Mill Road

Chelmsford, MA

Phone: (978) 692-9090

Prepared by:

EnviroScience
Excellence In Any Environment
5070 Stow Rd.
Stow, OH 44224
800-940-4025
www.EnviroScienceInc.com

ES Project No: 13485

Date: April 22, 2020

TABLE OF CONTENTS

LIST OF ATTACHMENTS

INTRODUCTION

EnviroScience, Inc. (ES) is pleased to submit a study plan for an acoustic bat presence/absence survey for the Candlewood Solar LLC, Candlewood Solar Project (project).

The project is a large-scale photovoltaic solar array installation and associated electric interconnection, and access road located between Candlewood Mountain Road and Kent Road in New Milford, Litchfield County, Connecticut (41.572828°, -73.451785°) (subject site). The subject site is approximately 163.5 acres in total size and includes an approximately 63.5 acre solar array area, approximately 1,240lf of electric interconnect corridor, and approximately 3000lf of access roads (see Attachment 1, Figure 1. USGS Site Location Map and Figure 2. Overall Site Plan Aerial). The site spans north-south on the southern reach of Candlewood Mountain and consists of a flattened hilltop at the site center of sloping hillsides. The site is predominately forested with several small cleared hay fields/horse pastures (approximately 15.9 acres) in the southern portion.

In order to construct the solar array, a total of 49.41 forested acres will need to be cleared. Within the subject site, the electric interconnect will be installed via Ground Mount. As noted in Wood's February 7, 2020 Revised Review Request, the ground mount segment will be hand laid, conduit encased circuit, secured with raised above grade by structures. As this segment of the electric interconnection corridor will be hand laid, selected clearing will performed, approximately 10 – 15 feet on either side of the conduit, minimizing soil disturbance and the width and amount of clearing required (approximately 0.8 acre). Tree clearing is proposed to begin in early May 2020 and take approximately one month to complete. The project does not have a federal nexus and is not subject to Section 7 coordination with the United States Fish and Wildlife Service (USFWS). However, because the project clearing involves impact to suitable summer habitat for several bat species, the Connecticut Department of Energy and Environmental Protection (CT DEEP) has requested acoustic survey of bats utilizing the site, prior to tree clearing activities.

The methods and requirements found in the *USFWS Rangewide Indiana Bat Survey Guidelines* (March 2020) provide a standardized and tested protocol for bat presence/absence survey. This guidance was created for Indiana bat, but the survey process facilitates recording and identification of all bat species utilizing the survey site. ES proposes to use the USFWS 2020 protocol for the Candlewood Solar Survey.

The following plan includes a detailed description of the survey effort and methodology, data analysis, and final survey report.

ACOUSTIC SURVEY

SURVEY EFFORT

According to the USFWS protocol, the appropriate level of survey for non-linear sites in the USFWS Northeast Recovery Unit, which contain 123 acres (0.5 km^2) or less of suitable summer habitat is 8 detector nights. A detector night is defined as one detector in one location, surveyed for one night. The project impact area is approximately 63.5 acres, with approximately 49.41 acres of forest. According to the USFWS parameters, ES proposes 8 detector nights. This will be

accomplished by placing 4 detectors at 4 separate survey locations throughout the site and recording at each location for 2 nights (4 detectors x 2 nights = 8 detector nights).

DETECTOR PLACEMENT

ES will use four Titley Scientific AnaBat SM2 zero-crossing (ZC) detectors with directional microphone for the survey. Acoustic detectors will be placed in the flight path/zone of foraging/traveling bats, to maximize the number of high-quality call pulses recorded. Locations that are recommended to be suitable sites for detectors/microphones, include, but are not limited to: (a) forest-canopy openings; (b) near water sources; (c) wooded fence lines that are adjacent to large openings or connect two larger blocks of suitable habitat; (d) blocks of recently logged forest where some potential roost trees remain; (e) road and/or stream corridors with open tree canopies or canopy height of more than 33 feet (10 meters); and (f) woodland edges. Acoustic sites will be at least 656 feet (200 meters) apart. Additionally, microphones will be deployed: (a) at least 10 feet (3 meters) in any direction from vegetation or other obstructions; (b) parallel to woodland edges; (c) at least 49 feet (15 meters) from suitable roosts; and/or (d) with a directional microphone straight up in smaller forest openings. Detectors will be mounted using a tripod, pole, or appropriate natural vegetation.

The decision to weatherproof detectors will be determined nightly based on the likelihood of precipitation in the survey area. If necessary, detectors will be placed in after-market weatherproof containers with a polyvinyl chloride (PVC) tube that forms a 45-degree elbow the same diameter as the microphone.

Once acoustic sites are identified and set, GPS location will be collected using Trimble GeoXT GPS units, and photographs documenting the orientation, detection zone, and relative position of the microphone will be taken. All equipment will be tested to ensure proper working during set-up in the field. All recording files will be named by detector location and night surveyed (e.g. Detector Site 1_Night 2).

The acoustic sampling period will begin at sunset and end at sunrise each night of sampling. The detectors will be downloaded, checked for call log and reset or removed following each night of survey.

Proposed Detector Locations

Initial analysis of current aerial photographs to determine locations that meet the USFWS suitable detector site recommendations have led to the following four detector sites (see Attachment B, Detector Location Plan). These locations are initial, and selection of the final detector locations will be made in the field, based on the most conducive sites at landscape level.

Detector Site 1- (approximately 41.570608°, -73.451918°). Detector Site 1 will be placed at the south west portion of the site, where the proposed access road from Candlewood Mountain Road meets an open field onsite. This detector will be placed so that the zone of recording includes bats traveling up the small cleared path and along the forested edges of the field.

Detector Site 2- (approximately 41.572700°, -73.450349°). Detector Site 2 will be placed along the eastern boundary of the site, at the corner open field onsite. This detector will be placed so that the zone of recording includes bats traveling up the wetland corridor just off the eastern

boundary of the site and along the forested edges of the field.

Detector Site 3- (approximately 41.577796°, -73.452537°). Detector Site 3 will be placed along the northern boundary of the site, adjacent to trench that begins the wetland just off the eastern boundary of the site. This detector will be placed vertically and elevated, so that the zone of recording includes bats traveling to the wetland corridor just off the eastern boundary of the site. Because this area is densely forested, placement of Detector 3 will be determined in the field, based on an area that provides the objective of recording and has minimal vegetative interference.

Detector Site 4- (approximately 41.574060°, -73.455637°). Detector Site 4 will be placed along the western boundary of the site, where small open areas and ponds lead to the site slope from Candlewood Mountain Road. This detector will be placed so that the zone of recording includes bats traveling up or down slope from Candlewood Mountain Road.

Weather Requirements

According to USFWS guidance, acoustic surveys are only effective if conducted under certain weather conditions. ES will only conduct survey on nights where temperatures do not fall below 50°F (10°C) during the first 5 hours of survey period, there is little to no precipitation, including rain and/or fog, that exceeds 30 minutes or continues intermittently during the first 5 hours of the survey period, and sustained wind speeds are not greater than 9 miles/hour (4 meters/second; 3 on Beaufort scale) for 30 minutes during the first 5 hours of the survey period. At a minimum, nightly weather conditions for survey sites will be checked using the nearest NOAA National Weather Service station and summarized in the survey reports.

Data Analysis

ES will conduct automated acoustic analysis for each detector recording file (each detector site, each night) using the USFWS approved bat call identification software Kaleidoscope Pro. Each file will be cleaned and processed individually to indicate which bat species are utilizing the site. In cases where the software identifies a potential listed bat call, the individual call will be qualitatively vetted by Mary Gilmore.

Survey Personnel

The following table details ES staff that are scheduled to work on this project. The project will be managed and coordinated by Jamie Willaman. Field detector placement will be performed by Sean Kline and support biologist staff. Mary Gilmore (Federal Permit # TE62311A-4) will conduct all call analysis, both quantitative and qualitative, assisted if necessary, by Daniel Cox (Federal Permit # TE43605A-2). The final report will be a collaboration.

Key Personnel	Project Role
Jamie Willaman	Project Manager, Agency Coordination
Mary Gilmore	Quantitative and Qualitative Data Analysis
Dan Cox	Qualitative Data Analysis Assistance
Sean Kline	Field Survey Leader

ACOUSTIC SURVEY REPORT

Results of the acoustic survey and data analysis will be provided in a comprehensive Listed Species Survey Report, following the requirements of the USFWS.

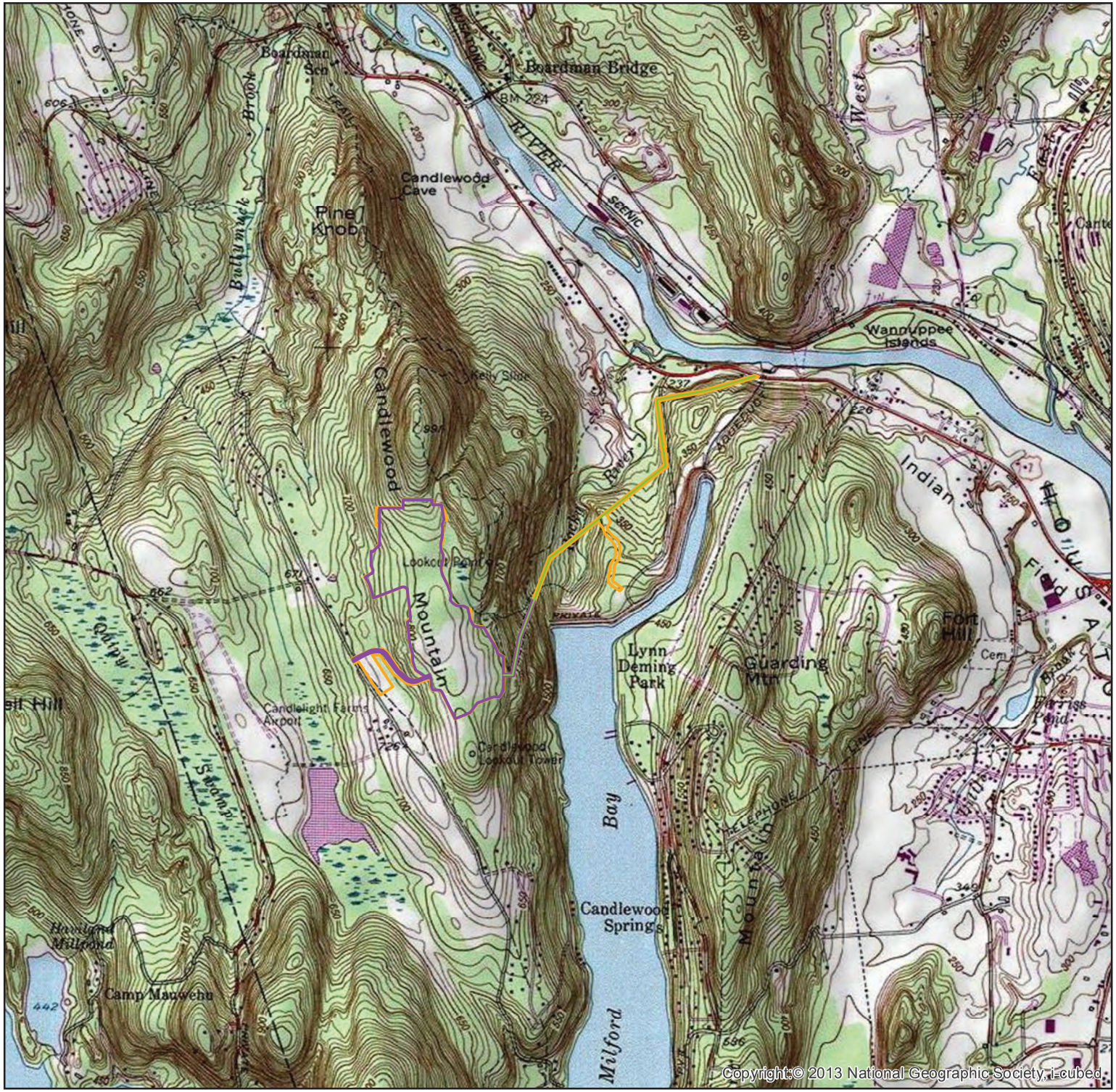
This report will include:

- All methodologies and protocols used for survey.
- Names of ES staff conducting acoustic surveys, including those that selected acoustic sites, those that deployed detectors, those that conducted the quantitative and qualitative acoustic analyses.
- A description of acoustic monitoring sites, GPS coordinates for each detector, survey dates and hours, duration of survey, and weather conditions.
- Mapping identifying acoustic detector locations with arrows showing directions of microphones.
- Description of all equipment used in the field including the acoustic detector, microphone, use of weatherproofing, acoustic monitoring equipment settings (e.g., sensitivity, audio division ratios), deployment data (i.e., deployment site, habitat, date, time started, time stopped, orientation), and a description of how proper functioning of bat detectors was verified.
- Photographs documenting the location of each detector, the orientation of the detector, and the intended sampling area.
- Discussion of what software program was used including software settings and file names.
- Acoustic analysis software program results by site, by night including the number of calls detected, species composition, MLE results, and settings files.
- If manual vetting is used, a discussion of how this was done, a detailed analysis and results of any qualitative acoustic analysis conducted, justification for rejecting any program MLE results including a table with each species ID from the program, suggested species ID from manual vetting, and rationale for any changes.

Attachment A.

Figure 1. USGS Site Location Map and

Figure 2. Overall Site Plan Aerial



SITE LOCATION MAP

Candlewood Solar LLC

Candlewood Solar Project
New Milford, Connecticut

Legend

- 2020 Project Area
- Acoustic Monitoring Survey Area
- Interconnect

Location of Site

Notes & Sources

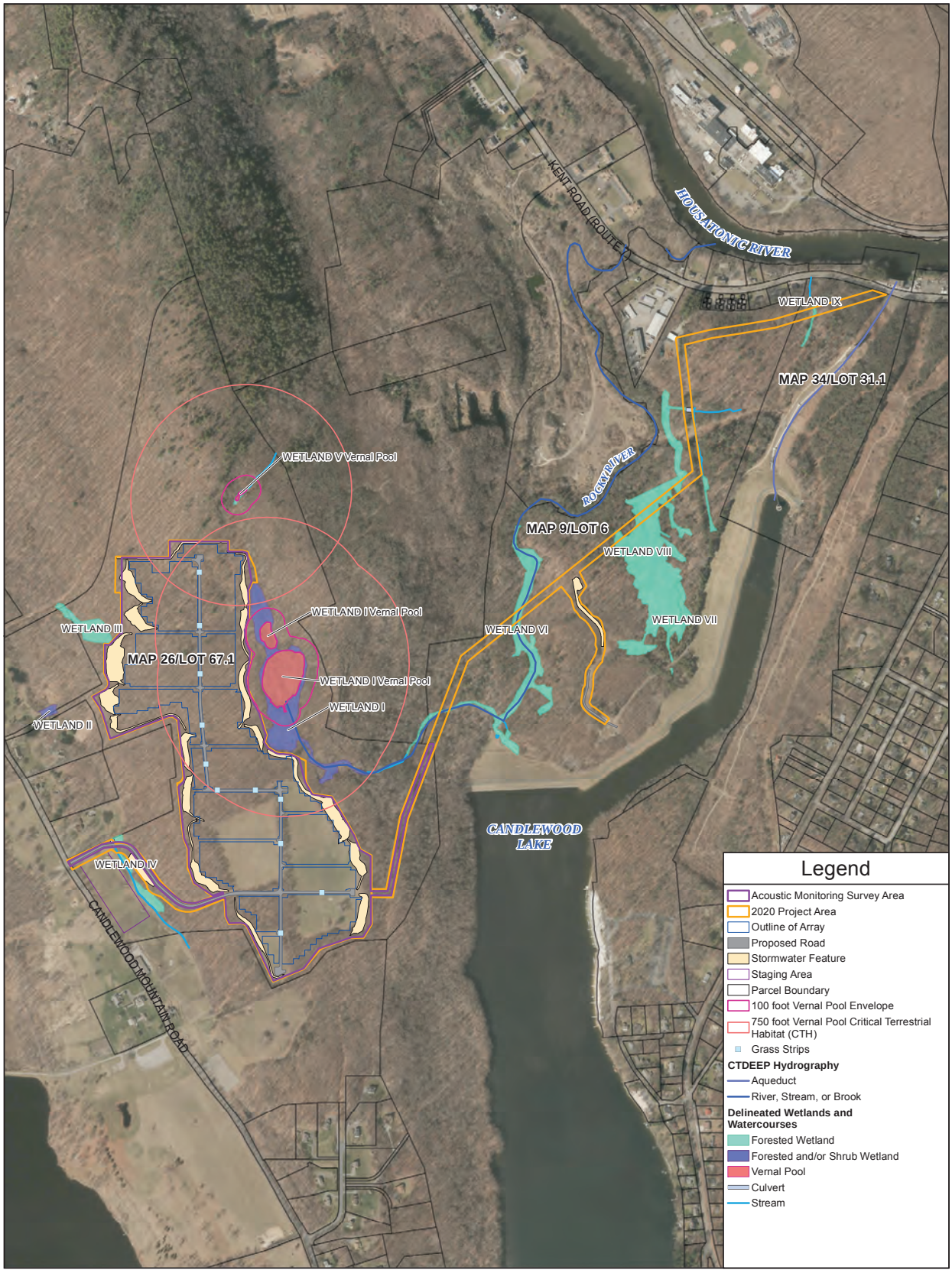
0 2,000 Feet

N

wood.
Wood Environment & Infrastructure Solutions, Inc.
271 Mill Road
Chelmsford, MA 01824
(978) 692-9090

FIGURE 1

H:\Ameresco\NewMildford_CT\Task4\MXD\Fig1_SiteLocus.mxd April 22, 2020 DWN: ilana.ton CHKD: AKN



Location of Site

OVERALL SITE PLAN

Candlewood Solar LLC

Candlewood Solar Project
New Milford, Connecticut

Notes & Sources

Basemap Source: 2016 Connecticut Orthophotography created by the University of Connecticut - Connecticut Environmental Conditions Online (UCONN CTECO), distributed by ArcGIS Online.
Datalayer Sources: Parcel Boundary from CTDEEP GIS website. Areas with Slopes ≥ 35% datalayer derived from the CTECO 2016 DEM.

0 340 680 Feet

N

wood.
Wood Environment & Infrastructure Solutions, Inc.
271 Mill Road
Chelmsford, MA
Phone: (978) 692-9090

FIGURE
2

Document Path: H:\Ameresco\NewMildford_CT\Task4\MXD\Fig2_OverallSitePlan.mxd

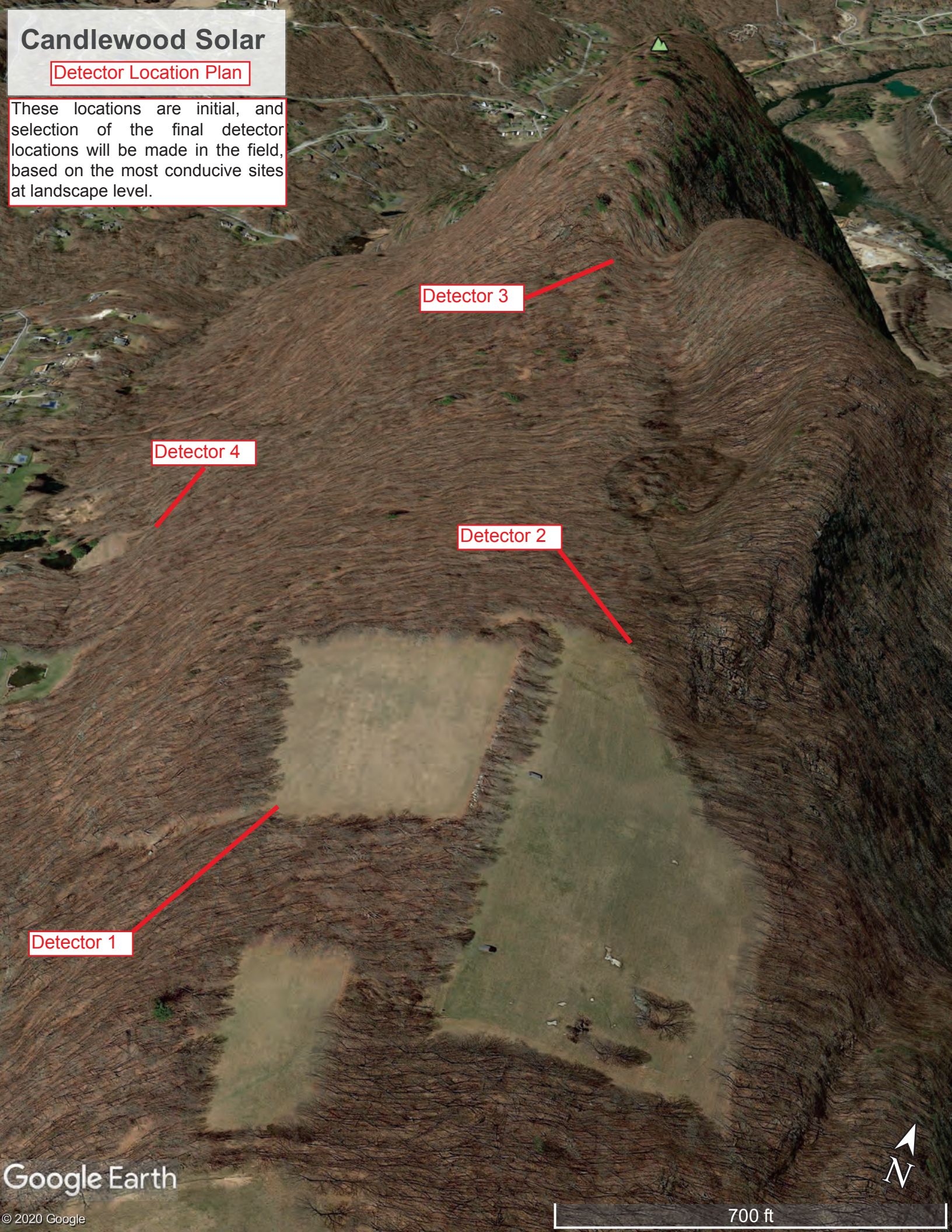
Attachment B.

Detector Location Plan

Candlewood Solar

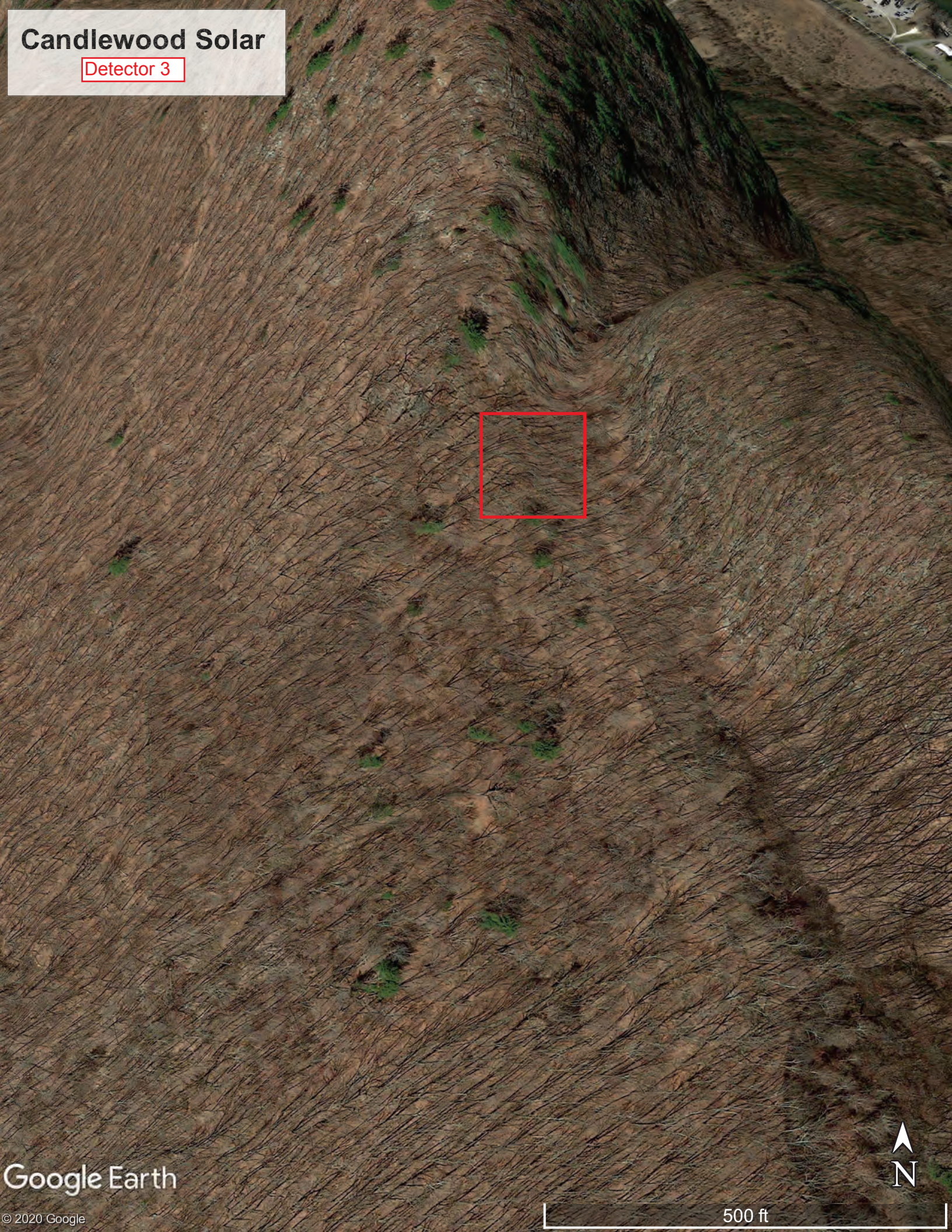
Detector Location Plan

These locations are initial, and selection of the final detector locations will be made in the field, based on the most conducive sites at landscape level.




Candlewood Solar
Detector 1
N
500 ft
Google Earth


Candlewood Solar
Detector 2
Google Earth
© 2020 Google
N
500 ft


Candlewood Solar
Detector 3
Google Earth
© 2020 Google
N
500 ft


Candlewood Solar
Detector 4
Google Earth
© 2020 Google
N
1000 ft

Attachment 4

KT Wildlife Resumes

Kathy Michell
KT Wildlife, LLC
Wildlife Biologist Resume
Timber Rattlesnake, Herpetological, Bald Eagle and Migratory Bird Experience

PERSONAL: Kathy Michell (Kathleen Joan Michell)
42 School St, Narrowsburg, NY 12764
Home Phone: 845-252-3501, Cell Phone:845-807-7485
e-mail: kathy.ktw@gmail.com
or kathy@nyturtlecenter.org

EDUCATION: Lebanon Valley College, Annville, PA
B. S. in Biology, minor in Chemistry

PROFESSIONAL EXPERIENCE:
Conducted numerous timber rattlesnake surveys for denning and gestating habitat in NY, NJ and PA as a qualified timber rattlesnake biologist. Studies include those for private development, public utilities, timber companies, and government agencies. Conducted several large scale timber rattlesnake telemetry studies resulting in the preservation of several thousand acres of land which were proposed for development and re-routing of windfarm roads and turbine pads. Developed techniques for protecting timber rattlesnakes and their critical habitat while linear utility work was conducted in close proximity to snakes and dens.

Conducted pre-construction surveys and construction monitoring for herpetofauna, primarily timber rattlesnakes, bog turtles, Blanding's turtles, and wood turtles, on natural gas pipelines, transmission lines, and windfarm projects including, Tennessee Gas 300 Line, KinderMorgan Northeast Upgrade, Spectra Energy NY-NJ Expansion Project, Spectra Energy AIM, Texas Eastern TEAM 2014, Algonquin emergency repair work in NY and NJ, BP Wind Energy Noxen Windfarm, Spectra Energy ANE project, Columbia Gas Pipeline, Millennium Pipeline, Central Hudson, Orange and Rockland, Con Ed, and Cricket Valley Energy.

Conduct for timber rattlesnake critical habitat, dens and gestation sites, for natural gas and oil pipeline projects, and other energy projects including Tennessee Gas, Spectra Energy, Pilgrim Pipeline, BP Wind Energy, Millennium Pipeline, and New York Power Authority Pump-Storage reservoirs.

2016 - Bald eagle winter roosting and nest surveys on the Connecticut, Housatonic and Naugatuck Rivers for the proposed natural gas pipeline crossings for Spectra Energy ANE.

2016-2018 - Bald eagle and nest surveys of the Neversink River in NY for proposed Millennium Pipeline ESU project. Monitored nest activity during the construction phase. The three new nests located were undisturbed by activity.

2015 – Coordinated and conducted timber rattlesnake den, basking and gestation surveys through 8 miles of NJ for proposed Pilgrim Pipeline, through EcolSciences. Responsible for all mapping and reporting.

2015 – Conducted rattlesnake monitoring activities for Spectra Energy AIM pipeline project in NY and CT.

2015 – Conducted timber rattlesnake assessments in Delaware Co., NY for timber harvest company.

2015 – Conducted Blanding's turtle monitoring in Dutchess County, NY for Central Hudson pole upgrade.

2015- Conducted timber rattlesnake and general ecological surveys for quarry expansions in Dutchess County, NY, including preparation of mitigation plans.

2015 – Responsible for timber rattlesnake impact analysis, mitigation plan and incidental take permit application for development project in Rockland County, NY

2015 – Herpetological and general ecological surveys for Watchtower in Orange County, NY through AKRF

2014 – Timber rattlesnake construction monitoring for Texas Eastern TEAM 2014 pipeline, Perry County, PA

2014 – Timber rattlesnake emergence and gestating surveys for proposed re-development project in Town of Tuxedo, Orange County, NY.

2014 - Timber rattlesnake habitat surveys for proposed land re-development project in Town of Wawarsing, Ulster County, NY.

2014 – Bald eagle winter roosting and nest surveys on Hudson River for proposed natural gas pipeline crossing project for Spectra Energy

2014 – Present -Timber rattlesnake surveys with NYSDEC on post construction (2008) pipeline site. Identified two previously unknown den locations and assessed the pipeline impacts to them. 2018 – constructed 600 feet of enhanced habitat at the site in association with a natural gas compressor station project.

2013 – Monitor and supervise monitors during emergency repair work conducted on a 1950s pipeline and electric cable replacement through critical rattlesnake habitat in Bergen County, NJ. Worked cooperatively with contractor and Spectra Energy to ensure that no rattlesnakes or denning locations were harmed during the construction. An excavated pipeline den location was successfully restored to its original condition.

2013 – Monitor construction of natural gas pipeline (Tennessee Gas Pipeline) in PA and NJ for reptiles and amphibians. Conducted wetland surveys for NJ State threatened blue spotted salamanders and supervised installation of exclusion fencing with one-way amphibian funnels prior to construction in the area.

2012, 2017 - Identified timber rattlesnake habitat for Town of Amenia, NY to protect area from proposed quarrying operation. Located previously unknown timber rattlesnake den in 2017 and new bog turtle site in the vicinity of the proposed project.

2012 – Performed timber rattlesnake habitat and presence/absence assessments for New York Power Authority and Kleinschmidt Associates at the Blenheim Gilboa pump storage facility.

2012 – Timber rattlesnake occurrence assessments in Town of Warwick and Town of Tuxedo for Watchtower Bible and Tract Society, and Town of Ramapo for Spectra Energy.

2012 – Coordinated and supervised snake monitoring at large scale wind farm (88 turbines) construction on mountain range in Pennsylvania with high density rattlesnake populations. Assisted Tom Michell in developing new monitoring techniques to locate and protect more snakes than traditional methods.

2012 – Conducted rattlesnake emergence surveys for dens for PSE&G in Picatinny Arsenal and Split Rock Reservoir, NJ.

2012 - Conducted emergence surveys for dens and gestation surveys for Picatinny SAFER project, a proposed underground ordnance testing facility.

2012 - Conducted additional emergence/den surveys and telemetry studies for Tennessee Gas Pipeline and Spectra Energy in northern NJ for the proposed metering station replacement. Located one new den. Confirmed opportunistic denning in 1950s pipeline corridor. Assisted Tom Michell in developing time lapse camera technique used in emergence studies and to confirm or negate potential hibernacula.

2012 – Timber rattlesnake monitoring for the Tennessee Gas 300 Line construction in Pike County, PA. Monitoring activities include moving snakes, turtles and amphibians out of harm's way, protecting gestation areas with

numbers of females present, and collecting data in accordance with state permitting requirements. In 2012 and 2013 supervised construction, restoration and enhancement of timber rattlesnake habitat in vicinity of known dens and gestating areas on several loops of pipeline.

2011- Timber rattlesnake monitoring for the Tennessee Gas 300 Line construction in West Milford, NJ and Pike County, PA. Lead monitor. Duties include moving snakes, turtles and amphibians out of harm's way, collecting data in accordance with each state's permitting requirements, and coordinating monitors.

2011- Conducted presence-absence den surveys for Mehoopany Wind Farm, Wyoming County, PA., including external telemetry on gravid and post partum females to locate dens to protect them from road, turbine, and power line construction. Responsible for changes to roads and turbine sites to avoid rattlesnake dens and gestation areas.

2011- Conducted emergence/den surveys for two loops of the Tennessee Gas Pipeline in northern NJ and proposed metering station upgrade for Spectra Energy. Rattlesnakes were confirmed denning in a nearby pipeline corridor. Coordinated with project engineers to avoid and protect den locations during construction. On-going research at this site will help develop methods for protecting timber rattlesnakes during future utility construction projects.

2011- Used time-lapse photography to record emergence at a timber rattlesnakes den. Slimy salamander emergence was also captured by camera contributing to research on their behavior. (Tom Michell was primary researcher).

2010 – Conducted field surveys to confirm or negate unsubstantiated timber rattlesnake den reports for New Jersey Endangered and Nongame Species Program under contract with NJ.

2009-2010 - Prepared Scope of Work and conducted timber rattlesnake telemetry study near a former R&D site in Orange Co., NY, Sterling Forest, NY and Ringwood Park in NJ. The purpose of the study was to identify critical habitats and any previously unknown dens in the area as well as to identify habitat use along the NY/NJ border. Previously unknown dens were identified in NY and NJ.

2009- Conducted timber rattlesnake habitat and occurrence assessments and surveys for proposed development, in Shohola Twp, Pike Co. PA.

2008 – Prepared description of surgical implantation of snakes for Pennsylvania Fish and Boat Commission, trained PFBC personnel on surgical implantation procedure and in field on use of radio telemetry.

2007-2008 – Prepared Scope of Work and conducted timber rattlesnake study in Dutchess County, NY. The study involved the tracking of 24 rattlesnakes using both internal and external transmitters resulted in the location of three previously unknown dens and refining the locations of two other known sites. As a result of this study the property became a 1500 acre wildlife preserve instead of the proposed development.

2006 – Prepared Scope of Work and conducted timber rattlesnake study in 2006 for Pierson Properties in Rockland Co., NY. This study involved radiotracking rattlesnakes from five dens located by surveys in 2005 to determine habitat use for a proposed land alteration project. Critical habitat areas and areas of genetic interchange were identified and protected by the regulatory agencies.

1999 to 2010 – Bald eagle monitoring for New York State DEC at Mongaup Falls Wildlife Management Unit, a 15,000 acre overwintering eagle sanctuary and the Delaware River System. Responsibilities included nest monitoring, trapping eagles for telemetry studies, radio tracking, daily observations of eagle activity and numbers, locating new nests in the system, investigating reports and recovering injured eagles.

1999-present- Continued volunteer work with eagles includes capture of sick or injured eagles, assisting with their care, coordinating releases, maintaining soft release sites and some post release tracking.

1994 to present – Performed over 300 transmitter implantation and removal surgeries on timber rattlesnakes for studies conducted by various agencies in addition to our studies, including the states of NY, NJ, PA,VT, NH, West Point Military Academy, several universities and environmental consulting companies. External transmitters have been attached to snakes in numerous studies utilizing a method which I developed in 1998 which is included in the USFWS Timber Rattlesnake Conservation Action Plan.

2004 to 2005 – Conduct Timber rattlesnake studies as a subcontractor for LMS/HDR Engineers for proposed Rockland County development. Duties included surveying dens, potential basking and gestating areas, capturing and performing surgical implantation of snakes, radio tracking, attaching external transmitters. Located five previously unknown dens in NY and NJ during this study, as noted above.

Spring 2005 – Conduct bog turtle surveys for New York State DEC of three known bog turtle sites for population size estimates. Captured and marked bog turtles.

2002 to 2004 – Contract herpetologist for LMS Engineers for three-year timber rattlesnake study in Sterling Forest for proposed development and golf course;

surveying dens, potential basking and gestating areas, capturing and performing surgical implantation and attaching external transmitters to rattlesnakes. Located one previously unknown den during this study.

Spring 2000 – Fall 2001 – Bog turtle and wood turtle surveys in the Delaware Water Gap National Recreation Area (DWGNRA) for joint project of the Wildlife Conservation Society and National Park Service. Surveying potential habitat, capturing and marking animals. Amphibian surveys were also conducted during this survey work for the New Jersey Herp Atlas Project. Located several species of salamanders that were not previously documented in the DWGNRA. Location data was submitted on NJ Herp Atlas cards for all reptiles and amphibians located during surveys.

2001 – Timber rattlesnake den and basking surveys and nuisance handling training were conducted at the Blenham Gilboa Power Authority, Schoharie County, NY. Spring salamander surveys with mitigation measures conducted for reservoir re-construction project.

2000 to present – implant PIT tags subcutaneously in timber rattlesnakes when required for various studies using sterile technique.

Sept-Oct 2000 – Timber rattlesnake monitor for American Tower Corporation during cell tower construction.

1998 to 2000 – Consulting field herpetologist for New York State Department of Environmental Conservation Natural Heritage Program conducting known and probable timber rattlesnake den surveys. Located three previously unknown dens in Orange Co. and two in Ulster Co., NY. Conduct bog turtle surveys of historic bog turtle sites.

1998 to 2000 – New York State Herp Atlas surveys conducted through Cornell University. Surveys conducted in Sullivan, Orange and Delaware Counties. Hundreds of amphibian locations (mostly salamander) were reported as one of the top 20 contributors to the Atlas Project.

1994 to 1996 – Timber rattlesnake radio-telemetry studies of snakes from three dens at West Point Military Academy. Performed the surgeries and assisted radio tracking snakes.

OTHER PROFESSIONAL EXPERIENCE:

1970-1976 – Environmental Health Inspector, Sussex County Health Department. Air and water quality inspection, well, sewage disposal systems, housing, food service, campgrounds, and infectious disease investigation.
1989-2003 – Coordinator and Instructor of Sullivan County Community College Emergency Medical Technician Program. Responsible for all aspects of

coordinating and training of EMTs and EMS faculty, corresponding with the regional and state agencies, setting up clinical training, specialty programs and testing arrangements.

2004-2012 – Town Clerk for Town of Tusten. Performed all duties of the elected town clerk position as outlined in General Municipal Law.

2017-present – Chairperson of Town of Tusten Zoning re-write committee (volunteer). Responsible for focusing the committee on changing needs of the town including updates on regulations for new technology such as solar farms. Work with land use attorney and consultant.

HERPETOLOGICAL RESEARCH

1995 to present – Numerous presentations on past and current research on timber rattlesnakes and wood turtles at conferences including the Northeast Natural History Conference (NENHC), Northeast Partners for Amphibian and Reptile Conservation (NEPARC), Eastern Box Turtle Conservation, Society for the Study of Amphibians and Reptiles, and national, international and state wildlife rehabilitation conferences.

The following timber rattlesnake research papers are in progress:

2014 – Identifying and Managing Impacts of Natural Gas Pipelines on Timber Rattlesnakes in the Northeast (NENHC)
2013 – Colonization of Natural Gas Pipeline Corridors by Overwintering Timber Rattlesnakes (NENHC)
2013 – Time Lapse Camera Study of an Undisturbed Timber Rattlesnake Den in the Northeast (NENHC) (NEPARC)
2011- Movements of Timber Rattlesnakes in Metapopulations Divided by Major Highways (NENHC)

Published papers:

Jeffrey M. Lorch, Susan Knowles, Julia S. Lankton, Kathy Michell, Jaime L. Edwards, Joshua M.Kapfer, Richard A. Staffen, Erik R. Wild, Katie Z. Schmidt, Anne E. Ballmann, Doug Blodgett, Terence M. Farrell, Brad M. Glorioso, Lisa A. Last, Steven J. Price, Krysten L. Schuler, Christopher E. Smith, James F. X. Wellehan, David S. Blehert. Snake Fungal Disease: An Emerging Threat to Wild Snakes. Phil. Trans. R. Soc. B 2016 371 20150457; DOI: 10.1098/rstb.2015.0457. Published 24 October 2016

Michell, Kathy. 2009. Rehabilitation of Venomous Snakes in Scott, Lynnette E., ed. 2009. *Wildlife Rehabilitation*, vol 26. National Wildlife Rehabilitators Association: St. Cloud, MN. 158 pages.

Michell, K. and R.G. Michell (2015) Use of Radio-Telemetry and Recapture to Determine the Success of Headstarted Wood Turtles in New York. Herpetological Conservation and Biology.

Long Term Wood Turtle Research, 1994 to present:

Michell, K. and R.G. Michell. 1999. Translocation, rehabilitation and headstarting of wood turtles *Clemmys insculpta* in New York State. Abstracts of the 1999 SSAR joint meeting at Penn State.

VOLUNTEER ACTIVITIES:

1997 to present – Member and contributing author of U.S. Fish & Wildlife Service Timber Rattlesnake Conservation Action Plan.

1993 to present – Submitted volunteer observations and data on Timber Rattlesnakes for NYS DEC and NYS Natural Heritage database. Volunteer work includes capture, implantation and telemetry for the purpose of locating previously unknown dens.

1993 to present – Nuisance timber rattlesnake responder for NYSDEC.

1993 to present – Licensed NYS Wildlife Rehabilitator specializing in reptiles, including venomous snakes. Currently the only NY wildlife rehabilitator working with timber rattlesnakes.

2004 to present- Founded and operated the New York Center for Turtle Rehabilitation and Conservation, Inc. President. (website: nyturtlecenter.org)

2006 – present – NJ Licensed Wildlife Rehabilitator for turtle and snake species including Endangered and Threatened species.

2004 to 2012 – Volunteer with New Jersey Endangered and Threatened Species Program.

2006 to 2011 – Research Partner with the State of New Jersey Endangered and Nongame Species Program.

2014 – Volunteer timber rattlesnake consultant for Kittatinny Mountain Raptor Research Association (non-profit) in Stokes State Forest to help resolve conflicts with banding sites and rattlesnake gestation sites.

Have presented reptile and amphibian programs for the general public at numerous nature centers and other public locations for over 25 years.

Thomas Michell
Herpetological Experience

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EXPERIENCE:

2018– Timber Rattlesnake construction monitoring for existing Trans Canada natural gas pipeline anomaly investigations and repairs. Orange County, NY.

2018– Wood Turtle construction monitoring for existing Enbridge Inc. natural gas pipeline anomaly investigation and repair. Tolland County, CT.

2018– Venomous snake construction monitoring for PSE&G electrical transmission line tower footing repairs. Passaic County, NJ.

2018– Timber Rattlesnake/venomous snake construction monitoring for Enbridge Inc. existing natural gas pipeline anomaly investigation and repairs. Rockland County, NY and Passaic County, NJ.

2018– Timber Rattlesnake construction monitoring for Millennium Pipeline/Enbridge Inc. natural gas metering and regulation facility construction. Rockland County, NY.

2018– Timber Rattlesnake construction monitoring for Orange and Rockland Utilities electrical substation work and powerline replacement. Orange County, NY.

2018– Supervised Timber Rattlesnake exclusion fencing installation for +/-50 acre new residential housing development. Monitored concurrent land clearing until fence was complete and functional. Rockland County, NY.

2018– Construction monitoring for Timber Rattlesnakes, Bog Turtles, and Blandings Turtles for Cricket Valley Energy new electric transmission line construction. Dutchess County, NY.

2018– Bog Turtle construction monitoring for new Millennium Pipeline natural gas right of way construction. Orange County, NY.

2017– Volunteer Bog Turtle surveys for NYSDEC in Dutchess County, NY. Located previously unknown site.

2017 – Blanding's Turtle and Timber Rattlesnake monitoring for pre-construction disturbances of new powerline Right Of Way preparation. Dutchess County, NY.

2017 – Timber Rattlesnake habitat assessment and presence-absence surveys for Town of Amenia, Dutchess County, NY. Located previously unknown den.

2017 – Timber Rattlesnake construction monitoring for Texas Eastern natural gas pipeline repairs, Bergen County, NJ and Perry County, PA.

2017 – Conducted Timber Rattlesnake early basking surveys for interstate 80 rockfall prevention project in Delaware Water Gap, Warren County, NJ.

2016 – Conducted habitat assessment and presence-absence surveys for proposed Bluestone quarry in Delaware County, NY. Critical habitat determination and mapping as well as mitigation/avoidance planning.

2016 – Conducted habitat assessment and presence-absence surveys for proposed Millennium Pipeline natural gas pipeline and compressor station expansion project in Delaware, Sullivan, Orange and Rockland Counties, NY. Critical habitat determination and mapping as well as mitigation/avoidance planning.

2016 – Conducted habitat assessment and presence-absence surveys for proposed Spectra Energy natural gas pipeline take up and relay and station expansion in Rockland County, NY. Critical habitat determination and mapping as well as mitigation/avoidance planning.

2016 – Conducted habitat assessment surveys for timberland property in Delaware County, NY.

2016 – Assisted archaeological crews conducting cultural resource surveys in known timber rattlesnake habitats in Hartford County, CT and Bergen County NJ. Identified and directed crews to avoid critical habitats and searched work areas for rattlesnakes and copperheads. Snakes which could not be avoided were moved a short distance in accordance with permits.

2016 – Conducted habitat assessment and presence-absence surveys for proposed Spectra Energy natural gas pipeline in Hartford County, CT. Critical habitat determination and mapping as well as mitigation/avoidance planning.

2016 – Conducted habitat assessment and presence-absence surveys for interstate 80 rockfall prevention project in Delaware Water Gap, Warren County, NJ. Critical habitat determination and mapping as well as mitigation/avoidance planning.

2016 – Construction monitoring for Spectra Energy AIM gas pipeline in Rockland County, NY. Duties include searching ROW workspace areas ahead of clearing and grading crews and moving rattlesnakes and other wildlife out of harms way. Once ROW

is cleared and graded, work areas, spoil piles, debris and equipment are searched regularly for rattlesnakes and snakes are captured and relocated to an appropriate area a short distance away. Data was collected in accordance with NY DEC permit requirements.

2016 – Conducted habitat assessment and presence-absence surveys for alternate route of proposed new Pilgrim oil pipeline in Bergen and Passaic Counties, NJ. Critical habitat determination and mapping as well as mitigation/avoidance planning.

2016 – Construction monitoring for Con Ed powerline restoration in Orange County, NY. Duties include searching ROW workspace areas ahead of clearing and grading crews and moving rattlesnakes and other wildlife out of harms way.

2015 – Construction monitoring for Ford paint sludge cleanup in documented rattlesnake habitat in Rockland County, NY. Duties include supervising installation of snake exclusion fencing being installed concurrent to land clearing. Areas to be cleared were searched and rattlesnakes and other wildlife moved out of harms way. All work areas were searched daily until snake exclusion fence was complete. Data was collected in accordance with NY DEC permit requirements.

2015 – Construction monitoring for Spectra Energy AIM gas pipeline in Rockland County, NY. Duties include searching ROW workspace areas ahead of clearing and grading crews and moving rattlesnakes and other wildlife out of harms way. Once ROW is cleared and graded, work areas, spoil piles, debris and equipment are searched regularly for rattlesnakes and snakes are captured and relocated to an appropriate area a short distance away. Data was collected in accordance with NY DEC permit requirements.

2015 – Conducted Blanding's turtle monitoring in Dutchess County, NY for Central Hudson pole upgrade.

2015 – Conducted habitat assessment and presence-absence surveys for large timberland properties in Delaware County, NY.

2015 – Conducted habitat assessment and presence-absence surveys for proposed new Pilgrim oil pipeline in Bergen and Passaic Counties, NJ. Critical habitat determination and mapping as well as mitigation/avoidance planning.

2014 – Conducted habitat assessment and presence-absence surveys for proposed new Spectra Energy AIM gas pipeline in Rockland County, NY.

2014 – Conducted habitat assessments for 2 proposed new casinos in NY. One of which required presence-absence surveys of den, gestation and basking habitats and mitigation planning.

2014 – Conducted habitat assessment for proposed quarry expansion in Dutchess County, NY.

2014 – Construction monitoring for new Spectra Energy TEAM 2014 gas pipeline in Perry County, PA. Duties include searching ROW workspace areas ahead of clearing and grading crews and moving rattlesnakes and other wildlife out of harms way. Once ROW is cleared and graded, work areas, spoil piles, debris and equipment are searched regularly for rattlesnakes and snakes are captured and relocated to an appropriate area a short distance away. Data was collected in accordance with PA Fish and Boat Commission permit requirements.

2013- Construction monitoring for new Tennessee Gas NEUP gas pipeline construction in Bergen and Passaic Counties, NJ. Duties include searching ROW workspace areas ahead of clearing and grading crews and moving rattlesnakes and other wildlife out of harms way. Once ROW is cleared and graded, work areas, spoil piles, debris and equipment are searched regularly for rattlesnakes and snakes are captured and relocated to an appropriate area a short distance away. Data was collected in accordance with NJ DEP permit requirements.

2013- Monitoring of repairs on an existing gas pipeline and buried cable in areas where timber rattlesnakes were known to den in Bergen County, NJ. Rocky and other work areas where rattlesnakes could be sheltered were searched for rattlesnakes before work commenced to ensure no snakes were accidentally harmed by the utility work.

2013- Monitoring the restoration of wind farm site in Wyoming County, PA. Site had to be restored including narrowing the roads, removing spoils, grading and planting turbine pads and lay-down areas. Rattlesnakes were extensively using the "edge habitat" of pushed aside rocks, stumps, logs and brush piles that needed to be removed. Areas were searched ahead of work commencing and rattlesnakes captured and removed to appropriate areas a short distance away.

2013- Conducted habitat assessment and presence-absence den and gestation area surveys for Spectra Energy TEAM2014 proposed new pipeline in Dauphin and Perry Counties, PA. Developed plan with Spectra and PA Fish and Boat Commission to minimize impacts to dens found during surveys.

2012- Supervised rattlesnake construction monitoring team of 5 monitors at large scale wind farm (88 turbines, 50 miles of road and power line) construction on mountain range in Wyoming County, Pennsylvania with a high density of rattlesnake dens. Duties include searching workspace areas ahead of clearing and grading crews and moving rattlesnakes and other wildlife out of harms way. Once workspace is cleared and graded, work areas, spoil piles, debris and equipment are searched regularly for rattlesnakes and snakes are captured and relocated to an appropriate area a short distance away. Developed new monitoring techniques to locate and protect more snakes than traditional methods. These efforts have been commended by PA Fish & Boat Commission.

2012- Assisted with timber rattlesnake potential den and gestation habitat presence-absence surveys for PSE&G power transmission line replacement in Sussex County, NJ.

2012- Assisted with timber rattlesnake potential den and gestation habitat presence-absence surveys for US ARMY project at Picatinny Arsenal, NJ.

2012 - Additional emergence/den surveys and telemetry studies for Tennessee Gas Pipeline and Spectra Energy in Bergen County, NJ for the proposed metering station.

2011- Developed techniques for using long term time-lapse photography to observe rattlesnakes emerging from their dens. This can be used to determine numbers of snakes in a den or to confirm or negate a suspected den. Techniques are now used by wildlife agencies and researchers in many states.

2011- Timber rattlesnake construction monitoring for the Tennessee Gas 300 Line Loop 325 construction in Passaic County, NJ and Loop 323 in Pike County, PA. Duties include searching ROW workspace areas ahead of clearing and grading crews and moving rattlesnakes and other wildlife out of harms way. Once ROW is cleared and graded, work areas, spoil piles, debris and equipment are searched regularly for rattlesnakes and snakes are captured and relocated to an appropriate area a short distance away. Data was collected in accordance with each state's permitting requirements.

2011- Conducted presence-absence den and gestation area surveys for proposed largest wind farm in Pennsylvania, BP Wind Energy's Mehoopany Wind Farm, Wyoming County, PA. Assessed habitat from aerial imagery and lidar terrain model and conducted ground searches of proposed limits of disturbance and 300' buffer for 88 turbines and approximately 50 miles of proposed roads and powerlines. Many previously unknown dens and gestation areas were found and we worked with BP to relocate proposed roads and turbines to avoid destroying critical rattlesnake habitat. Mapping and report submitted to PA Fish and Boat Commission.

2011- Conducted emergence/potential den habitat presence absence surveys for two loops of the proposed Tennessee Gas Pipeline in Sussex, Bergen and Passaic counties, NJ and for a proposed metering station and access roads for Spectra Energy in Bergen County, NJ.

2010- Timber rattlesnake construction monitoring for a loop of Tennessee Gas Pipeline construction. Duties include searching ROW workspace areas ahead of clearing and grading crews and moving rattlesnakes and other wildlife out of harms way. Once ROW is cleared and graded, work areas, spoil piles, debris and equipment are searched regularly for rattlesnakes and snakes are captured and relocated to an appropriate area a short distance away. Data was collected in accordance with NJ DEP permit requirements.

2010- Conducted field surveys under contract to New Jersey Endangered and Nongame Species Program to confirm or negate unsubstantiated timber rattlesnake den reports for

ENSP as Research Partners. Conducted potential den area surveys as well as potential gestation area surveys.

2010- Timber rattlesnake habitat assessment for potential den and gestation areas along 2 loops of proposed Tennessee Gas natural gas pipeline in Sussex, Bergen and Passaic counties, NJ. The timing of the habitat assessment was such that presence or absence surveys could be completed for potential gestating habitat the same season. Habitat mapping was conducted and submitted to NJ DEP.

2009 to 2010- Timber rattlesnake habitat assessment, presence absence surveys, and impact study around former industrial site on a large wooded property surrounded by parkland in Orange Co., NY and Sterling Forest State Park, NY and Ringwood State Park in NJ. Performed presence or absence surveys, capturing, assisting with surgical implantation of transmitters, assisting with external transmitter attachment, radio tracking, den population estimate surveys and mapping duties. The purpose of the study was to identify critical habitats and any previously unknown dens near the area proposed for redevelopment as well as to identify habitat use in that area along the NY/NJ border. Rattlesnakes were tracked during this study to determine where they came from and what habitat they used. Results of the study were provided to all interested agencies to allow them to make appropriate land use decisions in the area. Mitigation of the impact to rattlesnakes was required and we worked with the client to come up with mitigation plan. I also was a Research Partner with the State of New Jersey Endangered and Nongame Species Program for this study.

2009- Timber rattlesnake habitat assessment and presence or absence surveys for a proposed 760 acre housing development in Pike County, PA. Duties included identifying potential den, gestating and basking habitat and surveying for snakes in those areas.

2007 to 2008- Timber rattlesnake study of the feasibility of a proposed housing development at a 1000+ acre property which had multiple known rattlesnake dens in Dutchess County, NY. Duties included surveying and classifying habitat, identifying potential den and gestating habitat, surveying for snakes in different habitats at different times of their active season, capturing snakes and radio tracking using both implanted and external transmitters to determine rattlesnake use of the property. Den population surveys were conducted for the known and previously unknown dens found during the study. The results of the radio-telemetry and habitat surveys were mapped and analyzed and submitted to NYS DEC giving them a clear picture of timber rattlesnake use of the property, allowing them to make decisions about future land use.

2007- Conducted Phase 1 timber rattlesnake habitat assessment for proposed Mahamudra Buddhist Hermitage in Ulster County NY. Wrote and submitted report to NYS DEC.

2007- Analyzed data collected during previous Rockland County, NY timber rattlesnake telemetry and observations of other rattlesnakes in the area to determine the impact of the proposed Ramapo Hills development. Created and submitted report and mapping to NYS DEC.

2006 to 2007- Additional timber rattlesnake study for Pierson Properties in Rockland Co., NY. This study incorporated capturing timber rattlesnakes at two NJ dens and three NY dens for radio tracking to determine their habitat use of the proposed project. Four of the five dens were unknown prior to 2004 when we located two of them during potential den assessments working for HDR (see below). The other two and one additional den were located through telemetry. In this study 18 snakes were implanted and tracked and 12 received external transmitters. My duties included searching areas, capturing snakes, assisting with surgical implantation and external attachment of transmitters, releasing snakes, radiotracking and mapping. I was a Research Partner with the State of New Jersey Endangered and Nongame Species Program for this study.

Sept 2004 to Nov 2005- Contract herpetologist for timber rattlesnake studies with LMS/HDR Engineers for proposed developments at Pierson Lakes and Wrightman Plateau in Rockland County NY. The Pierson Lakes development also affected rattlesnakes from Bergen and Passaic counties in NJ. Duties included surveying and classifying habitat within proposed development properties as well as surrounding areas within range of rattlesnake travel. Snakes were captured from known dens as well as dens discovered during surveys and radiotracked using both implanted and external transmitters to determine rattlesnake usage of properties. Feasibility and planning of developments were assessed and adjusted to minimize impact to rattlesnakes and prevent loss of critical habitats. I was a Research Partner with the State of New Jersey Endangered and Nongame Species Program which allowed NY habitat usage of NJ rattlesnakes to be documented.

2004 to 2012- Volunteer with New Jersey Endangered and Threatened Species Program. Duties have included searching for undiscovered timber rattlesnake dens, documenting sightings and habitat usage as well as assisting ENSP biologist Kris Schantz with various projects.

2006 to present- Volunteer for NJ Licensed Wildlife Rehabilitator for Endangered and Threatened turtle and snake species. Duties primarily include transporting injured animals and assisting with treatment.

2005 to 2012- Research Partner with the State of New Jersey Endangered and Nongame Species Program.

May 2002 to Nov 2004- Worked as contract herpetologist for LMS Engineers for three-year timber rattlesnake study in Sterling Forest, NY for proposed Sterling Forge Development and Golf Course. Surveying dens and potential dens, potential basking and gestating areas, capturing and assisting with surgical implantation of 7 snakes, assisting with attaching external transmitters to 21 rattlesnakes and radio tracking during three seasons.

April 1998 to Oct 2000- Worked with herpetologists for New York State Department of Environmental Conservation Natural Heritage Program conducting population surveys of

known Timber Rattlesnake and Bog Turtle populations as well as surveying areas that had potential habitat for undiscovered populations.

1994 to 1996- Worked part time for Randy Stechert on timber rattlesnake radio-telemetry studies of 7 snakes from three dens at West Point Military Academy. Assisted with the transmitter implantation surgeries and assisted radio tracking snakes.

1994 to present- Assisted with approximately 200 transmitter implantation and removal surgeries on timber rattlesnakes for studies conducted by various agencies in addition to studies I was involved in, including the states of NY, NJ, VT, NH, West Point Military Academy, several universities and environmental consulting companies. Also assisted with attachment of external transmitters for several studies I was not involved in utilizing a method which Kathy Michell developed in 1998.

1993 to present- Submit volunteer observations of Timber Rattlesnakes for NYS Natural Heritage database. This includes finding den and gestating areas that were previously unknown, as well as surveillance of known dens and reporting locations of individual snakes encountered in their foraging range.

1993 to present- Volunteer for Licensed NYS Wildlife Rehabilitator specializing in reptiles. Duties have included driving to pick up injured animals (rattlesnakes, turtles etc.) from the people who found them, freeing entrapped animals, capturing injured animals, assisting with treatment, restraint and administering anesthesia when necessary.

1993 to present- Volunteering as a nuisance timber rattlesnake responder for NYS DEC. Duties include responding to calls from individuals, police, etc when rattlesnakes are near homes or businesses or in other areas where there is a concern for human or pets safety. Snakes are safely captured and relocated a short distance away. Educating people about rattlesnakes is also a big part of being a nuisance responder.

Erin (Smithies) Baker

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Relevant Employment History

2016-present: KT Wildlife, Timber Rattlesnake monitor for various projects, including Spectra Energy AIM pipeline construction, Rockland County; Harriman camps in Harriman State Park, Rockland/Orange County.

2015: KT Wildlife, Rattlesnake/ copperhead/ other herps habitat and presence/absence surveys for Pilgrim Pipeline.

2005 – 2016: **Animal Care Supervisor & Environmental Educator** at Teatown. Oversaw live animal collection. Reptiles and amphibians species cared for included: Northern water snake, Eastern garter snake, Eastern milk snake, Black rat snake, Ringneck snake, Northern brown snake, Eastern Hognose snake, Snapping turtle, Painted turtle, Eastern box turtle, Wood turtle, Spotted turtle, Diamondback terrapin, Blanding's turtle, Five-lined skink, Tiger salamander, Spotted salamander, Green frog, Bull frog, Wood frog, Grey tree frog, Pickerel frog, American toad. Educated the public on native reptile and amphibian species, natural history, and conservation. Performed onsite wetland/pond/vernal pool/ woodland surveys, used field guides/experience to key amphibian species (egg masses, tadpole and adult stages) including: Green frog, bull frog, Grey tree frog, Wood frog, American Toad, Spring peeper, Pickerel frog, Spotted Salamander, Two-lined salamander, Red-backed (Lead-backed) Salamander, Four-toed salamander, Red spotted newt (including eft and adult stage), Slimy salamander, Marbled salamander (located on off-site field trip).

Relevant Reptile Research Experience

2008 – 2016: Primary research & field tech for permitted research on population of Eastern Box Turtles at Teatown www.teatown.org. Performed data collection, habitat sampling, and radio-tracking of approx. 40 turtles over 8 year period to monitor habitat preference, movement patterns, hibernacula & nest site selection. Trained interns to radio-track in the field. Coordinated with ConEd crews to minimize impact on turtles in power line areas.

2015: Provided reptile safety and handling training workshop to ConEd employees working the powerlines on Teatown property where box turtle and copperhead populations are monitored.

2014-15, 2019-2020: Performed radio-telemetry of 3 Wood turtles in streams under Teatown permit to assess movement patterns and range.

2008: Field Assistant for radio-telemetry of female Spotted turtles in vernal pool habitat under Teatown permit to identify and protect potential critical habitat and nesting sites.

Published Paper

Megan C. Henriquez, Suzanne K. Macey, Erin E. Baker, Lisa B. Kelly, Rachel L. Betts, Michael J. Rubbo, and J. Alan Clark "Translocated and Resident Eastern Box Turtles (*Terrapene c. carolina*) in New York: Movement Patterns and Habitat Use," *Northeastern Naturalist* 24(3), 249-266, (1 September 2017).

Relevant Venomous Snake Experience

2014 – present: Contractual employee of **KT Wildlife** to work as venomous snake monitor at various job sites.

2012: Venomous snake handling for research purposes with **KT Wildlife**.

2012: Assisted with Timber rattlesnake implantation surgery with **KT Wildlife**.

2000: Safely moved herps including pygmy rattlesnake at a project work site in Big Cypress National Preserve while working as an SCA intern. Also moved Eastern cottonmouths & Diamondback rattle snakes off roadways.

1995-96: Primary caretaker of live animal collection including 1 juvenile copperhead on exhibit at Teatown (see below).

Relevent Volunteer Experience

2007 – present: NYS Class 1 Licensed Wildlife Rehabilitator specializing in the care of NY native reptiles.
Species worked with to date include: Snapping turtles, Painteds, Eastern Box, Spotted turtles, Wood turtles, Diamondback terrapin, Garter snake, Black rat, Black racer, Eastern milk snake, Eastern Hognose snake, Northern brown

snake, Northern water snake. Average annual intake is 20-50 reptiles.

2008 – present: Participate as citizen scientist for Teatown & NYSDEC program helping to move amphibians across known routes on local roads during spring migration March-April. Species identified and moved include: Spring peeper, Wood frog, Spotted salamander, Four-toed salamander, Slimy salamander, Green frog, American Toad, Grey tree frog, Pickerel frog.

Relevant Education

University of Louisiana, Lafayette, LA – Master of Science in Biology GPA 4.0 **2003-2005**

Thesis: Ecology of Forest Dwelling Bats in Louisiana: Evaluation of Survey Methods and Habitat Associations. Conducted 3 seasons of field research, mist-netting, bat ID, DNA collection and processing, use of Anabat detector and software, vegetation surveys. Frequently encountered Eastern cottonmouths in the field.

University of Maryland, College Park, MD – Bachelor of Science **1996 – 2000**

Major: Environmental Science and Policy with a focus in Conservation Biology.

School for Field Studies, Centre for Rainforest Studies, Queensland, Australia **Fall 1999**

Semester abroad focused on sustainable management of tropical ecosystems. Conducted field research project involving songbird ID, mist-netting, banding, point count surveys, nest searching. Identified various herps for fun.

Current Employment

2017 – present 6th grade life science school teacher at Ramapo Ridge Middle School in Mahwah, NJ. Attend annual spring field trip to Frost Valley where I assist in the pond study ID with students to key out invertebrates and a breeding population of Red-spotted Newts.

Wendy Townsend
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Callicoon, NY 12723
cyclura3@gmail.com

Herpetological Resume

Academic Degrees:
• Masters in Writing, Vermont College of Fine Arts, 2000-2002
• BS, Empire State College, 1998-1999

Field and Husbandry Experience
• Assist KT Wildlife with rattlesnake transmitter implantations and rattlesnake handling training 2015 to present
• Snake & turtle monitor with KT Wildlife, April 2018-present.

2019 season
• Monitor for snakes including hognose and timber rattlesnakes, and turtles including wood turtles on construction site in the town of Highland of Sullivan County, NY.
• Snake and musk turtle monitor, two construction sites, Harriman, NY.
• Snake and turtle monitor, natural gas utility, in the town of Ramapo in Rockland County, New York.

2018 season
• Monitor for spotted, box, bog, Blanding's and wood turtles, power line utility in the town of Dover, Dutchess Co, NY. Identified species-specific turtle habitat, directed machinery operator in areas to avoid. Moved box turtles from work site.
• Snake and turtle monitor, natural gas utility, in the town of Ramapo in Rockland County, New York.
• Volunteer assistant to KT Wildlife in rattlesnake habitat construction, 2 den surveys.

Other Reptile Work
• IUCN Species Survival Commission Iguana Specialist Group conference, Roatan, Honduras, November 9-16 2019.
• Assist field study, Jamaican iguana, *Cyclura collei*, Hellshire, Jamaica, June 9-15, 2019.
• Identify wood turtle habitat, move wood turtles from roads, deliver injured turtles to KT Wildlife, repatriate to same location after recovery, 1995-present.
• International Reptile Conservation Foundation field trip, Utila Island, Honduras. Volunteer fieldwork with *Ctenosaura bakeri, C. similis* and *Leptophis ahaetulla,* April 2003.
• International Iguana Society field trip, Belize. Volunteer fieldwork with *Iguana iguana, Ctenosaura similis* and *Bothrops asper*, March 1999.
• Friends World Program, Long Island University, Southampton. Natural Science, Writing: Study of *Cyclura cornuta* and *C. nubila* breeding, husbandry, and natural history at Finca Cyclura, Big Pine Key, Florida, 1992-1993.
• California State Polytechnic University, Pomona. Animal Science, Herpetology undergraduate study. Assisted Dr. Glenn R. Stewart (Desert Tortoise Council) tending college's reptile collection including caimans, tortoises, boas, garter snakes, and North American frogs,1987-1988.

• University of Miami, Florida. Tropical Biology undergraduate student. Assistant to graduate student, fieldwork on lizards (teiids, anoles, geckos) in Puerto Rico, 1981-1982.
• 1969-1998: Annual, seasonal field observation of Grand Bahama Island herpetofauna including: *Alsophis vudii, Sphaerodactylus notatus, Anolis sagrei, Anolis carolinensis, Leiocephalus carinatus, Ameiva sp.*
• 1969-1999: Annual, seasonal field observation of rural southern Indiana herpetofauna including: bullfrogs, common snapping turtles, eastern box turtles, painted turtles, northern water snake, black rat snake
• 1969-2010: Annual, seasonal field observation of northern Michigan herpetofauna including: common snapping turtles, painted turtles, Blanding's turtles, common garter snake, smooth green snake, blue racer, ring-necked snake, eastern milk snake, red-backed salamander, slimy salamander.
• Tended private reptile collection including pythons, anacondas, boas, tropical aquatic turtles, tropical frogs, north American colubrids, and Gila monsters (*Heloderma suspectum*), 1983-1986.
• Keeper of green iguanas (*Iguana iguana*) 1970-2001, keeper of rhinoceros (*Cyclura cornuta*) and Cuban (*Cyclura nubila*) iguanas, 2001-present.

Reptile & Amphibian-Related Publications
Books
• Blue Iguana, namelos, Spring 2014, Short-listed for The Green Earth Book Award
• The Sundown Rule, *Kirkus Reviews* best children's books of 2011, Bank Street College book of outstanding merit for 2012
• Lizard Love, Front Street Books, Spring 2008, *Booklist* starred review
• Iguanas: A Guide to Their Biology and Captive Care, Frye, Fredric L. and Townsend, Wendy. Krieger Publishing, 1993

Online Magazines, Op Eds
• "Nobody Loves Rattlesnakes." Talking Writing, theme essay, October 2019
• "The Gift of Connecting With Animals." Talking Writing, theme essay, March 2015
• "Book Review: In Search of Lost Frogs." FrogLog, Volume 22, number 4, October 2014
• "Jamaica Selling Out Its Paradise." CNN Opinion, July 2nd 2014
• "'Rattlesnake Roundup' Teaches Cruelty is Fun." CNN Opinion, April 9, 2014

Magazines
• "Going Green: A guide to Keeping Green Iguanas." *Reptiles* December 2009: 42-52.
• "Living With Reptiles: Rhino Romp." *Reptiles* September 2009: 76.
• "Green Giants." *Reptiles USA* Spring 2001 Annual: 64-69.
• "Why Iguanas?" *Reptiles USA* Spring 1999 Annual: 103-107.
• "Spot, Socks, Stanly and E.T." *Iguana Times, Journal of the International Iguana Society* Summer 1998, vol. 7, number 2: pp. 31-34
• "Living With Reptiles: Goosey." *Reptiles* June 1996: 100.
• "A Visit with Mao." *Iguana Times, Journal of the International Iguana Society* May, 1993, vol. 2, number 2: p. 17

Curriculum Vitae (updated March, 2020)

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EDUCATION & PROFESSIONAL DEVELOPMENT

University of Missouri, St. Louis, MO
M.S. Tropical Ecology, 2005 (3.789 GPA)

Charter Oak State College, Farmington, CT
B.A. Psychology, 1994.

American Zoological Association Management School, Oglebay Park, WV,
Certificate of completion, 1998.

WORK EXPERIENCE

Part-time Consultant, teacher, collection maintainer, assistant, for *Animal Embassy* Stamford, CT, 2010-2019. AE uses a large, diverse, live animal collection for educational outreach programs.

Herpetologist, (Field Scientist) Guide, Lecturer; *Operation Wallacea*, Calakmul Biosphere Reserve, Campeche**,** Mexico, 12 June – 13 Aug. 2015. Duties entailed:

- Completing herpetological surveys along transects established at multiple camps in order to assemble species inventories and contribute to long-term data sets aimed at determining
  distributions, abundance, and component analysis of changes over time.
- Initiate with fellow crocodilian scientist, a pilot study of the Morelet's crocodile.
- Instruct students in the field and assist with associated dissertation projects.
- Lecture on herpetological and various tropical ecology subjects.
- Assist to manage satellite camps and ensure that safety standards are met.
- Complete electronic data entry to "OpWall" standards at termination of the field season.

Herpetologist, Lecturer; *Operation Wallacea*, Cusuco National Park, Honduras 7 - 23rd March 2015 – 2015. *Inaugural spring expedition. Duties entailed:

- In collaboration with Honduran herpetologist lead student groups on diurnal and nocturnal transect surveys for reptiles and amphibians. Purpose; data collection and recording species inventories.
- Perform 6 lectures on a range of natural history subjects; mammalogy, ornithology, herpetology, entomology, tropical ecology, biogeography.
- Assist to manage satellite camps and ensure that safety standards are met.
- Complete electronic data entry to "OpWall" standards at termination of the field season.

Team member, *Northern Papua New Guinea Island, Benoit Mys Expedition* (West New Britain, Manus Island) Expedition, 14 Nov. – 17th Dec. 2014. Herpetological explorations, field inventory, museum destined collecting in poorly assessed areas of the country.

- As one of a team of three field investigators with special scientific visas, explore and collect critical information on the herpetofauna of West Britain Island and Manus Island in the Bismarck Archipelago of Papua New Guinea.
- Secure, preserve and obtain ecological information on representative specimens of snakes, lizards, frogs, and turtles in the region.
- Deposit subsets of expedition collected specimens in the National Museum of Papua New Guinea (PNG), and remainder in *The Royal Belgian Institute of Natural Sciences*, Brussels, Belgium.
- Present reports on preliminary expedition goals and findings to PNG officials and other supporting in-country organizations.
- *Species *new to science* were discovered and collected during the course of this expedition including a spectacular large gecko (*Gehyra* sp.).

Head Megafauna Scientist; *Operation Wallacea*, Lambusango Forest, North Buton site(s), Buton Island, Indonesia 13 June – 13 August 2014. Duties entailed:

- Lead assigned megafauna team members in carrying out surveys on Buton Island of anoa buffalo, pigs, deer, macaque monkeys, cuscus, feral cattle and hornbills using grid-based/transect coverage and camera trapping to obtain occupancy and distance sampling data.
- As part of establishing new node camps extend or create transect lines to support multidisciplinary survey projects.
- To lecture at base camp and node camps; take students and volunteers into the field to observe our field data collection methods in action.
- Insure that all team data is organized and submitted to Opwall Senior Scientists. Additionally, to provide a preliminary report on finding to the Ministry of Research and Technology Indonesia (RISTEK).
- Assist to manage all other field and camp activities, logistics as needed. Help insure a safe and educational experience for OpWall students and teachers.

Herpetological Team member; *Operation Wallacea*, Cusuco National Park, Honduras 10th July 2013 – 8th August 2013. Duties entailed:

- Completing herpetological surveys along transects established at multiple camps in order to assemble species inventories and contribute to long-term data sets aimed at determining distributions, abundance, and component analysis of changes over time.
- Execute special focus surveys on viperid snake species in Cusuco NP with emphasis to collect information and genetic material on endemic March's palm vipers (*Bothriechis marchi*).
- Instruct students in the field and assist with associated dissertation projects.
- Lecture on herpetological and tropical ecology subjects.
- Assist to manage satellite camps and ensure that safety standards are met.
- Completing electronic data entry to "OpWall" standards at termination of the field season.

Herpetologist; Head of Terrestrial Projects, *Operation Wallacea*, Lambusango Forest, North Buton site(s), Buton Island, Indonesia, 18 June 2012 – 15 August 2012. Duties entailed:

- Installing, maintaining and monitoring pit-trap arrays at 28 selected sites widely distributed throughout the Lambusango Forest on the Island of Buton, Indonesia: study in its 13th season.
- Documenting in detail, (i.e. gender, species ID's, morphometrics) all herpetological specimens, rodents, insectivores, and large arachnids captured in or near (20-meter radius) of the pit trap arrays.
- Training and teaching all student volunteers in methodologies of the monitoring project and natural history of Lambusango.
- Lecturing on herpetological and tropical ecology subjects.
- Entering all data in Microsoft Excel spreadsheets, writing and supplying reports to regional government agencies (RISTEK) with raw data, description and short-term analysis of the study.
- Facilitate opening of a new site; "North Buton Camp" and perform initial investigations (essentially 11-day RAP -= Rapid Assessment Program) of the area.

Herpetological Team member; *Operation Wallacea*, Cusuco National Park, Honduras 8th June 2011 – 9th August 2011. Duties entailed:

- Completing herpetological surveys along transects established at multiple camps in order to assemble species inventories and contribute to long-term data sets aimed at determining distributions, abundance, and component analysis of changes over time.

- Collecting DNA and *Batrachochytrium dendrobatidis* "Chytrid" fungal samples on order to monitor that disease on a species-specific level within the park.
- Instruct students in the field and assist with associated dissertation projects.
- Lecture on herpetological and tropical ecology subjects.
- Assist to manage satellite camps and ensure that safety standards are met.
- Completing electronic data entry to "OpWall" standards at termination of the field season.

Primary Researcher: *Black Caiman Project*, based at Yupukari Village, Region # 9, Guyana, 4/2005 to 11/2007. Project coordinator, consultant, grant writer: 11/2007 to 01/2016 and continuing.

Plans for this community based collaborative project, established in a remote Amerindian Village, began to take shape after visits to the Rupununi savannah region of the country beginning in 2000. In the course of its development a substantial infrastructure was established to supply a full range of professional needs; lodging, supportive outbuildings, kitchen, garden, independent water supply and water storage, substantial solar power, electrical, plumbing and septic installations, internet service, library, outboard engines, boats, and required field equipment.

Basic goals of the study:

- Conduct a detailed ecological study of the black caiman, (*Melanosuchus niger*) and track its status.
- To train indigenous Macushi in field techniques and data collection.
- To define problems in order to develop management protocols related to Human/Crocodile Conflicts or HCC's as defined by the Croc Specialist Group.
- Provide informed recommendations for the sustainable use of black caiman.

Realized and ongoing project components:

- Mark/recapture of two local sub-populations totaling over 750 tagged specimens; 26 data points/treatments per specimen.
- Detailed data collection on 50 black caiman nests, eggs, reproductive aspects, hatchlings and predation.
- Telemetry based tracking of black caiman. (initiated - 2015 season: 30 specimens now radio equipped – Adam Rosenblatt, PhD. /Yale U. post doc - field coordinator for this phase.
- Stable isotope analysis (SIA) via tissue examinations, stomach lavage. (A. Rosenblatt, coordinator, researcher this phase 2013-14 –& 2014-15 dry seasons).
- Gaining critical insights into growth and survival rates of wild caiman; poorly documented in this species. (See peer-reviewed publication 2016).
- Local survey of populations, ecological information on all four local caiman species.

- Details concerning HCC's; fishing, livestock and human fatalities from black caiman.
- Training to independent field project functioning of over 30 indigenous (Macushi) participants.
- Bioacoustic communication studies in collaboration with French scientists (pub. - Jan. 2011 *Zoology* featured paper (cover). "Acoustic Signals of Baby Black Caiman".
- A full ecological view of the area has led to the generation of multiple species lists, including identifications of over 110 herp species, 45 mammal species, over 250 bird species, and many invertebrates. Several probable "new to science' taxa are included.
- Internal and international conference reports, publications and presentations generated from project efforts. This includes reporting at past three *Crocodile Specialist Group* Working Meetings
- The establishment of regular ecotourist activities benefiting the project and Yupukari Village. Over 1000 visitors have come to Yupukari Village see the project, and assist with it, or participate in other associated wildlife and community-based projects.
- Successful support through various granting agencies, including the IUCN (40K USD). The BCP has been a featured Conservation and Research project of Zoo Miami.

Future components, planned project phases include:

- Genetic analysis of black caiman populations.
- Comprehensive survey, status assessment, across the Rupununi range of black caiman in Guyana.
- Pollutant screening using caiman tissue samples for detection.
- Continued build-up of self-sustaining project inputs, (i.e. ecotourism, visiting scientist(s) contributions).

Zoological Manager, Herpetarium, *St. Louis Zoo* 2/96 to 3/05

Basic duties entailed:

- Managing and coordinating the diverse inputs necessary to run one of the largest herpetological facilities in the United States at a zoo receiving over 3 million visitors per year.
- Supervising, training, disciplining, of four full-time Herpetarium keepers, three Aquatics keepers, two part-time keepers, interns and custodial staff. Interacting and coordinating with a constant flow of researchers, educational groups, donors, media, and special visitors.
- Screening, recruiting and interviewing to receive 8-10 university *interns* and *externs* each year participating in semester-length, certificated programs. A high

percentage of those interns are currently employed at St. Louis Zoo or other AZA accredited institutions.
- General expectations for the ZM are to supervise, plan, and troubleshoot all operational and day to day aspects of the Herps and Aquatics department to ensure the highest standards of care, husbandry, exhibition and staff development, and oversee the department in the absence of the curator.

Specific responsibilities:

- Working closely with the curator and herpetology keeping staff, run bi-monthly staff meetings, yearly work performance reviews.
- Coordinate with veterinary staff making rounds, with surgical procedures, health screening, disposition, and maintenance of animals in hospital quarantine facilities.
- Performing collection inventories, including animal acquisitions and deaccessions, collection planning, daily log entries, registrar reports.
- Execution of snake bite and other emergency drills, interaction with the medical community and distribution of antivenin in support of snakebite emergencies.
- Exhibit design, maintenance and improvement.
- Input to zoo research and breeding programs.
- Packing, shipping, and receiving of collection specimens.
- Enrichment committee participation.
- Frequent public presentations, literary contributions to the zoo magazine, media inputs, special events, and various cooperative ventures inside and outside the zoo.
- Photographic documentation of the collection, and assistance in generating and installing graphics.
- Safe restraint, handling of venomous specimens, powerful and potentially dangerous reptiles. Hands on venomous snake procedures restricted to ZM's and curator.
- Primary responsibility for the zoo's important collection of tuatara.
- Working closely with Facilities Management on all Physical plant needs; initiation of work orders for repairs, maintenance, and with the curator for new installations, construction.
- Policing the public and working with zoo security as needed.
- Regular involvement with the Public Relations Department related to frequent media interactions and for contributions to zoo publications.

Selected St. Louis Zoo based projects:

- Successful Puerto Rican crested toad and Wyoming toad breeding programs per SSP recommendations.
- Analysis of tuatara glandular secretions, (w/Dr. Paul Weldon, Notre Dame College).
- Tuatara calorie consumption, intake data, (self-initiated, St. Louis Zoo).

- Morphological plasticity of anoline lizards, (w/Dr. Jonathan Losos, Washington University, (Now Harvard U.) w/St Louis Zoo).
- Reproductive biology of boids, (St. Louis Zoo, PhD project, w/Dr. Jodie de Camillo, St Louis University, PhD. thesis).
- Behavior and reproductive biology of dwarf caiman, (self-initiated, St. Louis Zoo).
- Dietary study of rock iguanas and tortoises, (w/Jan Dempsey nutritionist, St. Louis Zoo).
- Effects of hibernation on physiology of viperid snakes, (w/Chris Dutton DVM).
- UV light effects on the growth and development of near east mountain vipers, (student project science project, St. Louis Zoo).
- Biomechanical investigations of viperine snakes, (w/Dr. David Cundall, Lehigh University).

Wild Animal Keeper, Herpetology Dept., *Bronx Zoo*……..1988 – 1996

- Entailed the full contingent of responsibilities required relating to the exhibition, maintenance, and development of one of the world's largest and most important collection of reptiles and amphibians. Main duties included care, feeding an hygiene of 100's of living specimens in the collection, carrying out medical directives/treatments as scheduled by veterinary staff, record keeping, exhibit construction, work on captive breeding projects, shipping and receiving specimens, collaborating with researchers in the collection or in the field, touring special visitors to the Herp Dept, and educating the public. This full-time position provided an enormous base of experience for professional postings going forward.

Hospital Manager and Veterinary Assistant……..…….1985 – 1988
Blue Cross Animal Hospital, Greenwich, CT.

- Working constantly and closely with Veterinary Staff in medical care and handling of dogs, cats, domestic stock, exotics, surgical assistance, lab sample analysis; care, feeding, & medicating of hospital charges, bathing animals/flea and parasite control, care of boarding animals, supply orders, repairs to facility and facility hygiene, training of new staff. In short, engagement in the full range of hospital related needs. Work weeks often required 60-70 hours of attendance.

FIELD EXPERIENCE

- *Herpetologist Operation Wallacea, Calakmul Biosphere Reserve, Campeche Mexico,* 2015 Expedition (full season - 8 weeks).
- *Team member, (w/Jonathan Clegg, Merlijn Jocque) Northern Papua New Guinea Islands* Expedition, (West New Britain, Manus Island) Expedition, 14 Nov. – 17th Dec. 2014.

- *Head Megafauna Scientist, Operation Wallacea (OpWall) Indonesia site(s) 2014*. Led team to assess status, occupancy of large fauna (anoa, feral cattle, pigs, deer, macaques, cuscus, hornbills) at various sites, camps on Buton Island. Primary focus was to add to data to support our better understanding of the status of the endangered anoa buffalo. This project an expanded effort based largely on 2012 discoveries (below).
- *Herp Team Leader, Terrestrial projects, Operation Wallacea, Buton Island, Indonesia, 2012* (Lambusango Forest and North Buton Forest "Anoa Camp". Data collection, reports in support of robust, long-term pit trap monitoring study, (herps, small mammals, large invertebrates) and general species inventorying. Student training/teaching, lecturing.
- As part of above opportunistic survey work on North Buton Island, Indonesia, collected important information on the status of endemic, endangered anoa buffalo. Reports shared with anoa Species Survival Coordinator (SSP), San Diego Zoo, made available to associated Taxon Advisory Group.
- *Herp Team member, Operation Wallacea, Cusuco National Park Honduras, summers 2011 & 2013* Full time, (7 day a week) presence for 9 weeks and 4 weeks respectively, completing wide ranging field surveys for amphibians and reptiles, lecture and instruct students, sample local amphibians for DNA and chytrid fungus, assisting in camp(s), ecological and genetic information on viperid snake species.
- *Primary Researcher, Yupukari Village, Region # 9 Guyana Black Caiman* (*Melanosuchus niger*) Project. Full-time presence on site in 2005, 2006, 2007, gathering a range of ecological data while training, educating, and exchanging information with 20 field assistants. Details above under "Work experience".
- Field data collection of Australian freshwater crocodiles, (*Crocodylus johnstoni*) participant, w/Dr. Graham Webb, Dr. Adam Britton, 2004.
- Turkey Point, Florida American crocodile recovery study (*Crocodylus acutus*) field study w/ Joe Wasilewski, 2003-2007.
- *St. Louis Zoo Wild Care Institute/Missouri Department of Natural Resources*, Ozark hellbender (*Cryptobranchus a. bishopi*) field study, conservation program (with Ron Goellner). 2003-2004.
- *St. Lucia Forestry Service*, field data collection and status assessment of the St. Lucia lancehead (*Bothrops caribbaeus*) and St. Lucia boa (*Boa constrictor orophias*), with reports, images and video submissions., two trips; 2003-2004.
- *Ceiba Biological Station, Guyana*, graduate studies and observations of whiptail lizards (*Cnemidophorus*), saturnid caterpillars (with Dr. Godfrey Bourne), 1997 and 2000.
- *New York State Department of Environmental Conservation,* timber rattlesnake (*Crotalus horridus*) surveys (with Randy Stechert), 1990- 2016. Observer.
- *National Park Service/ Breezy Point* project; reintroduction of eastern hognose snakes (*Heterodon platyrhinos*), 1990-1994. Bronx Zoo project w/Bob Cook, NPS.
- *Wildlife Conservation International, Apure, Venezuela*. Anaconda (*Eunectes murinus*) field data collection, telemetry, mark/recapture. Apure, Venezuela, 1993, 1994. Jesus Rivas, PhD project.

- *New York State Department of Environmental Conservation*, bog turtle (*Clemmys muhlenbergi*) population status assessment, with John Behler and NYDEP, 1992.
- *Landtech Co., CT.* Slimy salamander (*Plethodon glutinosus*) environmental impact study (with John Behler), 1989.

PROGRAM PARTICIPANT/CONSULTANT

Panthera (Leaders in wild cat conservation). Beginning in 2008, initiated a series of meetings with, and presentations to *Panthera* in support of the Guyana component of the Jaguar Corridor Initiative (JCI); intended to span all range countries. Supplied initial data, organized early trip logistics, contacts for *Panthera* personal to begin on-the-ground investigations. These actions have led to the establishment of a full-time scientific presence in the country, the drafting of three extensive reports on jaguars and other representative regional fauna in Guyana, and Memorandum's of Understanding (MOU's) for jaguar protection, signed with pertinent Guyana Ministries in 2013.
AZA Lizard Taxon Advisory Group (TAG). Taylor, P 1996. "An Inquiry into the Depredation of the Prehensile-tailed Skink, (*Corucia zebrata*)". Background report, proposal submission.
American Zoological Association (AZA), Chelonian Taxon Advisory Group, 2000.
Asian Box Turtle (genus *Cuora*) status Reports.
AZA Snake Taxon Advisory Group, 1999.
Authored species accounts and status reports for five species of Indonesian pythons.
Department of Health, Stamford, CT, 1992.
Ordinance #680 Report, Venomous Snake Ownership/Snakebite Protocols for the City of Stamford, CT.

SELECTED MEDIA

2012	*Pet Talk* News 12, CT, "*Animal Invaders*" segment. Assistant.
2012	*Biggest & Baddest* Season 1, episode 1#, consultant, Gryphon Productions
2012	*River Monsters* Season #4 final episode, credited consultant w/Icon Films
2002 - 2005	KMOV St. Louis. "*At the Zoo*" television series, made six appearances.
2002, 2003	New Zealand Natural History Films, *The Most Extreme Animals* (Television program, three appearances).
2003	Hearst-Argyle Productions, *Wild Moments* (TV series). One appearance.
1996 - 2002	Twelve radio interviews, various stations, representing the St. Louis Zoo.
1994, 1995	NBC Today Show. Provided animals and assisted Jim Fowler.
1992	BBC Television, Lake Titicaca frog documentary. Design, construction of environments & animal handling.
1990	"Bronx Zoo Babies," film appearance.
1990	WGCH Greenwich, CT, several radio interviews.
1986	Connecticut Channel 12, live reptile presentation.

PUBLICATIONS/REPORTS/POSTER PRESENTATIONS since 2000

Losos, J.B., D.A. Creer, D. Glossip, R. Goellner, A. Hampton, G. Roberts, N. Haskell, P. Taylor, and J. Ettling. 2000. "Evolutionary implications of phenotypic plasticity in the hind-limb of the lizard *Anolis sagrei.*" *Evolution* 54:301-305.

Taylor, P. 2002. "The "Matchbox Croc": What captivity has taught us about *Paleosuchus palpebrosus." Proceedings of the 25th International Herpetological Symposium on Captive Propogation and Husbandry*, *Detroit, Michigan, July 14-17, 2001* (pp.102-115).

Dutton, C.J. and P. Taylor. 2003. "A comparison between pre-and post-hibernation morphometry, hematology, and blood chemistry in viperid snakes." *Journal of Zoo and Wildlife Medicine* 34 (1): 53–58.

Taylor P. GEPA - Environmental Protection Agency of Guyana Reports, (4 reports covering the period of April 2005 – June 2007) on the *Black Caiman Project* based at Yupukari Village, Region #9, Guyana.

Taylor, P. 2006. "A Collaborative Ecological Study of the Black Caiman (*Melanosuchus niger*), at Yupukari Village, Guyana, A First Year Report", *Proceedings of the 18th working Meeting of the Crocodilian Specialist Group,* Montelimar, France, (pp. 212-219)

Taylor, P. 2007. "A Collaborative Ecological Study of the Black Caiman (*Melanosuchus niger*), at Yupukari Village, Guyana, A Second Year Report." Abstract and oral presentation The 88th Meeting of the American Society of Ichthyologists and Herpetologists, St Louis, MO, USA, 12 July 2007. Abstract and oral presentation.

Vergne, A. L., Mathevon, N., Aubin, T. & Taylor, P. 2007 "How do young crocodilians use sounds to communicate?" International BioAcoustics Congress (Pavia, Italy). Poster presentation.

Vergne, A. L., Mathevon, N., Aubin, T. & Taylor, P. 2007, "How do young crocodilians use sounds to communicate*?", Journée de la recherche de l'Ecole doctorale* (Saint Etienne, France). Poster presentation.

Taylor, P. 2008, " "Vergne A, Aubin T, Taylor P, Mathevon N. Acoustic signals of baby black caimans" Nesting Habits of the Black Caiman (*Melanosuchus niger*) in the Rupununi Savannah region of Guyana"; Abstract and oral presentation. "*Proceedings of the19th Working Meeting of the Crocodile Specialist Group*", Santa Cruz, Bolivia 2008.

Taylor, P. 2010, Injury Patterns in a Black Caiman (*Melanosuchus*) Population in the Rupununi Region of Guyana, abstract and oral presentation. "*Proceedings of the 20th Working Meeting of the Crocodile Specialist Group*", Manaus, Brazil 2010.

Vergne A., Aubin T., Taylor, P., Mathevon N. "Acoustic signals of baby black caimans", (*Melanosuchus niger*) cover paper, Journal *Zoology*, Dec. 2011.

Taylor, P. "Final Seasonal Herpetology Research Report; OpWall, (= *Operation Wallacea*) Buton Island, Indonesia Summer 2012, A report for RISTEK: Ministry of Research and Technology, Indonesia." *Herpetofauna Monitoring Project, 2012 includes expanded date sets on large invertebrates, i.e. chilopoda, arachnidae) and small mammals, i.e., insectivores (shrews) and murid rodents.

Taylor, P. Cadwallader, H. Dibden, G. "Monitoring the Megafauna Populations of Buton Island", 2014. A report to RISTEK: Ministry of Research and Technology, Indonesia (pp. 7).

Rosenblatt, A., Li, F. Holland, A, Taylor, P. Kalacharan, L., MELANOSUCHUS NIGER (Black Caiman). DIET. Herp Review, 46 (3) 2015 (pp. 430).

Peter Taylor[1]; Fernando Li[1]; Ashley Holland[1]; Michael Martin[1] and Adam E. Rosenblatt[2] , "Growth rates of black caiman (*Melanosuchus niger*) in the Rupununi Region of Guyana", Amphibia – Reptilia, Dec. 2015, Vol 36, issue 1, page count, 6.

Confirmation of the occurrence of a poorly known species, *Ecnomiohyla salvaje* (Anura: Hylidae) from El Cusuco National Park, Honduras with an updated list of its amphibians species José Mario Solís[1,2,3,4]*, Peter Taylor[2] & Jarek Lopez-Paredes[1,2]. *Alytes*, 2017, 34, (1-4): 61-67.

GRANTS & PROPOSALS

Farfan & Mendez Georgetown, Guyana; Financial support for telemetry tracking of black caiman for 2016, (Black Caiman Project based at *Caiman House Field Station*, Yupukari Village, Region #9, Guyana) $4000.00

National Geographic Society; for 2014/15; acquired by Adam Rosenblatt PhD., (Yale U. post-doc, Os Schmidt Lab) – with critical support from our Project data; for continuance of the *Black Caiman Project* based at Yupukari Village Region, #9, Guyana. To be applied to staple isotope/dietary investigations of black caiman, continued mark recapture work, and establishment of radio telemetry tracking for 30 individual caiman. $20,000.00

Miami Zoo, *Conservation Trust Fund*: 2014; Black Caiman Project, Guyana, support for basic supplies of petrol, PIT tags, (passive integrated transponders) and snares to continue mark-recapture programs and related investigations of Rupununi populations of the black caiman (*Melanosuchus niger*). Award $4000.00

Hartford Performs; Request for Qualifications 2013: Successful application for proposed science and art-based curriculum, "Animals in their Environment", using a diverse living collection to be directed at 4th grade level(s) in up to 25 Hartford Public School System schools. Written for *Animal Embassy*; will be administered by outreach *AE* program staff. Other programs may follow this initial offering. Cost per student $10. Continuing through 2018…many hundreds, up to a few thousand students have utilized this program.

International Union for the Conservation of Nature (IUCN); 2009, "Environmental Monitoring as an Engine for Capacity Building and Ecotourism"; based at Yupukari Village, Guyana. Primarily support of local Black Caiman Project, herpetological, other local environmental studies. W/Mike Martin. Award $40,000.00

Sea World Busch Gardens (SWBG) Conservation Fund, 2007 for Collaborative Ecological Study of Black Caiman (*Melanosuchus niger*) based at Yupukari Village,

region # 9 Guyana. Award $5000.00

Guyana Environmental Protection Agency, 2005 – 2007, acceptance of Black Caiman Project Proposal and permit acquisitions for project. Initial support distributed from St. Louis Zoo, $25,000.00

CONFERENCES/SYMPOSIA/*past decade*

Turtle Survival Alliance Meetings, (TSA) - St. Louis, MO 2009

International Herpetological Symposia, (IHS), attendances.

Cincinnati, OH 1998
San Diego, CA 1999
New Orleans, LA 2000
Detroit, MI 2001
St. Louis, MO 2002
Houston, TX 2003

Crocodile Specialist Group (CSG) - Working Meetings participation/presentations:

Gainesville, FL, 2002
Darwin, Australia 2004
Montelimar, France 2006 (presented: *Black Caiman Project; A First Year Report*)
Santa Cruz, Bolivia 2008 (presented: *Nesting and Reproduction of Black Caiman*)
Manaus, Brazil 2010 (presented: *Injury Patterns in a Rupununi pop. of Black Caiman*)
Lake Charles, Louisiana, USA 2014

Society for the Study of Amphibians and Reptiles (SSAR/ American Society of Ichthyologists and Herpetologists (ASIH) - Joint Meetings:

St. Louis, MO, 2007 (presented: "A Collaborative Ecological Study of Black Caiman".)
Providence, RI, 2010

LECTURES & TEACHING

Professional programs since 1992
New York Entomological Society at American Museum of Natural History (2018)
University of California at Berkeley Cheadle Center, *on line lectures*(2), (2016)
Operation Wallacea; field instruction, lectures, Mexico (2015)

Operation Wallacea; field instruction, lectures, Honduras (2015)
Operation Wallacea; field instruction, lectures, Indonesia (2014)
Operation Wallacea; field instruction, lectures, Honduras (2013)
Weston High School Animal Behavior classes (2013, 2014)
Operation Wallacea; field instruction, lectures, Indonesia (2012)
Operation Wallacea; field instruction, lectures, Honduras (2011)
Fowler & Friends (w/Jim Fowler) animal handler lecturer, Wilton, CT 2017
Wolf Conservation Center, South Salem, NY (2010)
NY Turtle & Tortoise Society Annual Seminar speaker (2010)
CSG 20th Working Meeting Manaus, Brazil (2010)
New Canaan Round Table Meeting New Canaan, CT (2010)
Linnean Society of New York (2009)
Greater Cincinnati Herpetological Society, Cincinnati, OH (2009)
Beardsley Zoo, Bridgeport CT (2008)
CSG: 19th Working Meeting, Santa Cruz, Bolivia (2008)
Joint Meeting of Ichthyologists and Herpetologists, (SSAR) St. Louis, MO (2007)
North Rupununi District Development Board, Annai, Region # 9, Guyana (2006)
Crocodilian Specialist Group: 18th Working Meeting, Montelimar, France (2006)
Greenwich, CT Senior Men's Club (2006)
National Animal Control Association Annual Meeting, St. Louis, MO (2003)
St. Louis Mensa Society (2002)
Chicago Herpetological Society, IL (2002)
St. Louis Department of Health, St. Louis, MO (2001, 2002)
St. Louis Turtle & Tortoise Society, St. Louis, MO (2002)
International Herpetological Symposium, Detroit, MI (2001)
St. Louis Zoo Friends Speaker Series, St. Louis, MO (2000, 2001 2002)
Mid-Missouri Herpetological Society, Columbia, MO (2000)
International Toxicology Conference, St. Louis, MO, *featured speaker* (1999)
Kansas City Herpetological Society, Kansas City, MO (1999)
Washington University Herpetology Group, St. Louis, MO (1998)
St. Louis Herpetological Society, St. Louis, MO (1997)
National Park Service, New York, NY (1994)
Philadelphia Zoo lecture to staff (1994)
Lehigh Valley Herpetological Society, Sellersville, PA (1994)
Explorer's Club, New York, NY at Waldorf Astoria (1994)
New York Herpetological Society, New York, NY (1993)
Southern New England Herpetological Society, Fairfield, CT (1993)
New York Turtle and Tortoise Society, New York, NY (1992)

Children and Youth Programs 1992-1996
Bank Street College of Education, (many programs) New York, NY
The Calhoun School, New York, NY
4-H School, Stamford, CT
Greenburgh Nature Center, Scarsdale, NY
Greenwich Country Day, Greenwich, CT

New Canaan High School, New Canaan, CT
New Canaan Nature Center, New Canaan, CT
P.S. 6, New York, NY
The Ramaz School, New York, NY
Ridgefield Discovery Center, Ridgefield, CT
The Rowayton School, Rowayton, CT
St. Saviour's School, Brooklyn, NY
West School, New Canaan, CT
Westport Discovery Center, Westport, CT
Woodcock Nature Center, Weston, CT
Yeshiva Rabbi Samson Hirsch, New York, NY

RELATED & SUPPORTING INTERESTS

Dedicated interest in Zoos and Aquariums - realized through visits to 2010 zoos, aquariums and animal parks in Australia, Belgium, Bolivia, Brazil, Canada, Costa Rica, China, (Hong Kong), France, French Guiana, Great Britain, Germany, Guyana, Indonesia, Papua New Guinea, Singapore, South Africa, Suriname, Switzerland, Taiwan, The Netherlands, and the United States.

Travel, independent field interest - A lifetime of field experience observing, studying, and photographing reptiles, amphibians, and other wildlife in *US states of Arizona, California, Connecticut, Florida, Georgia, Illinois, Kentucky, Maine, Massachusetts, Missouri, New York, South Carolina, Tennessee.

*Internationally, (5+ years field time) spent in Australia, Belize, Bolivia, Brazil, China, (Hong Kong) Costa Rica, France, French Guiana, Guatemala, Guyana, Honduras, Indonesia, Mexico, Papua New Guinea, South Africa, Suriname, Eswatini (Swaziland), St. Lucia, Taiwan, and Venezuela.

Herpetological, natural history, (all taxonomic categories) zoo related literature – Large collection of journal material, other media and over 3700 volumes (chiefly books) in those subject areas.

Private collections – Have maintained herp collections at home most of the time since the age of four, lecturing using captive charges - “live props” since grade school.

Past or present membership, professional affiliations – ASIH, AZA, CSG, IHS, SSAR, and various local herp societies.

Photography, video – over 45,000 slides, images pertaining to herpetology, animals, nature, zoos. 35 DVD’s of personally shot Guyana field footage. Since 2005, 10,000’s additional digital images and videos.

Desk-set – Possess good to excellent computer, internet, writing, research, communication, and keyboard skills.

Languages – some "*un poco, algunas palabras, frases*" Spanish, a bit of French, Bahasa Indonesian.

Field skills – Well-tested biking, hiking/trail-blazing, navigation/GPS skills, camping, bush, canoeing, outboard boating skills, other aquatic skills; exceptional physical fitness and demonstrated ability to perform under challenging field conditions for extended periods.

Attachment 5

FAA Determinations of No Hazard to Air Navigation and Extensions –

See Attachment A

Attachment 6

FAA Advisory circular 70/7460-1 L Change 1 –

See Attachment A

Attachment 7

L-810 Red Obstruction Light

OL LED 860 Series Red Obstruction Light L-810

UNIMAR
Brighter lighting solutions

3195 Vickery Rd. North Syracuse NY 13212 | (315) 699 4400 | Unimar.com

Meets:
FAA AC NO: 150/5345-43F
FAA Engineering Brief No. 67
ICAO (Annex 14 - Fourth Edition, July 2004)
ICAO Aerodromes Design Manual, Chapter 18
Canadian Aviation Regulation CAR 621.19
Nachrichten für Luftfahrer Tel I Langen, 6. January 2005
German Air Traffic Control Notices for Pilots Part I 6, January 2005

Qualified By:
Intertek ETL
Lighting Sciences Canada

Features

- Available as a single or dual unit
- Available in 12 VDC, 24 VDC, 48 VDC, 120 VAC & 220 VAC (50 or 60 Hz)
- Earth grounding provisions provided
- Unique optically designed lens to enhance LED operation and provide 360° visibility
- State-of-the-art high-flux LED technology
- Estimated service life 12-15 years
- Weather/corrosion resistant lamp assembly and housing
- Self-contained wiring compartment eliminates additional boxes
- Threaded 1" and ¾" bottom hub for mounting
- Can be operated steady or flashed *(controller not supplied)*
- 5 year warranty
- Resistant to shock and vibration
- IP65 / IP66 / NEMA 4X rated

Application

The 860 Series is the FAA type L-810 red LED obstruction light. Designed for steady burning, this fixture is used to mark any obstacle that may present hazards to aircraft navigation. The U.S. patent office has issued patent number 6,425,678 B1 for this series.

Operating Conditions

Temperature: -67° F to +131° F
(-55° C to +55° C)

Materials/Finish

- Cast Aluminum housing
- Stainless steel hardware

Ordering Information

Single Units

Part Number	Cert	Volts
860-1R01-001	FAA	120 VAC
860-6R01-001	TC	120 VAC
860-1R02-001	--	220 VAC
860-1R03-001	FAA	12 VDC
860-3R03-001 (Low wattage)	--	12 VDC
860-1R05-001	FAA	24 VDC
860-6R05-001	TC	24 VDC
860-1R04-001	FAA	48 VDC
860-5R02-001	ICAO	220 VAC (10cd)
860-1R02-001-EU	Eur. Ver.	220 VAC
860-4R02-001-EU	Eur. Ver.	220 VAC (50 cd)

Dual Units

Part Number	Cert	Volts
860-1R01-002	FAA	120 VAC
860-6R01-002	TC	120 VAC
860-1R02-002	--	220 VAC
860-1R03-002	FAA	12 VDC
860-3R03-002 (Low wattage)	--	12 VDC
860-1R05-002	FAA	24 VDC
860-6R05-002	TC	24 VDC
860-1R04-002	FAA	48 VDC
860-7R02-002	CASA	220 VAC (100cd)
860-1R02-002-EU	Eur. Ver.	220 VAC
860-4R02-002-EU	Eur. Ver.	220 VAC (50 cd)

OL LED 860 Series Red Obstruction Light L-810

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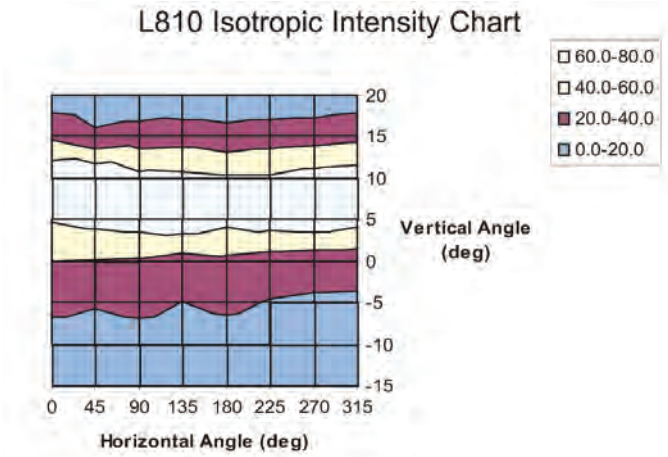
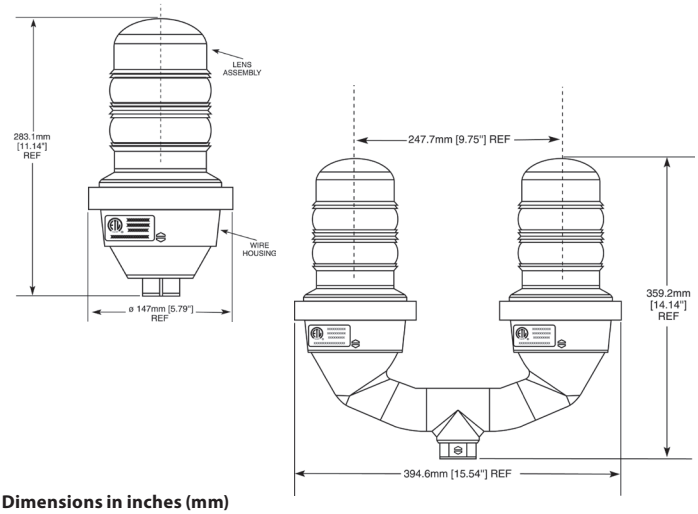
Brighter lighting solutions

3195 Vickery Rd. North Syracuse NY 13212 | (315) 699 4400 | Unimar.com

Photometric Data



Mechanical Dimensions



Dimensions in inches (mm)

Electrical Specifications

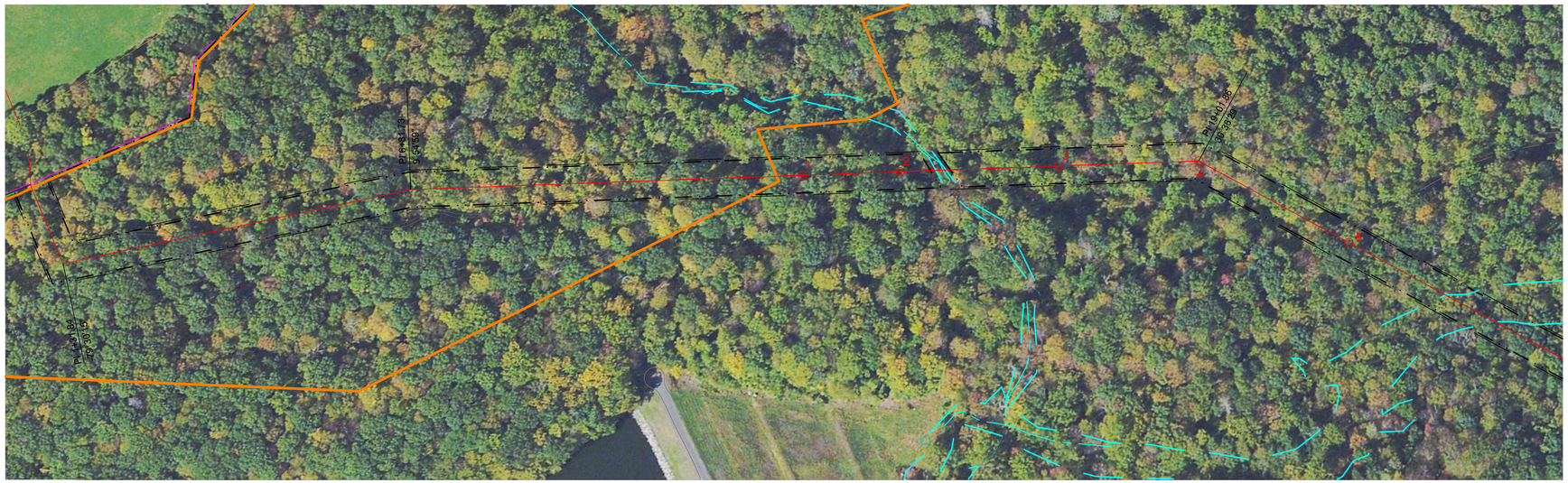
	PF	VA	Operating Voltage			Watts (W)			Amps
			Min	Typ	Max	Min	Typ	Max	
120 VAC Units	.3	46.5	92	120	132	10	15	18	0.120
240 VAC Units (60Hz)	.17	72	198	240	264	11	15	18	0.120
240 VAC Units (50Hz)	--	--	198	240	264	12	14	17	--
12 VDC Units (Standard)	--	--	10	12	14	20	25	29	2.000
24 VDC Units	--	--	21	24	27	17	22	29	0.920
48 VDC Units	--	--	43	48	53	11	14	16	0.275

Weights and Measurements

Model	Shipping Weight	Container Dimensions
Single Unit	7.1 lbs	16” x 9” x 8” (406mm x 229mm x 203mm)
Dual Unit	16.1 lbs	22” x 17” x 9” (559mm x 432mm x 229mm)

Attachment C

Exponential Interconnection Drawings



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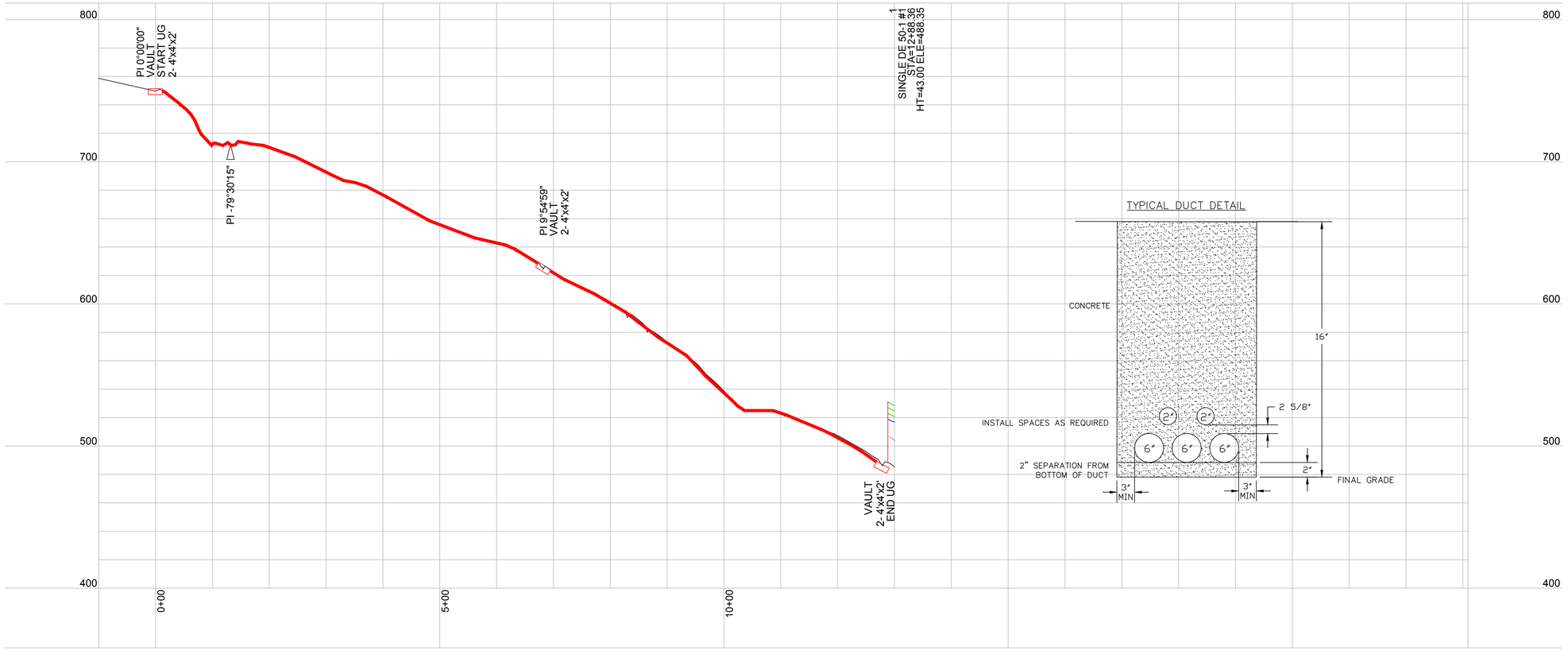

TYPICAL DUCT DETAIL

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Fort Collins, CO 80528
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Fax: (970) 207-9657

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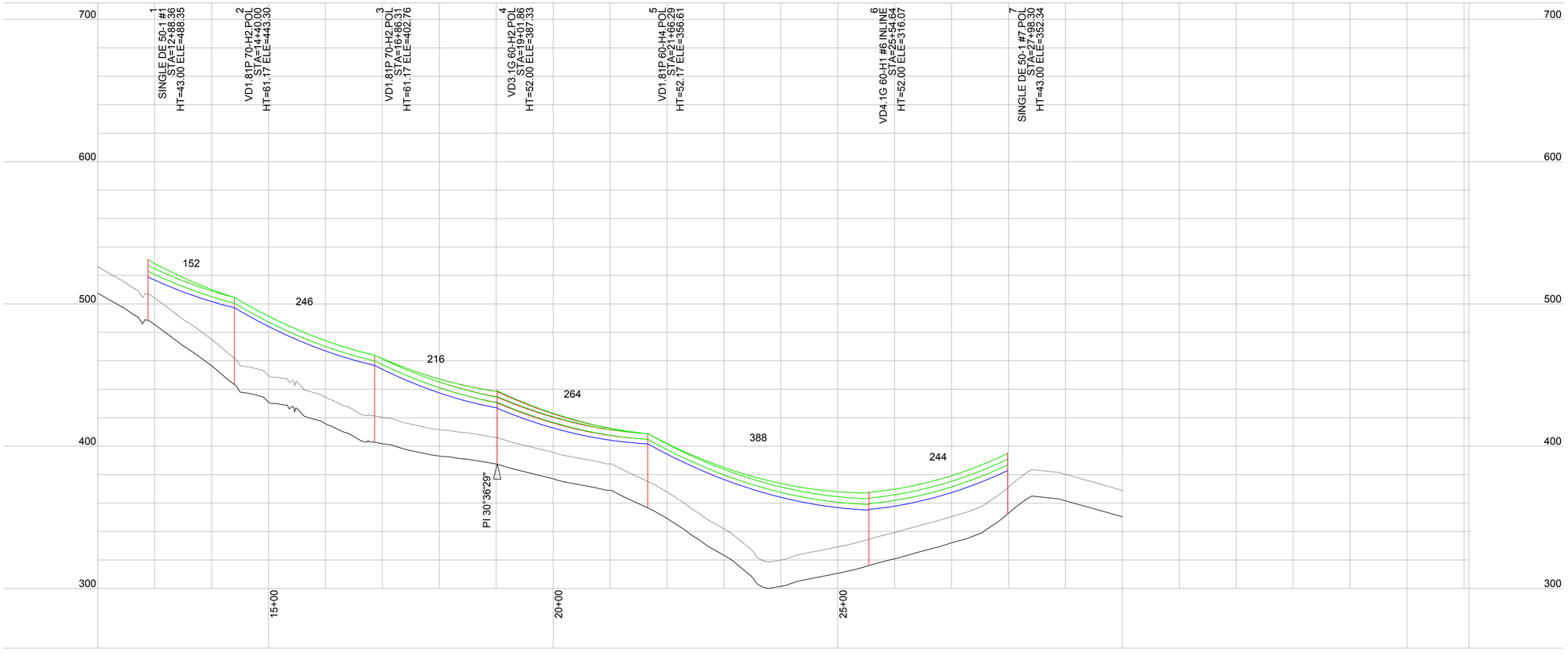

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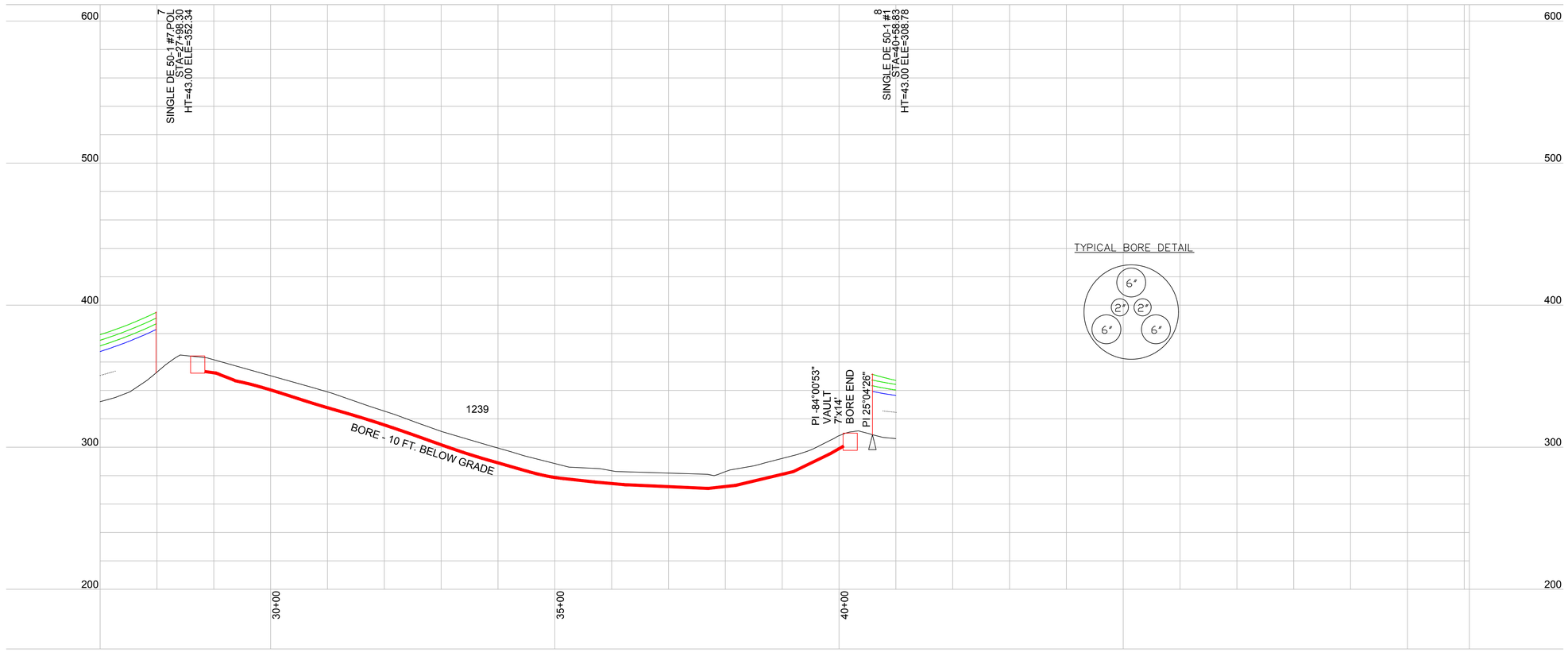

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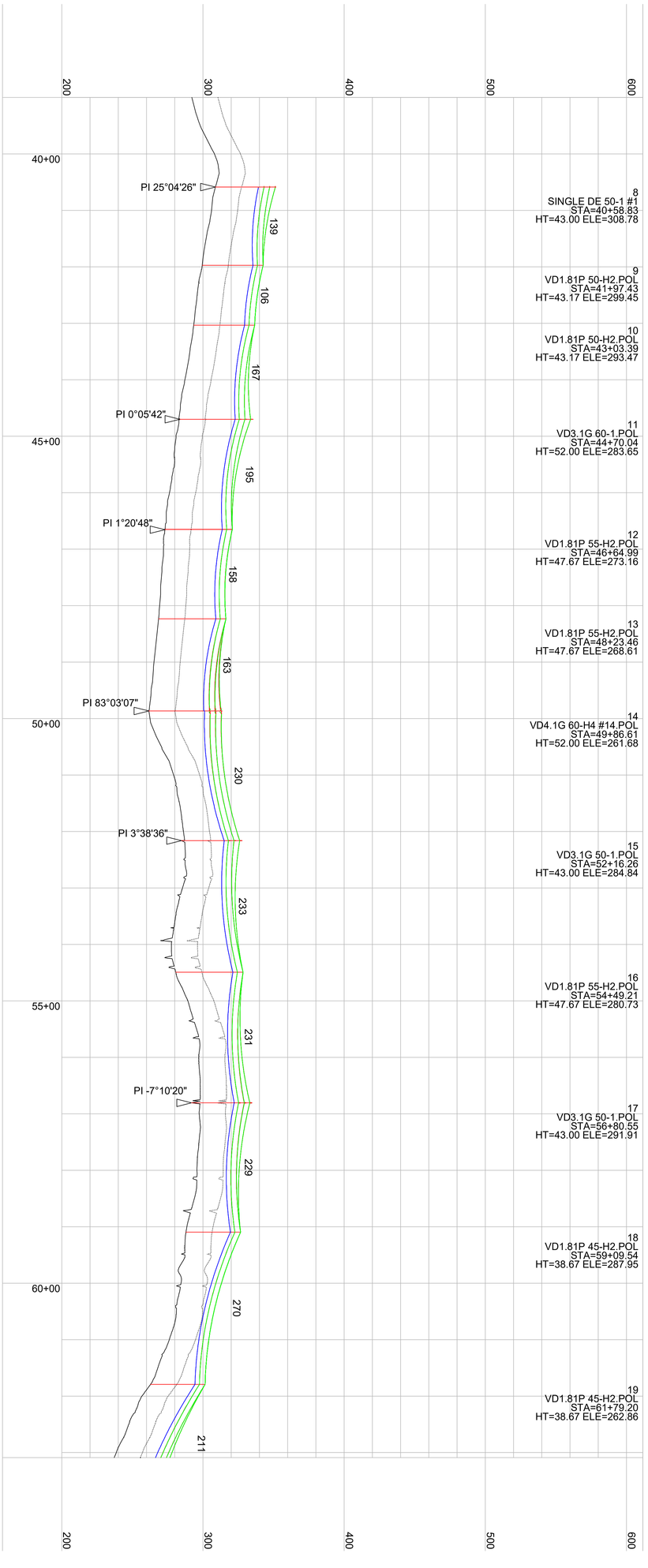

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PLS-CADD DRAWING

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D103

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200.0 FT. HORIZ. SCALE

80.0 FT. VERT. SCALE

NORTH

600
500
400
300
200

VD1.81P.45-H2.P0L
STA=61+79.20
HT=38.67 ELE=262.86

SINGLE DE 50-1.0P1-31.P0L
STA=63+90.54
HT=43.00 ELE=224.54

270
211
PI 0°00'00"

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