Nashville Streets and Pathways Lighting Manual

NDOT

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Preface

A top priority for the Nashville Department of Transportation (NDOT) has always been safety on the transportation network. The City committed to being a Vision Zero community which is a program that aims to reduce traffic related fatalities and severe injuries to zero for all modes. The Vision Zero Action Plan and Implementation Plan were adopted in August 2022. Adequate levels of street and pathway lighting play an important part in reaching this goal.

The Metro Council also passed legislation in 2021 pertaining to outdoor lighting being Dark Skies compliant (BL2020-535). This legislation includes recommendations for the streetlighting fixtures to be converted to Light Emitting Diode (LED) fixtures, provide controls for dimming or turning lights off when they are not needed, and sets the maximum color temperature at 3000 Kelvin.

This manual establishes guidelines that help NDOT reach the goal of zero crashes on the transportation network and work towards reducing light pollution. The implementation of appropriate lighting levels in the different areas and developments across the City will help improve safety of the multimodal transportation network.

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1 PURPOSE OF MANUAL

The purpose of the *Nashville Street and Pathways Lighting Manual* is to provide guidelines for lighting projects that are intended to illuminate the right of way including streets, sidewalks, and multi-use paths located within the public right of way. The manual will serve as a reference for developers, contractors and designers to complete a lighting project starting with determining the type of fixture and pole, required lighting levels, lighting plan sheet set requirements. In addition, fundamental lighting information is provided.

This manual ***does not replace*** any requirements outlined in the Nashville Electric Service (NES) Lighting Guidelines for providing street lighting. It also ***does not replace*** any requirements outlined in the Tennessee Department of Transportation (TDOT) Street Lighting Guidelines on interstates or state routes. Rather, this manual is intended to complement and enhance the requirements in those documents and provide clarification of the review and approval process for street lighting projects in Nashville.

A brief summary of information provided in the sections is below:

- **Section 1: Purpose of Manual –** This section describes the intent of the manual and the information that can be found in each section.
- **Section 2: Fixture, Pole, and Lighting Level Selection** – This section describes the information the designer needs to identify the type of fixture and pole that can used in the lighting design from the approved NES and NDOT list. Definitions of the information to be supplied on the proposed fixture and pole form are included.
- **Section 3: Lighting Fundamentals** – This section provides general information about lighting designs. The basic terminology and concepts used in lighting design are explained for new lighting professionals.
- **Section 4: NDOT Lighting Plan Requirements** – Requirements for preparing the lighting design layout and the information to be shown on the layout sheets are provided in this section. It includes the lighting software requirements, pole spacing layout, voltage drop calculation process, layout requirements for different roadway alignments, and an explanation of pedestrian activity levels. This section also includes a list of items to be shown on the layout sheets and a checklist to be completed by the designer. The review process requesting temporary or permanent removal of fixtures lighting designs is explained in this section.
- **Section 5: Equipment Specifications** – This section includes the general specifications for determining the equipment to be used based on the location of the project. The requirements for projects located in the General Service District (GSD), the list of fixture and poles, the control system requirements, and the process for small cell co-location with lighting equipment are provided in this section.
- **Section 6: Lighting Levels** – Lighting levels for the project vary based on the roadway functional classification and pedestrian activity level. This section also describes required lighting levels for intersections, crosswalks, and midblock crossings.
- **Section 7: NDOT Lighting Process** – Citizens often request removal or installation of street and pathway lights. The section explains the process and criteria used to determine the appropriate response.

2 FIXTURE, POLE, AND LIGHTING LEVEL SELECTION

The first step of a lighting project in Metro Nashville is to determine the fixture and pole type and obtain approval from NDOT. An approved list of fixtures, poles, and mast arm lengths for projects within the jurisdiction of the Metropolitan Government is provided in the NES Lighting Guidelines version 6 which can be found online. This section provides guidance on the information needed to select the appropriate fixture and pole from the NDOT/NES list.

2.1 Determine the Fixture and Pole

Project Location

Metro Nashville has a General Services District (GSD) and an Urban Services District (USD). Streetlights and pedestrian lighting are provided for projects located in the USD. To determine if the project is in the USD, use the link to view the boundary on the Metro map, https://data.nashville.gov/General-Government/Service-Districts-GIS-/xxxs-vvs4.

Street lighting and pedestrian lighting are not typically provided by NDOT in the general services district (GSD), but developments in the GSD may request lighting. The requirements for lighting or lighting equipment in a GSD area are detailed in *Section 5.1 Equipment Specifications – General Service District (Infrastructure Requirements)*.

NDOT has developed Lighting Regions to define the location of different types of fixtures, poles, and mast arms. These regions indicate placement of both Contemporary and Traditional LED fixtures. Notably, the Globe fixtures that are shown on the map are no longer available for new projects. However, the presence of those fixtures on the map acknowledges those fixtures are grandfathered in those specific locations only. The cobra head street light fixtures can be used in all regions. For the latest Street Lighting Region Map, please refer to https://www.nashville.gov/sites/default/files/2024-06/Nashville_Street_Lighting_Districts_Map.pdf.

A lighting form is provided in the Appendix of the manual that should be completed and submitted to NDOT. The proposed pole and fixture to be used by the development are indicated at the bottom of the form.

Tear Drop Fixture

Cobra Head Fixture

Contemporary Fixture

2.2 Lighting Level Requirement

Pedestrian Activity and Land Use

The pedestrian activity level which is influenced by the proposed land use, affects the required lighting level for streets and pedestrian pathways. Since the number of pedestrian trips generated is influenced by the location of uses, proposed land uses will determine the level of pedestrian activity expected by the project. Guidance for determining the pedestrian activity level is explained in more detail in *Section 6 Lighting Levels*.

Roadway Functional Classification

Roadway Functional Classification categorizes roadways based on factors such as the number of trips using the roadway, roadway geometry, and the type of land use in the area. NDOT uses the Major & Collector Street Plan (MCSP) to guide the roadway geometry and characteristics of the transportation network for all users and modes of travel. The lighting designer or engineer should identify the roadway functional classification in the MCSP prior to beginning the lighting layout. The MCSP map can be found here, https://maps.nashville.gov/MCSP/.

After determining the Pedestrian Activity Level and Roadway Functional Classification, refer to *Section 6 Lighting Levels* for the required lighting level of the streets and pedestrian pathways in the project.

2.3 Exception request

The location of the development, the number of pedestrians expected, and the roadway functional classification should guide the designer to the appropriate approved fixture and pole for the street or pathway to be lit and the required lighting level. If the designer wants to install a different fixture from the one required based on the Lighting Region Map an exception should be requested. The exception should be for a different fixture that is on the approved NES/NDOT list. Fixtures not on the approved NDOT/NES list will ***not*** receive an exception. Details regarding exceptions to install in the GSD, are provided *Section 5.1 General Service District (Infrastructure Requirements)*.

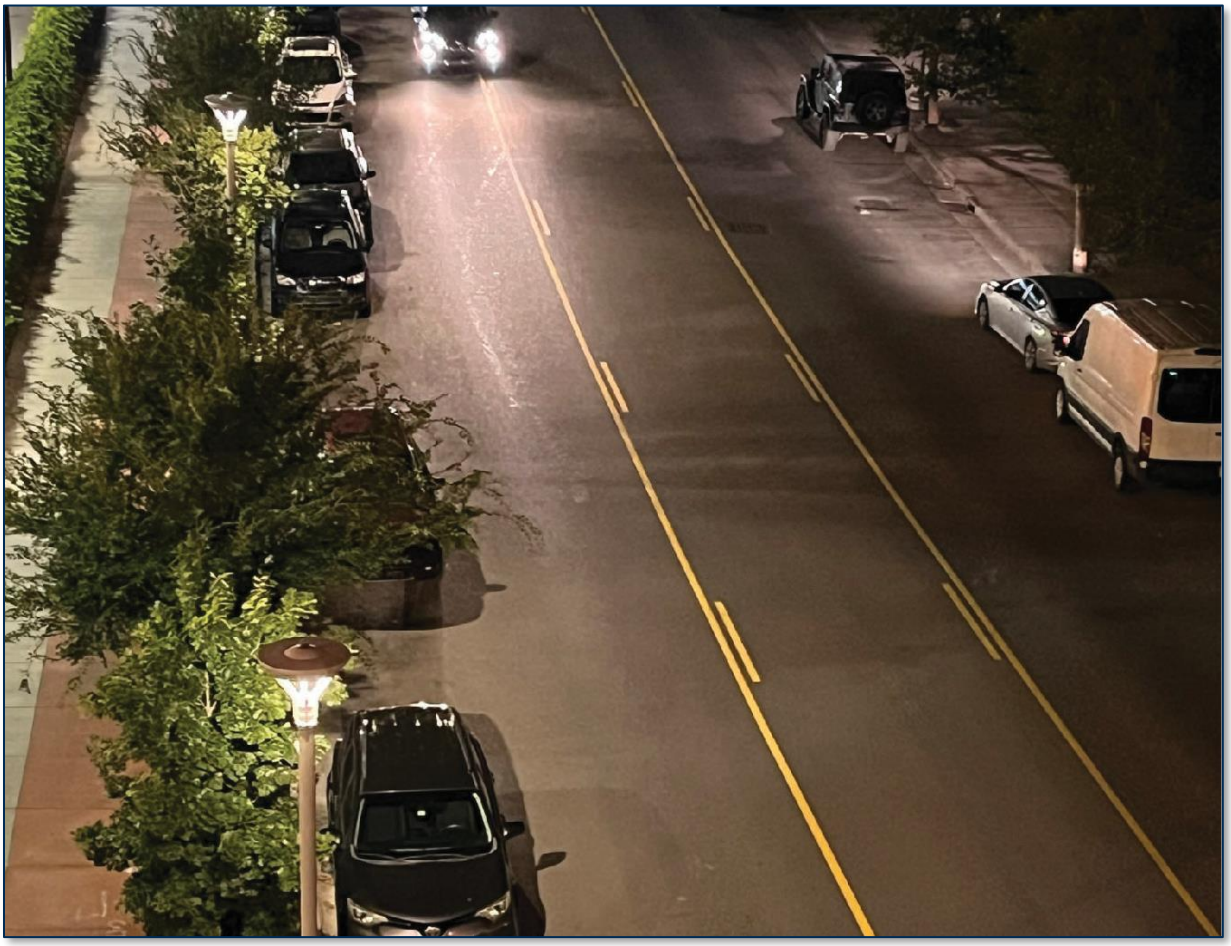
An exception request should be completed if the final lighting level does not meet the levels in *Section 6 Lighting Levels*. Exceptions to the required lighting level will not be granted if the project includes a crosswalk, midblock crossing, intersection, or is located on the High Injury Network as defined in the Vision Zero Action Plan. The High Injury Network can be found online at the Nashville Vision Zero Data Dashboard located at the link.

(https://experience.arcgis.com/experience/74363e0dbb3e43138bc7d451a90817ef/page/High-Injury-Network/)

An exception request can be submitted through an email to the following address: NDOTStreetlights@Nashville.gov. The email should reference the project name, location, and exception being requested. If it is for a fixture or pole, the Lighting Region should be listed and the reason for the exception should be clearly stated. If the request is for a

variance in the required lighting level, the reason for not changing the fixture, pole height, and mast arm length to meet the required lighting level should be clearly stated. Once the information is received, a minimum of one month should be provided for a response.

For some exceptions to be granted, a meter may need to be installed and the funding source or customer to be billed will need to be identified. If this is required, it will be stated in the response to the exception request and the installation of a meter and payment will need to be coordinated with NES. If NDOT is identified as the maintaining agency for the equipment, that will also be stated in the exception response.



11th Avenue Lighting in the Gulch

3 LIGHTING FUNDAMENTALS

This section explains some of the basic definitions and concepts, for professionals that are new to lighting design. It also includes standard requirements for calculations specifying the software, basic lighting level calculation process, process for voltage drop calculations, and placement of lighting fixtures based on roadway alignment.

3.1 Design Factors

Effective lighting design is evaluated using multiple factors. There are six key controlling factors that control the visibility of the roadway or pedestrian way: illuminance, luminance, uniformity, glare, contrast, and adaptation. The standards provided for each factor must be adequately met to ensure visibility is appropriate.

In addition to these six factors, other considerations in lighting design may include color temperature, color rendering index (CRI), energy efficiency, and the type of lighting fixtures used. The specific requirements and priorities for each factor will vary depending on the purpose of the lighting design, and the land development in the area, including residential, commercial, industrial, or public spaces.

By carefully addressing these factors and tailoring the lighting design to the specific needs of the space and its users, designers can create environments that are both visually pleasing and functional, while also promoting energy efficiency and well-being. These factors help motorists with visibility, safety and wayfinding, especially in the context of streets and pedestrian spaces and are very important in the aspect of lighting design.

Visibility

Visibility is an important concern in transportation and pedestrian safety, particularly during nighttime conditions. It involves the ability of individuals, whether they are motorists or pedestrians, to see and detect objects and potential hazards in the environment. The ability for motorists and pedestrians to see and detect objects and other pedestrians at night, is called task visibility. Drivers rely on adequate visibility of obstacles in the roadway, street signs, and other users, like pedestrians in a crosswalk, or bicyclists in a bike lane. The visibility of an object is dependent on the size, brightness, vertical luminance, and contrast of all the objects in an area. Increasing the amount of light (brightness and luminance) that falls on an object increases the task visibility. However, the object's brightness must be balanced with its surroundings to prevent light source glare.

Wayfinding

Wayfinding refers to the visual guidance provided by the lighting, such as a light at the corner of an intersection or lighting a sign. The lighting system may also provide wayfinding by establishing consistent patterns and visual cues. For instance, bollards and pedestrian light poles often signify pedestrian walkways or plazas, while roadway light standards imply a roadway. Some additional aspects that enhance wayfinding include:

Lighting Markers: Objects like bollards, pedestrian light poles, or distinct lighting fixtures that serve as markers or wayfinding elements. These indicate pathways, intersections, or specific areas of interest.

Consistent Patterns: Consistency in lighting design helps people understand the layout of an area. Uniform lighting patterns can guide pedestrians along sidewalks, crosswalks, and plazas, enhancing safety and convenience.

Sign Illumination: Properly illuminated signs are essential for wayfinding. Street signs, directional signs, and informational signs need adequate lighting to be legible and easily noticed.

Zoning: Differentiating between roadway lighting and pedestrian walkway lighting is crucial. Appropriately lighting a zone ensures that motorists and pedestrians can identify their respective areas and routes.

Key / Landmark Locations: Special lighting can be used to highlight significant landmarks, intersections, or architectural features, making them prominent wayfinding points.

Illuminance

Illuminance refers to the amount of light that falls on a surface and is usually measured in lux or foot-candles. Different roadways, sidewalks, and multi-use paths require different levels of illuminance and are the primary lighting metric used for roadway applications. Horizontal illuminance refers to the amount of light falling on a horizontal surface, such as pavement. Vertical illuminance is the amount of light falling on a vertical surface, such as a person, which is critical for pedestrians to be visible to drivers in a crosswalk.

Luminance

Luminance refers to the brightness or the amount of light that is emitted or reflected by a surface. It's important to consider the luminance of light sources and surfaces to create a visually comfortable environment. Balancing the luminance of various elements in a space can help prevent visual discomfort and enhance aesthetics. Luminance is measured in units of candela per square meter (cd/m2). This metric is important because, unlike illuminance, luminance best describes what a person sees. In roadway lighting, pavement luminance refers to how bright the pavement appears to motorists. When the pavement is not lit well, it is harder to see pavement markings and small objects on the road. Higher pavement luminance provides the driver with visual information on the roadway boundaries and in conflict areas such as crosswalks and intersections. Light colored surfaces, such as concrete, reflect more light and require less light to provide the same luminance level as darker, less reflective surfaces, such as asphalt.

Uniformity

Uniformity in lighting design relates to the even distribution of light throughout a space. Achieving uniformity is essential to minimize shadows and dark spots, providing consistent lighting conditions. Uniform lighting contributes to better visibility and reduces eye strain. Our

eyes are continually adapting to the brightest object in our field of view. Uniformity that meets the lighting criteria allows the pavement and sidewalk to be evenly lit. However, surfaces with an average to minimum uniformity of 1:1 may minimize surface contrast of an object, which can cause some objects to blend into the background, making them harder to detect. A balance is required between uniformity and contrast.

Glare

Glare occurs when there is excessive contrast between bright and dark areas in the visual field, leading to visual discomfort and reduced visibility. Properly controlling glare is critical in lighting design. This can be achieved through techniques like using diffusers, indirect lighting, or glare shields. Direct glare is caused by excessive light entering the eye from a bright light source. A system designed solely on lighting levels tends to aim more light at higher angles to increase pole spacing, thus producing more glare potential. With direct glare, the eye has a harder time seeing contrast and details. Direct glare can be minimized with careful equipment selection and placement.

Contrast

Contrast refers to the difference in brightness or luminance between objects or surfaces within a space. Appropriate contrast levels can enhance visibility and aesthetics, but excessive contrast can lead to discomfort and reduced visual performance. High contrast is necessary for good visibility.

However, if the contrast is excessively high, the brighter surface can become a source of glare. Surface or object contrast provides motorists with the most information for guidance. When contrast is diminished, such as flat daylight on snow packed roads, or when objects on the road have the same luminance as the pavement background, then navigation becomes difficult. Lighting designers must carefully manage contrast to balance functionality and comfort.

Adaptation

Adaptation is the process by which the eyes adjust to changing lighting conditions. Lighting design should consider both initial and prolonged adaptation. For example, when transitioning from a bright outdoor environment to a dimly lit tunnel or when coming out of a tunnel and into the bright sunlight or as a driver approaches a well-lit interchange after driving at night along a non-lit roadway, transitional lighting is needed to help the driver's eyes adjust. Adequate lighting design should support the eyes' ability to adapt gradually without causing discomfort.

Light Trespass

Light trespass, often referred to as nuisance glare, is a common issue associated with outdoor lighting. It occurs when light from a source spills over or extends beyond its intended target area and intrudes into spaces where it is not needed or wanted. This can be annoying to neighbors and contributes to light pollution, which has adverse effects on the environment and human health. To minimize light trespass and light pollution, the Illuminating Engineering Society (IES) provides guidance in the IES Recommended Practice for Outdoor Lighting (RP-33). Below are some key points from IES RP-33 on controlling light trespass.

1. *Uncontrolled Light Sources:* Light trespass is often caused by uncontrolled or poorly designed light fixtures. These fixtures allow light to scatter in unintended directions, including into neighboring properties or the night sky.
2. *Shielded Luminaires:* While shielded luminaires are designed to direct light downward and reduce light spill, they may still cause light trespass if they are not properly installed and aimed. Factors such as luminaire height, orientation, and aiming play a crucial role in preventing light from escaping into unwanted areas.
3. *Location and Shielding:* If changing the luminaire's location is not feasible, additional shielding may be necessary to control the direction of light and prevent it from trespassing into unwanted areas. Properly designed shielding can help minimize this issue.
4. *Luminaire Alignment:* It is important to ensure that the luminaire head is level and parallel to the roadway. Aiming the luminaire too far upward or downward can contribute to light trespass by directing light where it is not needed.
5. *Avoid Over Lighting:* Overly bright lighting, known as over lighting, can lead to light pollution. Excessive illumination causes more light to be reflected off surfaces, resulting in poor adaptation between brightly lit areas and adjacent non-lit areas. It is essential to use the right amount of light for a given area to avoid this problem.

Controlling light trespass and light pollution involves using well-designed, shielded luminaires, proper installation and aiming, and avoiding excessive illumination. Following the recommendations outlined in IES RP-33 can help communities and individuals reduce the negative impacts of outdoor lighting. Over lighting areas will increase reflected light which will result in light trespass on adjacent non-lit areas. Over lighting should be avoided as it increases light trespass and light pollution.

Light Pollution

Light pollution, also known as sky glow, is a significant environmental concern caused by the excessive and misdirected use of artificial lighting. It has adverse effects on the night sky and ecosystems.

1. *Causes of Light Pollution:* Light pollution can result from various sources, including:
   - Direct Upward Light: Light fixtures that emit light directly upward into the sky contribute to sky glow.
   - Near-Horizontal Light: Light emitted at near-horizontal angles can scatter and cause sky glow.
   - Reflected Light: Light reflecting off the ground or other objects can also add to light pollution.
2. *Direct Light as the Main Cause*: Among these causes, direct light that goes into the sky (uplight) is often the most significant contributor to light pollution. Luminaires with poor

shielding, such as acorn-style pedestrian lights, globe lights, floodlights, and wall packs, are major culprits in emitting light upward.

Below are some strategies to minimize light pollution:

1. *Use Luminaires with No Uplight (U0 Rating):* To minimize light pollution, it is essential to use luminaires that are designed to direct light downward and have little to no uplight. Luminaires with a U0 rating indicate that they emit minimal or no light above the horizontal plane, making them effective in reducing sky glow.
2. *Dimming Strategies:* Lower Traffic and Pedestrian Volumes: Dim or reduce lighting during periods of lower traffic or pedestrian activity when full illumination is unnecessary.
3. *Curfew Hours:* Implementing curfew hours during which outdoor lighting is reduced or turned off can significantly reduce light pollution during nighttime hours when it is not needed.

Correlated Color Temperature (CCT)

The correlated color temperature (CCT) rating is a metric that describes how "warm" or "cool" a light source appears to be. Light sources with a CCT rating below 3200K are usually considered "warm" and more closely match firelight while those with a CCT at or above 4000K are usually considered "cool" in appearance. Anything between 3200K and 4000K is considered "neutral." See **Figure 3.1** for an example of "warm" and "cool" color temperatures.

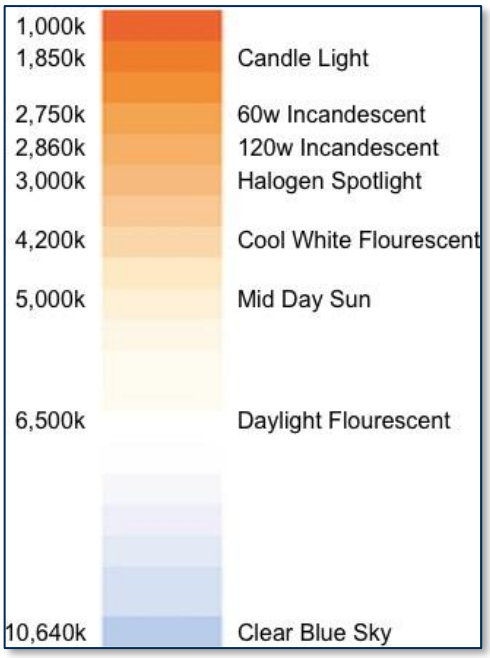


Figure 3.1 Correlated Color Temperature

Here's a breakdown of the common associations:

1. Warm Light (Below 3200K): Light sources with a CCT rating below 3200K are often considered "warm." They emit a yellowish to reddish light, which is similar in appearance to the warm, cozy glow of firelight or candlelight. Fixtures that are Dark Skies compliant are 3000K or warmer.
2. *Neutral Light (3200K - 4000K):* Light sources with a CCT in the range of 3200K to 4000K are considered "neutral" or "daylight white." They emit a more balanced white light, neither too warm nor too cool.
3. *Cool Light (Above 4000K):* Light sources with a CCT rating at or above 4000K are typically considered "cool" in appearance. They emit a bluish-white or cool white light that resembles natural daylight.

There is typically a significant difference in color temperature between High-Pressure Sodium (HPS) lamps and LED lamps used for street lighting.

1. *HPS Lamps:* High-Pressure Sodium lamps have a relatively low color temperature, usually in the range of 2000K to 2200K. This low color temperature gives off a warm, yellowish-orange light. HPS lamps are energy-efficient and have been used for roadway lighting for many years. They have a distinct yellowish color that can affect visibility and color rendering. The warm color may not provide the best visibility or color recognition, especially in inclement weather.

2. *LED Lamps:* LED (Light Emitting Diode) lamps used for roadway lighting typically offer a range of color temperatures, but they are often chosen with higher color temperatures, typically around 3000K or higher. This results in a cooler, bluish-white light that more closely resembles natural daylight. LED roadway lighting is favored for its energy efficiency, long lifespan, and better color rendering properties. The cooler color temperature can improve visibility and color recognition, making it a popular choice for roadways and outdoor areas where safety is a concern. NDOT is installing LED fixtures at all new locations and when old fixtures need to be replaced.

BUG Ratings

The BUG (Backlight-Uplight-Glare) rating system is an important tool used in lighting design to assess and control light pollution, especially in outdoor lighting applications. It is defined in the IES Technical Memorandum TM-15-11, which provides guidelines for evaluating and specifying luminaires based on their light distribution characteristics. The selected luminaire must not exceed the BUG rating requirements listed in Section 5 - Lighting Applications. Here's a breakdown of what each component of the BUG rating system represents:

Backlight (B): Backlight refers to the amount of light emitted behind the luminaire. This component of the BUG rating system is essential to consider because excessive backlight can result in unwanted light trespassing onto adjacent surroundings. However, in some cases, controlled backlighting may be beneficial, such as providing lighting for sidewalks or an amenity zone. Careful consideration is needed to balance the advantages and disadvantages of backlighting.

Uplight (U): Uplight measures the amount of light emitted in the upper 90 degrees of the luminaire's distribution. Low-angle uplight, typically in the range of 80° to 100°, is a major contributor to sky glow, which negatively impacts astronomy, increases smog levels, and obstructs views of the night sky. Higher-angle uplight, greater than 100 degrees, is generally considered wasted light and should be minimized to reduce light pollution.

Glare (G): Glare is related to the potential for light sources to cause discomfort or reduce visibility. Front lights with high angles (above 63°) can lead to disability glare, which can be problematic for drivers. These definitions and guidelines are crucial for lighting designers and authorities to ensure that outdoor lighting installations are designed and specified in a way that minimizes light pollution, protects the night sky, and promotes safety and visual comfort.

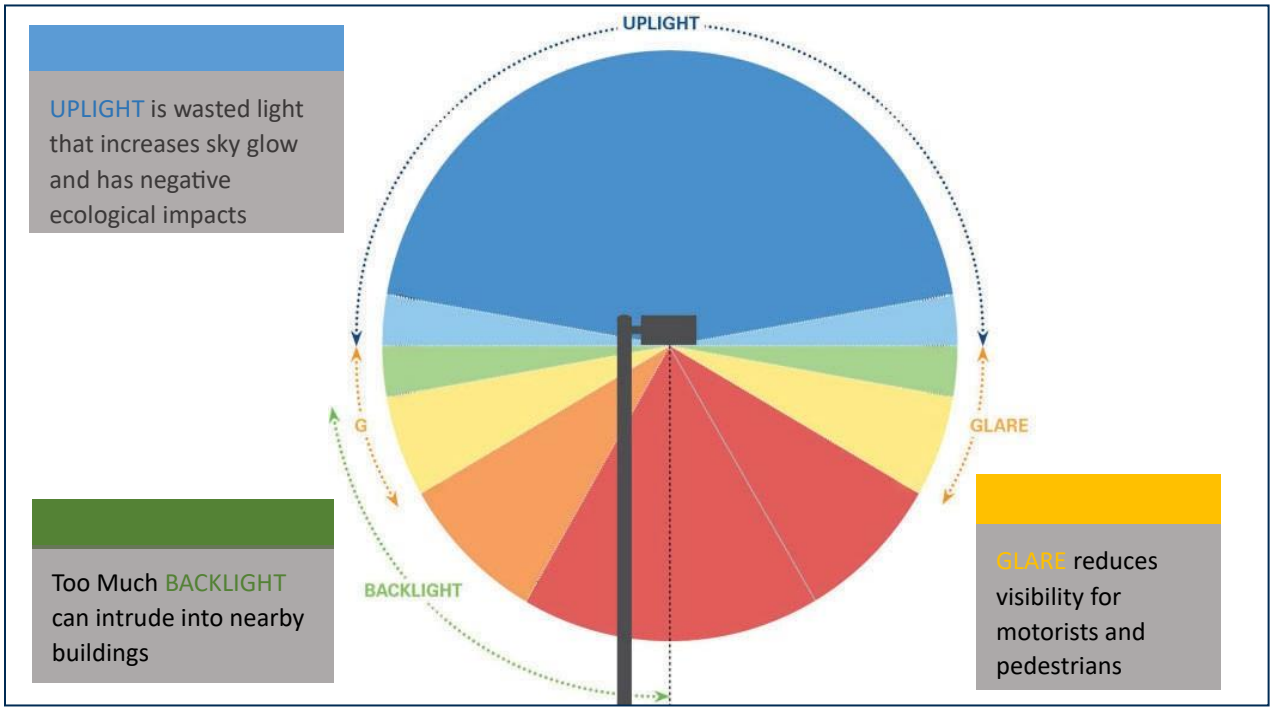


Figure 3.2 BUG Rating

Light Loss Factor / Luminaire Maintenance Factor

The luminaire light loss factor (LLLF), also known as the Luminaire Dirt Depreciation Factor (LDDF) or Luminaire Maintenance Factor (LMF), is a parameter used in lighting design and calculations to account for the reduction in light output from a luminaire over time due to various factors. LLLF is an important consideration in maintaining the desired lighting levels throughout the lifespan of the lighting installation.

Several factors can contribute to the decrease in light output of a luminaire over time:

1. *Dirt and Dust Accumulation*: As luminaires are exposed to the environment, dust, dirt, and other contaminants can accumulate on the fixture's surfaces, including the reflectors and lenses. This accumulation can reduce the amount of light that effectively reaches the target area.
2. *Lumen Depreciation:* Over time, the light source within a luminaire (such as an LED or fluorescent lamp) may experience lumen depreciation. This means that the light source's initial brightness gradually decreases as it ages, impacting the overall light output.
3. *Fixture Design:* The design and quality of the luminaire itself can influence how well it resists dirt accumulation and maintains its efficiency over time.

The LLLF is typically expressed as a numerical factor or percentage and is used to adjust the initial lumens (light output) of a luminaire to account for these factors when calculating the illuminance (light level) in a space. It helps ensure that the lighting design maintains the

required lighting levels for the duration of the luminaire's expected life.

The LLLF is specific to the type of luminaire, the environment in which it is installed, and the maintenance practices in place. Lighting designers and engineers use manufacturer-provided data and industry standards to estimate the LLLF for a given lighting system, allowing them to design lighting installations that account for the expected reduction in light output over time. The light loss level value to be used for calculations generally ranges between 0.7 to 0.9.

3.2 Basic Calculations for Lighting Design

3.2.1 Luminaire, Pole Spacing, and Pole Height

The three main factors in lighting design that affect the lighting levels are the type of luminaire, pole spacing, and pole height. These variables play a critical role in achieving a proper and effective lighting design for various applications, including roadways and pedestrian facilities.

1. ***Type of Luminaire:***
   Luminaire Selection: Choosing the right type of luminaire is crucial. Different luminaires have various light distribution patterns (e.g., flood, spot, streetlight), wattages, color temperatures, and control options. It is important for the lighting design to be performed with the chosen fixture or a fixture of equivalent type, lumens, and BUG rating.

   Light Output: The luminaire's light output, measured in lumens, should match the desired illuminance levels for the area. It's essential to consider the luminaire's photometric data, such as its distribution curve, to ensure uniform and appropriate light coverage.

2. ***Pole Spacing:***
   Spacing Considerations: Pole spacing refers to the distance between consecutive lighting poles or fixtures. The optimal spacing depends on the type of area being illuminated, lighting fixtures, and the luminaire's characteristics. Narrower spacing may be necessary for areas that require higher illuminance levels or uniformity. Where possible, consistent spacing between fixtures is preferred.

   Uniformity: Properly spaced luminaires should provide uniform lighting to avoid dark spots or excessive glare. The goal is to achieve the desired illuminance level consistently across the entire area.

3. ***Pole Height:***
   Height Selection: The choice of pole height affects the distribution of light and the spacing between luminaires.

   Light Distribution: Taller poles can provide broader light distribution patterns and may be suitable for illuminating wider areas. Shorter poles may be used for localized lighting or to minimize light spill onto adjacent properties. Street trees and other obstructions may affect the pole height and should be considered as part of the design.

Light Control: Pole height can also impact light control. Higher poles may reduce light trespass and glare by directing light downward, while lower poles may have a more horizontal spread.

To achieve a proper lighting design, these three variables must be carefully balanced to meet the project's specific goals and requirements.

3.2.2 Voltage Drop Calculation

Preparing voltage drop calculations for roadway street lighting is essential to ensure that the electrical distribution system can effectively deliver power to the luminaires while maintaining adequate voltage levels. Below is a step-by-step guide on how to prepare voltage drop calculations for roadway street lighting:

1. ***Gather Information:***
   Obtain the electrical design specifications for the street lighting project. This should include the electrical layout, conductor sizes, luminaire specifications, and the expected load (total connected wattage of the luminaires).

   Identify the length of the electrical circuits that power the streetlights. Determine the distances from the power source (usually a distribution panel or transformer) to each lighting pole.

2. ***Determine Voltage Drop Limits:***
   Voltage drop should not exceed 5% of the voltage used in the lighting Circuit.

3. ***Calculate Load Current:***
   Calculate the total load current for the street lighting circuit. This can be done by summing up the wattages of all the luminaires and dividing by the voltage (usually 120V, 240V, 277V or 480V)

4. ***Determine Conductor Size:***
   Select an appropriate conductor size (wire gauge) based on the load current and the allowable voltage drop percentage. You can use electrical code tables or online calculators to determine the correct conductor size.

5. ***Calculate Voltage Drop:***
   Use the voltage drop formula to calculate the expected voltage drop along the length of the circuit. The formula is:

   Voltage Drop (Vd) = (2 x Length x Load Current x Resistance) / (Conductor Cross-Sectional Area x Conductivity)

   Length = Length of the circuit (the 2X in the formula is for the length of the circuit to the end and back) (in feet or meters)

   Load Current = Total load current (in amperes)

   Resistance = Resistance of the selected conductor size (in ohms per unit length)

   Conductor Cross-Sectional Area = Cross-sectional area of the selected conductor (in circular mils or square millimeters)

   Conductivity = Conductivity of the conductor material (usually specified in electrical code or standards)

6. ***Compare Voltage Drop with Limits:***
   Compare the calculated voltage drop with the allowable voltage drop limits specified in the electrical code or standards. Ensure that the calculated voltage drop is within the acceptable range.

7. ***Adjust Conductor Size if Necessary:***
   If the calculated voltage drop exceeds the allowable limit of 5%, consider increasing the conductor size and recalculate until the voltage drop is within the acceptable range.

8. ***Document Results:***
   Document your voltage drop calculations, including the conductor size selected and the final voltage drop percentage. This documentation may be required for permitting and inspection purposes.

9. ***Consult with Electrical Engineers:***
   For complex or large-scale street lighting projects, it's advisable to consult with electrical engineers or professionals experienced in lighting and electrical design to ensure compliance with local regulations and best practices.

3.2.3 Requirements for Horizontal and Vertical Curves

Depending on the degree of horizontal or vertical curvature, different pole placements may be needed to meet the required lighting levels. Guidelines for designing street lighting systems to enhance safety and visibility on these roads are provided. They consider factors like road geometry, pole placement, and light distribution to optimize the lighting design for curved and sloped sections of roadways.

Horizontal Curves:

1. **Illuminance Goals**
   Streets with a radius of 2,000 feet (or greater, rounded to the nearest 100 feet) are calculated using the same lighting level tables used for straight streets. This means that the levels should meet the standards set for straight segments of the road.

2. **Closer Spacing for Sharper Curves**
   Sharper radius curves (less than 2,000 feet, rounded to the nearest 100 feet) require closer spacing of luminaires to provide higher pavement illuminance. This ensures that the road remains well-lit through horizontal curves.

3. **Pole Placement**
   Poles should be located behind the sidewalk, curb, guardrail, or other natural barriers. Whenever possible, poles should be placed two feet behind the face of the curb or six feet behind the edge of the shoulder. If sidewalks or a pedestrian pathway are present, poles should be placed outside the clear zone and should provide vertical clearance on the pedestrian pathway to meet ADA guidelines. The pole should be placed outside the pedestrian pathway when possible. This placement helps protect the poles and minimizes potential obstructions for drivers and pedestrians. Poles can be placed in a buffer area if necessary but consideration of the sight between vehicles and

pedestrians should be considered to maintain adequate visibility at crosswalk locations when pedestrians are waiting or crossing the roadway. Clear zone standards that should be met are established in the AASHTO Roadside Design Guides and ADA requirements.

4. **Inside Curve Placement**
   Whenever feasible, place poles on the inside of the curve. Some evidence suggests that poles are less likely to be struck by vehicles if placed on the inside of curves, reducing the risk of accidents and damage to lighting infrastructure.

5. **Luminaire Orientation**
   Aim luminaires with mast arms perpendicular to the centerline of the street. This orientation helps distribute the light uniformly across the road and minimize glare for drivers.

Vertical Curves / Slopes:

1. **Luminance vs. Illuminance**
   Streets with a grade (slope) less than six percent should be designed using luminance criteria. The lighting should meet specific luminance standards for visibility and safety.

2. **Illuminance for Steeper Grades**
   Streets that have a grade of six percent or greatercan be calculated using illuminance criteria. Steeper grades may require closer-spaced luminaires to provide higher pavement illuminance, compensating for the increased elevation changes and potential visibility challenges.

3. **Proper Orientation**
   Ensure that the luminaire and mast arm are oriented so that the luminaire is plumb (vertical) to the streetlight foundation centerline and level (notilt). This ensures that the light is directed appropriately and maintains uniformity along the road.

4 NDOT LIGHTING PLAN REQUIREMENTS

This section provides the NDOT requirements for a lighting design. The requirements for the lighting software, calculations to be shown on the layout sheet, and other information to be included on the lighting sheet set are described.

4.1 Lighting Plan Requirements

4.1.1 Lighting Software

AGi32 lighting software (or equivalent software approved by NDOT) shall be used for NDOT lighting designs. Using the proposed fixtures, poles, and mast arms, the lighting designers shall use the software to calculate photometrics and depict the uniformity on the street, intersections, crosswalks, transit stops, and pedestrian paths showing the lighting levels. The required lighting levels can be found in *Section 6 Lighting Levels*. Contractors/designers shall provide the lighting software photometric files along with the lighting design and layout sheets for review and approval.

4.1.2 Calculation Process

Lighting level calculations on the street are to show the visual layout of photometrics on the streets, pedestrian pathways, intersections, crosswalks, and transit stops using the proposed fixtures, pole layout, and mast arm length. For a straight roadway segment, the steps below explain the required lighting level calculations.

1. Determine the roadway functional classification, pedestrian activity level / land use area, and review the lighting requirements from Lighting Levels (Section 6).
2. Use the fixture and pole from the NDOT/NES approved fixture list. (Note: All fixtures shall be LED.)
3. Using AGi32 or equivalent software calculate and show the photometrics on the roadway, intersections, sidewalk, crosswalks, bike lanes, and transit stops. The appropriate light loss factors shall be included in the calculation process.

Adequate clearance from other items in the ROW are required to meet ADA standards. Light poles shall be placed to provide adequate sight distance at intersections and outside the required clear zone as stated in the AASHTO Roadside Design Guide. National Electrical Safety Code (NESC) provides minimum clearance distances to other overhead utilities. For reference, the NES Electric Service Guidelines include the NESC standards in the appendix.

If the lighting project includes crosswalks at an intersection or midblock crossing the same steps should be followed as listed above. Photometrics should be shown for the entire crosswalk from face of curb to face of curb with a minimum coverage of at least 5 feet on either side of the crosswalk. The vertical calculation grid should be located 5 feet above the finished grade.

4.2 Review Criteria

Final Lighting Designs will be reviewed for the following general information:

Criteria	Requirements
Are the existing conditions shown?	Show the roadway, edge of pavement, striping, bike lanes, crosswalks, utility poles, overhead and underground utilities, signals, transit stops, street trees, and existing light sources that produce ambient lighting in the project area
Are the proposed poles and fixtures listed and placement shown?	Show the proposed lighting pole locations with the height of the fixture and mast arm length specified. Note the pole finish and type of fixture to be installed
Are the roadway functional classification, lighting region, pedestrian activity level, and lighting level requirements noted?	Based on the roadway functional classification, proposed land use, and pedestrian activity level, reference the lighting level requirements from the guidelines for this design
Are the photometrics shown and legible?	Photometric requirements with the summary tables should be included in the sheet set
Are all conduits, pull boxes, and control boxes shown?	Show the conduit runs, pull boxes, and control boxes
Is there a removal diagram for lighting?	Show a removal diagram noting all fixtures and lighting equipment to be deenergized after the new lights are installed
Is there a temporary lighting plan for construction?	If fixtures are being deenergized during construction, a temporary lighting plan should be submitted. A complete temporary lighting plan should be completed with additional information showing how lighting levels will be maintained through construction (i.e. layout sheet showing deenergized fixtures and temporary lighting fixtures and, if necessary, photometrics)

Note: All electrical power runs and power supply are to be coordinated directly with NES.

4.2.1 Lighting Design Layout Checklist

The review checklist is for the lighting designer/engineer to use prior to submitting the plans to be sure all the required elements are included in the plan set. Before lighting plan submittals, review the below checklist to ensure that the lighting design plans are in compliance with NDOT requirements.

Review Checklist	
❖ *Prior to submittal ensure compliance with local, state, and national lighting codes and standards.* ❖ *Verify adherence to NDOT, NES, and TDOT specific design requirements and Metro ordinances.*	
General Information	Project Name and Location
	Roadways Labelled
	North Arrow Shown on Plan
	Plan scale identified
	Legend with symbols and descriptions
	Include 811 Call before you Dig logo
Identify Lighting Fixture and Equipment	Luminaire type, lumen output, wattage, finish (Per NDOT/NES approved Luminaire List)
	Light Standard height, type, finish (Per NDOT/NES Approved Pole List)
	Mast Arm type and length
	Foundation type
	Photocell or control node
	Identify and locate pull boxes (See NES Guidelines)
	Conduit located and size and type labelled
Lighting Design Sheets	Roadway layout and striping with lane markings and crosswalks
	Existing utilities both overhead and underground labelled
	ROW line shown and labelled
	Removal diagram with equipment being removed labelled
	Curb, shoulder, sidewalk, driveways, alleys, and transit stops labelled
	Information from Pre-Submittal Form – Lighting Region, Pedestrian Activity Level, Roadway Functional Classification, High Injury Network, Crime Area
	Clearly locate lighting fixtures and poles

Lighting Level Calculation	Photometric values shown on the layout and a photometric summary table included
	Check to be sure the photometrics meet illuminance and uniformity requirement based on roadway functional classification and pedestrian activity level
Existing Streetlights	Existing streetlights within project limits that will remain in place
Remove and replaced Streetlights	Streetlights to be removed and replaced, within project limits, clearly denoting where the streetlight will be moved from and the proposed new location.
New Streetlight	New streetlights shown on plans, symbol to match what is shown in the legend
Deenergized Streetlight	Label streetlights being permanently removed and streetlights to be deenergized during construction only
Streetlight Clearances	Outside other utility conflicts (utility locations determined during SUE investigation)
Power Source Location	NES power source (transformer, secondary riser, or pullbox) shown with feeder to lighting equipment (to be coordinated with NES)
Conduit Type	Schedule 80 PVC (min.) when located under roadway
	Schedule 40 PVC (min.) when located under sidewalk or softscape
Wire Sizes	Each wire size, type, and grounding wire to be identified per circuit. See NES requirements for sizes available.
Trenching / Bore Depth	Trenching depth identified (typically 24”)
	Bore depth identified (typically 36” to 48”) 48” maximum depth
One-Line Diagram	*Not required when resetting light standards or connecting to an existing lighting control center or meter power pedestal*
	New/ existing transformer
	Service lateral wire size and type and ground wire size
	Service lateral conduit size and type
	Short circuit
	Maximum service lateral distance from transformer
	Typical connected load

Lighting Control Center / Meter Power Pedestal (Not NES Streetlighting)	NEMA 3, 3R, or 4 rated enclosure
	Cold sequence meter (disconnect ahead of meter)
	Meter housing
	Load center
	Contactors
	Ground rod (confirm 8'-0" in contact with earth
	120V GFCI maintenance receptacle
	Photocell (confirm no photocell is located on the streetlights if located on the lighting control center)
Panel Schedule	Voltage and phase
	Main breaker size
	Enclosure NEMA rating
	Minimum Amp Interrupting Current (A.I.C)
	Breaker size and number of poles
	Circuit number
	Load description
	Load per circuit
	Load per phase
	Total estimated load

4.3 Removal Request

During construction, it is sometimes necessary to deenergize or remove streetlights and equipment, in order to build the new development. An unlit road can create unsafe driving conditions and an environment with a higher tendency for crime. When streetlights need to be removed, NDOT should be notified and a plan should be established to create a safe environment for drivers, pedestrians, bicyclists, micro mobility users, and transit users with a temporary lighting plan.

4.3.1 Temporary Lighting Removal

A form has been created by NDOT that identifies the poles to be deenergized, who is responsible for the project, who is responsible for paying for the power, and identifying the temporary lighting. With the submittal of this form, the applicant should provide enough information so that NDOT can identify if the lighting level will, at a minimum, remain the same throughout construction. A removal diagram or demolition plan and the location of

the temporary lights will be the minimum layout accepted with the forms. In some cases, a photometric layout of the temporary lighting may be required.

4.3.2 Permanent Lighting Removal

If the lighting equipment will be permanently removed, it should be noted on both the temporary lighting plan and the proposed lighting layout. On the proposed lighting layout it should be part of the removal diagram.

5 EQUIPMENT SPECIFICATIONS

This section provides information for designers to identify equipment to be used for lighting projects. An approved list of fixtures, poles, and mast arm lengths for the City is provided in the NES Lighting Guidelines. This list is further refined by the Lighting Regions that determine the type of fixture, pole, and mast arm length that can be chosen from the NDOT/NES approved list. The Lighting Regions shown on the map are intended to provide boundaries for the special lighting districts. Residential neighborhoods that may have lighting other than cobra heads are not depicted on the map and require a special NDOT exception to be requested when it is desired. See the process for an exception request in Section 2.3.

5.1 General Services District (Infrastructure Requirements)

Lighting for roadways and pedestrians is not provided by NDOT in the general services district (GSD). Developments in the GSD may request lighting when being developed or in the future. If a development is requesting lighting, it will require the lights to be provided by the developer and the development will be required to pay for the installation with the understanding the owner will be billed for the services in the future. If it is a residential subdivision, the Home Owners Association (HOA) or equivalent neighborhood group with a funding source will be required to sign an agreement to pay for the services.

There are areas of the GSD where NDOT may request infrastructure for lighting to be installed for a future lighting project. These locations will require the installation of conduit and pull boxes for future pole foundations, poles, and fixtures.

5.2 Lighting Fixtures and Poles

NDOT has developed Lighting Regions to define the location of the different types of fixtures, poles, and mast arms. The map at https://www.nashville.gov/sites/default/files/2024-06/Nashville_Street_Lighting_Districts_Map.pdf is intended to define the location of Contemporary and Traditional LED fixtures. The Globe fixtures that are shown on the map are no longer available for new projects, but the locations of those fixtures are shown to acknowledge the specific locations where they are grandfathered in. The cobra head street light fixtures can be used in all regions. When completing the fixture and pole form explained in *Section 2 Fixture, Pole, and Lighting Level Selection*, this map should be referenced. The fixtures and poles chosen should be from the approved NDOT/NES list provided in the NES Lighting Guidelines. The process for requesting an exception to the fixture and poles in the NDOT/NES approved list is explained in *Section 2 Fixture, Pole, and Lighting Level Selection*.

5.3 Control Systems

As the Metro Nashville moves forward the ability to control the amount of light emitted from the fixtures needs to be controlled either in the field or remotely depending on the location. This requires the fixtures to be ordered with the equipment needed for dimming features and sensors needed now or in the future. The fixtures listed in the NES Guidelines should provide a 7-pin receptacle that will allow the installation of remote dimming and control devices with the sensors the city requires.

The pedestrian activity level as defined in *Section 6.1 Pedestrian Activity Level* will determine the need for the control device. High and Medium pedestrian levels will require a remote-control device. For lower pedestrian traffic areas and rural lighting, a remote device for dimming will not be required unless specified by NDOT.

5.4 Small Cell Co-locations

If a company requests to co-locate small cell (5G) facilities at an existing light pole location, all applicable permits must be obtained from the City prior to installation. If the light pole is owned by the City, the provider should submit an application to the City permitting department. If the streetlight is mounted on a utility pole owned by NES, the provider should obtain permission from NES to co-locate. Detailed guidance on small cell locations will be provided in the *NDOT Small Cell Policy*.

6 LIGHTING LEVELS

This section provides guidance for the lighting levels required on roadways based on functional classification and pedestrian activity level. It also includes lighting levels for intersections, sidewalks, and transit stops. Lighting levels follow industry standard values established in the IES American National Standard Practice for Roadway Lighting and Parking Facility Lighting (RP-8) and AASHTO *Roadway Lighting Design Guide*.

The Lighting Design Process begins with the designer identifying the approved fixture and pole height based on the location of the project. Prior to the design layout, the designer will submit the fixture and pole form that identifies the appropriate fixture and pole for the project using the NDOT/NES approved fixture list. If bike facilities, sidewalks, or other pedestrian facilities such as crosswalks are part of the project, a fixture and pole should be chosen to appropriately light all the facilities and limit light trespass.

After NDOT approves the fixture(s) and pole(s), the designer will use lighting design software to lay out the lighting fixtures, poles, and mast arms to achieve the required lighting levels for the area. An iterative process should be used to determine the best mast arm length, pole location and pole pattern. All lights should be mounted plumb with the roadway to be compliant with the Dark Sky Ordinance.

6.1 Pedestrian Activity Level

The amount of lighting required for pedestrians depends on the number of pedestrians, type of interaction with other transportation modes, and the land use in the area. The levels of pedestrian activity are high, medium, and low. They are defined by the existing number of pedestrians, future pedestrians expected by the proposed land use, and pedestrian facilities on the transportation network in the development area. The proposed land use should consider the intensity allowed by current zoning as well as the intensity of the proposed development. The pedestrian facilities should include neighborway bikeways and on-street walkways. The pedestrian activity levels are presented in **Table 6.1**.

Table 6.1 Pedestrian Activity Level

Pedestrian Activity Level	Existing Walking Trips (per hour)	Land Use
High	≥50	Event Space Mixed-Use Development Retail
Medium	25≥ X ≤50	Office Neighborhood Commercial Transit Stop
Low	<25	Residential

To determine the pedestrian activity level, both the walking trips and land use should be evaluated individually. From the two categories, the evaluation resulting in the highest rank will determine the activity level to be used in the design. For example, if a neighborhood commercial development with sidewalks is proposed in an area with 30 pedestrians in the peak hour, both the existing walking trips per hour and the land use result in medium pedestrian activity level so the medium activity level should be used for the lighting level analysis. If for example, a mixed-use development with sidewalks is proposed in an area with 20 pedestrians in the peak hour, the high pedestrian activity level should be used when evaluating the lighting levels since the type of land use it is a high pedestrian activity level.

6.2 Intersections and Crosswalks

6.2.1 Traffic Signal Mounted Streetlight / Intersection

Determining the lighting levels for streetlights used to illuminate the roadway at intersections requires consideration of the functional classification of both intersecting streets. **Table 6.2** includes lighting levels required based on the roadway functional classification and the pedestrian activity level expected in the area.

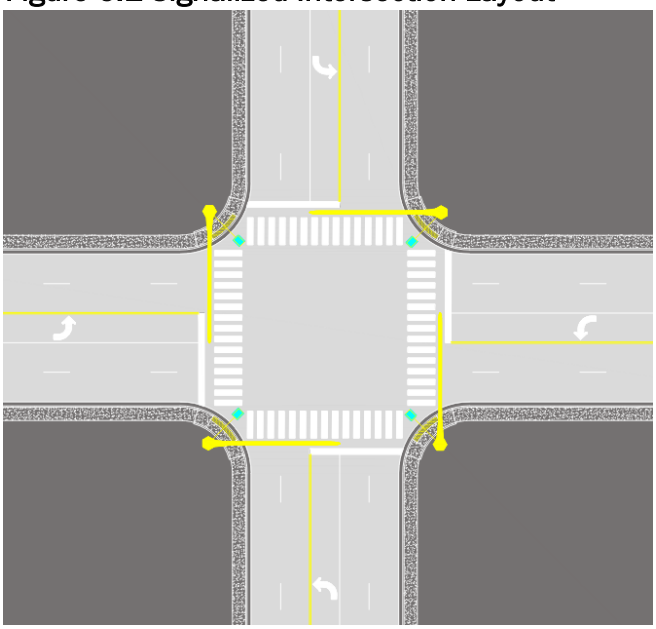
Table 6.2 Intersection Lighting

Functional Classification (Main /Side Street)	Average Illuminance (fc) *Pedestrian Activity Level*			Avg:Min Illuminance
	High	Medium	Low	
Arterial*/Arterial*	3.2	2.4	1.7	3
Arterial*/Collector Ave	2.7	2	1.4	3
Arterial*/Local	2.4	1.9	1.2	3
Collector Ave/Collector Ave	2.2	1.7	1.1	4
Collector Ave/Local	2	1.5	0.9	4
Local/Local (>30mph)	1.7	1.3	0.7	6
Local/Local (<30mph)	n/a	n/a	n/a	n/a

Note: See Section 6.1 for Pedestrian Activity Level
*Includes Arterial Parkway and Arterial Boulevard

Typical lighting layout at a signalized intersection is depicted in **Figure 6.1.** It shows the lighting mast arm and fixture at a 45-degree angle so the light does not shine over the mast arm. If crosswalks are present at the intersection, lighting levels should meet the requirements for lighting pedestrians in the crosswalk. This may require light poles on the approach similar to lighting required for mid-block crosswalks.

Figure 6.1 Signalized Intersection Layout



6.2.2 Crosswalks (Midblock and Intersection)

Lighting at crosswalks needs to illuminate the pedestrians waiting on the sidewalk and as they are walking across the crosswalk in the roadway ROW. Crosswalks are typically striped at both signalized and stop controlled intersections. However, there are some cases where uncontrolled crossings will have cross walks installed. As part of all crosswalk installations the lighting levels through the crosswalk area should meet the minimum levels to ensure pedestrians are visible to other users especially drivers in advance of the crossing. The lighting levels required for crosswalks are listed in **Table 6.3** in accordance with industry standards.

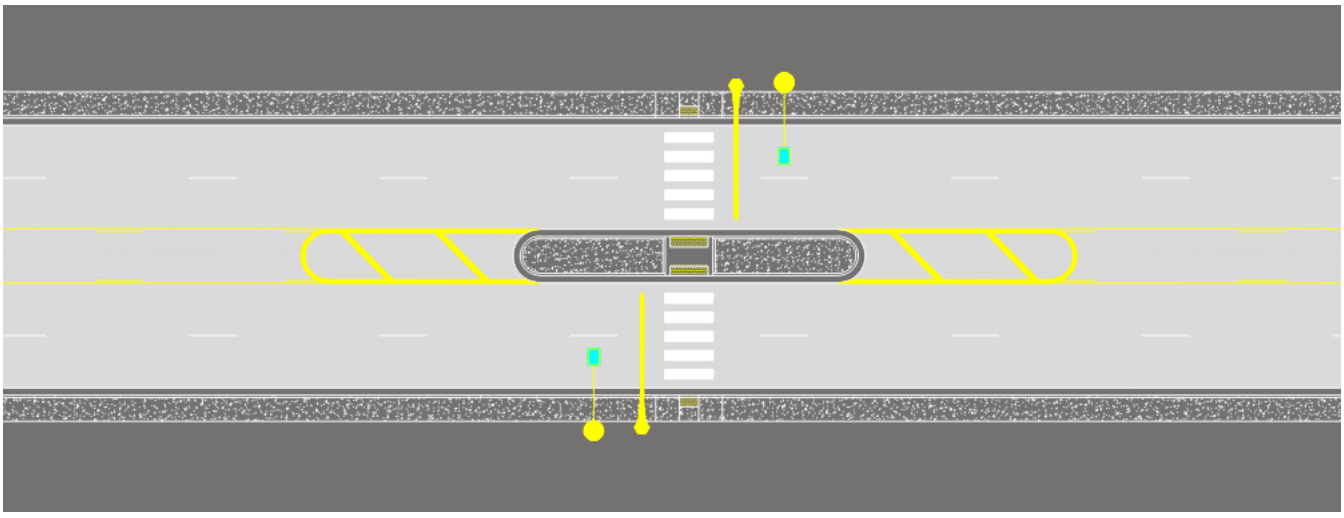
Table 6.3 Crosswalk Lighting

Functional Classification (Main / Side Street)	Average Illuminance (fc)						Avg:Min Illuminance
	High		Medium		Low		
	Hor.	Vert.	Hor.	Vert.	Hor.	Vert.	
Arterial*/Arterial*	3.2	1.6	2.4	1.2	1.7	1	3
Arterial*/Collector Ave	2.7	1.3	2	1	1.4	1	3
Arterial*/Local	2.4	1.2	1.9	1	1.2	1	3
Collector Ave/Collector Ave	2.2	1.1	1.7	1	1.1	1	4
Collector Ave/Local	2	1	1.5	1	0.9	1	4
Local/Local (>30mph)	1.7	1	1.3	1	0.7	1	6
Local/Local (<30mph)	n/a	1	n/a	1	n/a	1	n/a
Midblock Crossing	3.7	1.8	2.8	1.4	1.8	1	4

Note: See Section 6.1 for Pedestrian Activity Level
*Includes Arterial Parkway and Arterial Boulevard

The lighting levels shown in the table depend on the pedestrian activity levels in the area. These are defined in *Section 4.3 Lighting Requirements – Removal Requests*. Typical lighting locations for a midblock crossing are depicted in **Figure 6.2**. As shown light poles with fixtures are typically located on the approach to the crosswalk to provide time for approaching vehicles and bicyclists to identify pedestrians and react in time to stop ahead of the crossing.

Figure 6.2 Midblock Crosswalk Lighting



6.3 Roadway Functional Classification

The list of poles and fixtures provided by NDOT/NS shall be used for all roadway functional classifications discussed in this section.

6.3.1 Interstates

For lighting projects on the interstate inside the City limits, TDOT will be the primary reviewer and will coordinate with NDOT and NES regarding the lighting. The designer should review the TDOT lighting requirements manual for the lighting levels required on the roadway.

6.3.2 State Routes

For lighting projects located on State Routes inside the City limits, NDOT, as the lead agency, will provide the lighting levels based on the roadway functional classification. The project designer should review the TDOT requirements based on the roadway functional classification. If the lighting level requirements are not equivalent, the TDOT lighting manual levels will take precedence.

6.3.3 Arterial (Parkway and Boulevard)

An Arterial Parkway and Arterial Boulevard carry a higher number of vehicular trips and typically have a higher posted speed limit than lower classified roadways. The lighting levels need to provide visibility to the roadway and immediate area outside the path of travel to allow adequate reaction time. The proposed lighting levels shown in **Table 6.4** are based on pedestrian activity levels. The required lighting levels for sidewalks or adjacent walking paths are also included in the table.

Table 6.4 Arterial Parkway and Arterial Boulevard

Pedestrian Activity	Roadway		
	Avg. Luminance (cd/m^2)	Luminance Avg:Min Ratio	SW/Adjacent Path Avg. Illuminance
High	1.2	3	0.9
Medium	0.9	3	0.5
Low	0.6	4	0.4

Note: See Section 6.1 for Pedestrian Activity Level

Typically, one-sided layouts are preferred for the utility and power runs to be maintained on one side of the roadway. This layout is usually able to provide adequate lighting levels on roadways with one to three lanes. An alternative layout for large roadways, is alternating the poles on both sides of the road or opposite spacing of poles when the center of the roadway needs additional lighting to meet the requirements. Additional pedestrian lighting may be required or requested for sidewalks or pathways if appropriate lighting levels are not met on the pedestrian pathways. In some instances, on wide roadways lighting is required on both

sides of the roadway opposite each fixture. An example of a roadway segment with the one side lighting layout is depicted in **Figure 6.3. Figure 6.4** shows the layout with alternating fixtures.

Figure 6.3 One Side Lighting Layout

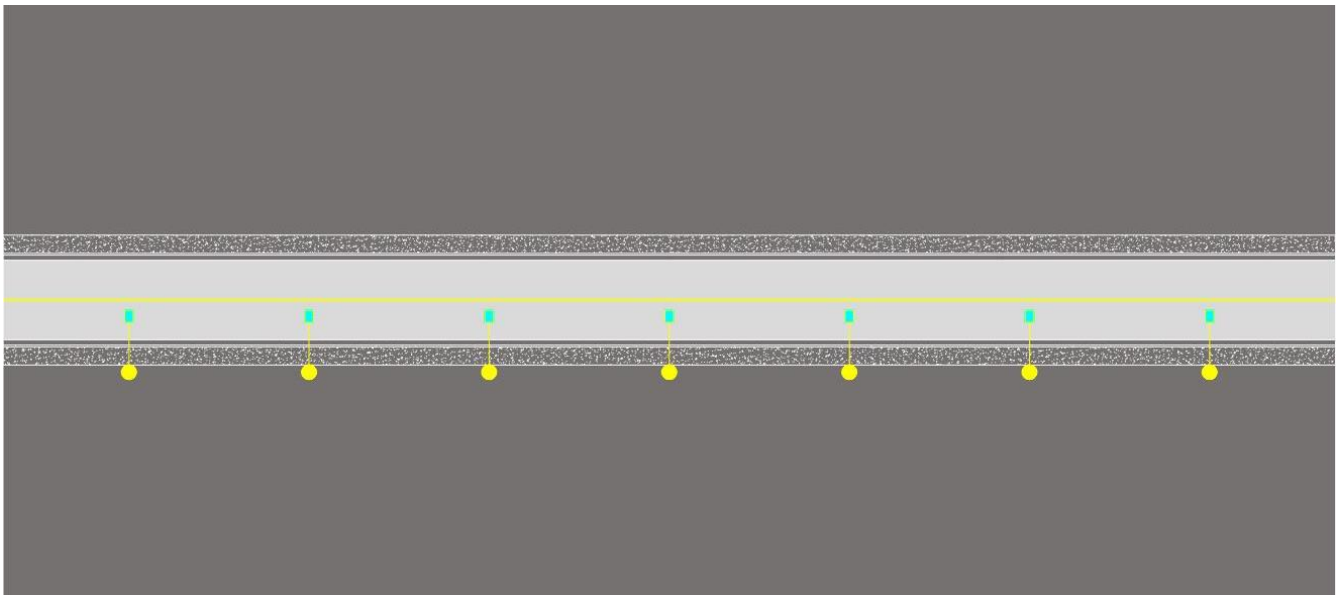
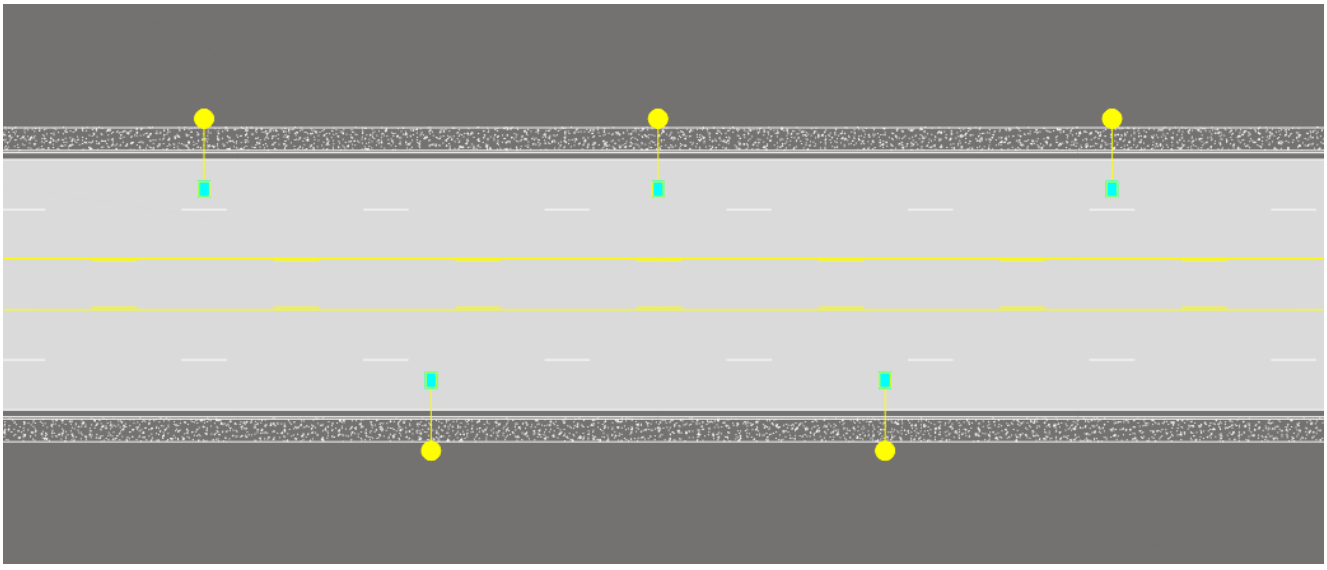


Figure 6.4 Alternating Lighting Layout



6.3.4 Collector Avenue

A Collector Avenue provides a connection between arterial roadways and local roads and sometimes supplies access to parcels. These roads typically have slower speed limits and fewer vehicles than the arterial roadways. The lighting levels are intended to provide visibility of the roadway and crosswalks while limiting the amount of invasive light. The lighting levels in **Table 6.5** are intended to provide safe movement of vehicles, pedestrians, and bicyclists along the roadway and sidewalks or pathways adjacent to the road.

Table 6.5 Collector Avenue

Pedestrian Activity	Roadway		
	Avg. Luminance (cd/m^2)	Luminance Avg:Min Ratio	SW/Adjacent Path Avg. Illuminance
High	0.8	3	0.9
Medium	0.6	4	0.5
Low	0.4	4	0.4

Note: See Section 6.1 for Pedestrian Activity Level

Similar to the Arterial lighting layout, it is preferred for the poles and fixtures to be on one side of the roadway for power and electrical wiring to be on one side of the road. If an alternative layout is needed to meet the lighting levels, a layout alternating fixtures and poles on both sides of the road can be used.

6.3.5 Residential and Downtown Local

Local roadways provide direct access to parcels and are typically located closer to buildings and homes than higher functionally classified roadways. The lighting levels are lower than those required on higher functionally classified roadways and vary depending on the pedestrian activity level. Lighting levels for Local Downtown and Local Residential roadways are shown in **Table 6.6** and **Table 6.7**, respectively.

Table 6.6 Local Downtown Lighting

Pedestrian Activity	Roadway		
	Avg. Luminance (cd/m^2)	Luminance Avg:Min Ratio	SW/Adjacent Path Avg. Illuminance
High	0.8	3	0.9
Medium	0.6	4	0.6
Low	0.4	4	0.3

Note: See Section 6.1 for Pedestrian Activity Level

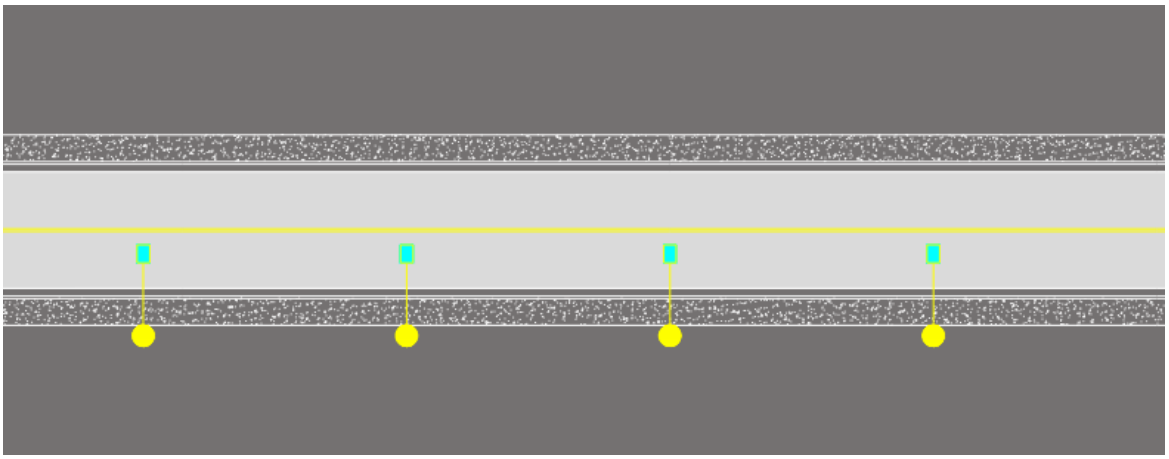
Table 6.7 Local Residential Lighting

Pedestrian Activity	Roadway		
	Avg. Luminance (cd/m^2)	Luminance Avg:Min Ratio	SW/Adjacent Path Avg. Illuminance
High	0.5	6	0.9
Medium	0.3	6	0.6
Low	n/a	n/a	n/a

Note: See Section 6.1 for Pedestrian Activity Level

A typical lighting layout for a two-lane local roadway is shown in **Figure 6.5** where poles are located so that an appropriate lighting level is possible. If additional lighting is needed or pedestrian lighting is requested a photometric layout should be provided to determine if shields are needed to prevent lighting from encroaching on the parcels.

Figure 6.5 Local Road Lighting Layout



6.3.6 Residential and Downtown/Commercial Alley

The Metro Nashville has alleys in business and residential areas that serve different purposes, but both require lighting. Ensuring adequate lighting in alleys creates a safe area for pedestrians, business owners, and residents regardless of the land use. Proper lighting can help prevent accidents, deter crime, and create a more welcoming environment. Table 6.8 shows the lighting levels for both business and residential alleys. When analyzing the lighting level of alleys, if fixtures are mounted on buildings that illuminate the alley and can be identified, they should be included in the photometric analysis.

Table 6.8 Alley Lighting

	Avg. Luminance (cd/m^2)	Luminance Avg:Min Ratio
Downtown/ Commercial	0.6	4
Residential	0.4	6

6.4 Bikeways and Multi-use Paths

Bicycle facilities can be provided on the roadways and in the ROW behind the back of the curb. Bicycle facilities, such as bike lanes and bike cycle tracks, provided on the roadway should be lit according to the roadway functional classification. Multi-use paths or bicycle facilities that are provided within the ROW and maintained by NDOT should be illuminated according to the pedestrian way lighting levels provided for the roadway functional classification. If a multi-use path is inside an area maintained by Metro Parks, the lighting levels needed for the multi-use path will be determined by Metro Parks. That layout must be reviewed and approved by Metro Parks.

6.5 Pedestrian Paths

In addition to roadway lighting, pedestrian lighting for pedestrian paths encourages walking trips while providing a safer environment. The level of lighting needed on a pedestrian path or sidewalk is determined by the pedestrian activity level and is shown in **Table 6.9**.

Table 6.9 Pedestrian Lighting

Pedestrian Activity Level	Horizontal Illuminance (Avg. fc)	Vertical Illuminance (Avg. fc)	Uniformity Ratio (Avg:Min)
High	0.9	0.5	4
Medium	0.5	0.2	4
Low	0.4	0.1	4

Note: See Section 6.1 for Pedestrian Activity Level

6.6 Replacing Existing Luminaires

When replacing existing lighting fixtures, the designer should ensure that the new lighting meets the necessary standards and requirements for the specific location. Some lighting projects will require replacing existing lighting fixtures. A photometric layout showing the new lighting levels should be submitted when new fixtures are required, using the new lighting fixtures and the existing light pole and mast arm length. The required level will be determined by the Roadway Functional Classification and Pedestrian Activity Level. If the required lighting level is not met, supplemental lighting should be used to meet the required lighting level for the location.

6.7 Adjacent Legacy Fixture Lighting Projects

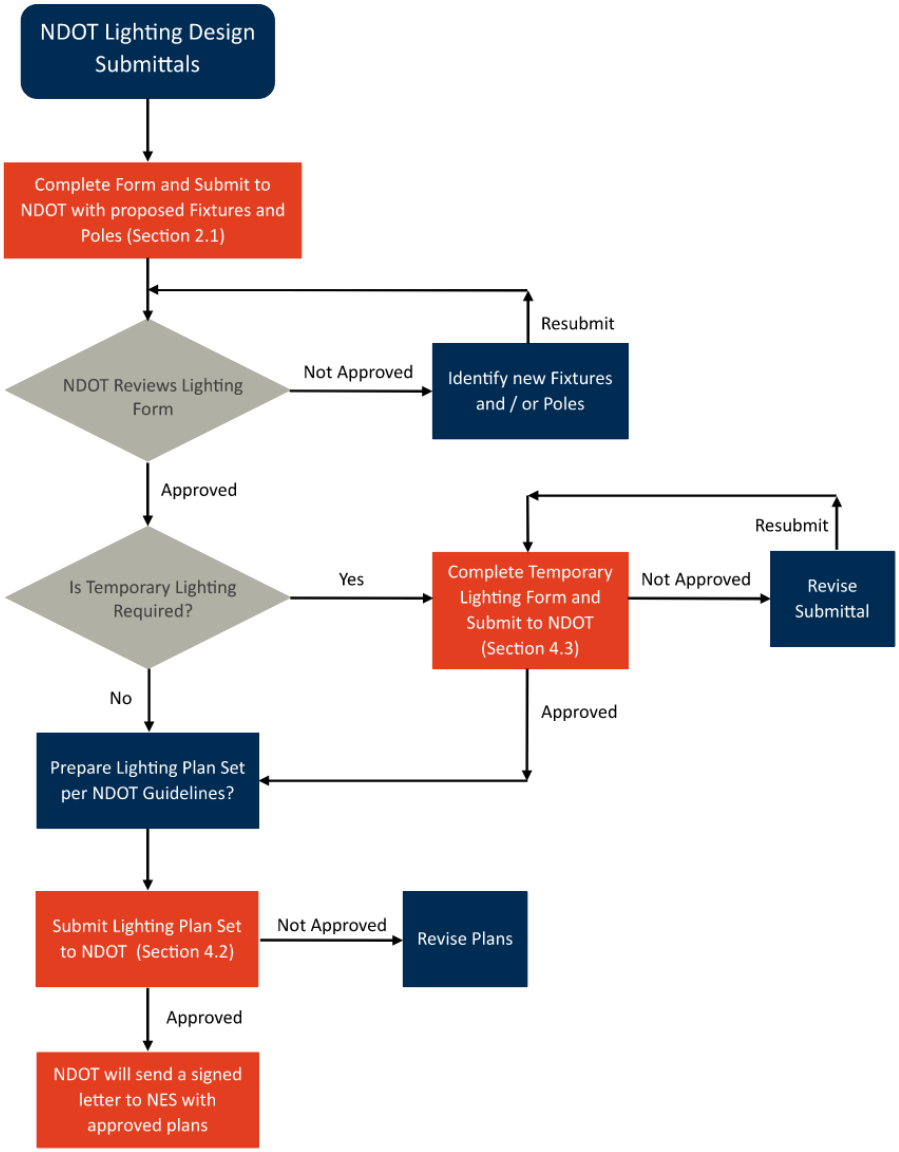
Within the Metro Nashville there are multiple light fixtures installed depending on the area. As Nashville transitions to LED lighting, the type of fixtures being installed will be guided by the Lighting Regions Map at https://www.nashville.gov/sites/default/files/2024-06/Nashville_Street_Lighting_Districts_Map.pdf. If a project is located on the border of two different lighting regions, NDOT will work with the developer to determine the appropriate fixture from the NDOT/NES approved list. This process will occur at the beginning of the lighting project as outlined in *Section 2 Fixture, Pole, and Lighting Level Selection* which explains the fixture and pole selection process.

7 NDOT LIGHTING PROCESS

The Lighting Manual has provided the necessary information for a street or pathway lighting project located in Nashville. This section summarizes the submittal process and explains the coordinating agency responsibilities.

7.1 Summary of NDOT Lighting Design Process

The flowchart below summarizes the coordination process for a lighting project in Nashville. This flow chart only includes the coordination with NDOT when they are the managing agency of the design. The coordination required with NES for power and other lighting equipment is outlined in the *NES Lighting Guidelines*.



7.2 Agency Responsibilities and Coordination

NDOT and NES

For roadway lighting projects inside Metro Nashville Davidson County except for interstates, NDOT is responsible for the lighting levels and type of fixture and pole installed. For state routes, photometrics on state routes will be submitted to TDOT for their approval. However, NDOT has a contract with NES to maintain the right of way lighting. This requires constant coordination between NDOT and NES on the type of fixture and pole to be installed. NDOT works closely with NES to identify lighting fixtures that create a safe environment and work towards the goals of Dark Skies.

Poles and Fixtures

NDOT has to approve the fixture and poles to be used in the project.
NES lists the available fixtures and poles in their Lighting Guidelines.

Lighting Level

NDOT requires lighting levels for the design based on the location and will review the plan set for the appropriate levels on the street and pedestrian pathways.

Power, Voltage Drop, Conduit, Trench, and Foundation Inspections

NES is responsible for identifying and approving the power source, and voltage drop calculations. NES also inspects all components of the street light infrastructure.

TDOT

For interstate lighting projects inside Metro Nashville Davidson County, TDOT will be the lead agency for the design. They will coordinate with NDOT and NES while identifying the poles and fixtures. NES will be the approving agency for the power, and TDOT and NES will review and approve voltage drop calculations, conduit, trench, and foundation inspections.

NDOT Streetlight Fixture and Pole Form

Requested By (Company Name)	Click or tap here to enter text.
Contact Name	Click or tap here to enter text.
Email address	Click or tap here to enter text.
Phone Number	Click or tap here to enter text.
Project Name	Click or tap here to enter text.
Who is fund the streetlighting?	Click or tap here to enter text.
Project Location (Street names)	Click or tap here to enter text.
ROW Permit Number (Metro Permit Office)	Click or tap here to enter text.
Building Permit Number (Metro Permit Office)	Click or tap here to enter text.
Lighting Region (Section 5.2 Lighting Region Map)	Choose an item.
Roadway Functional Classification	Choose an item.
Pedestrian Activity Level	Choose an item.
High Injury Network	Choose an item.
Proposed Fixture (From NDOT/NES List)	Choose an item.
Proposed Pole (From NDOT/NES List)	Click or tap here to enter text.

Please attach location map of project to identify the lighting region.
Submit completed form to NDOTStreetlights@nashville.gov

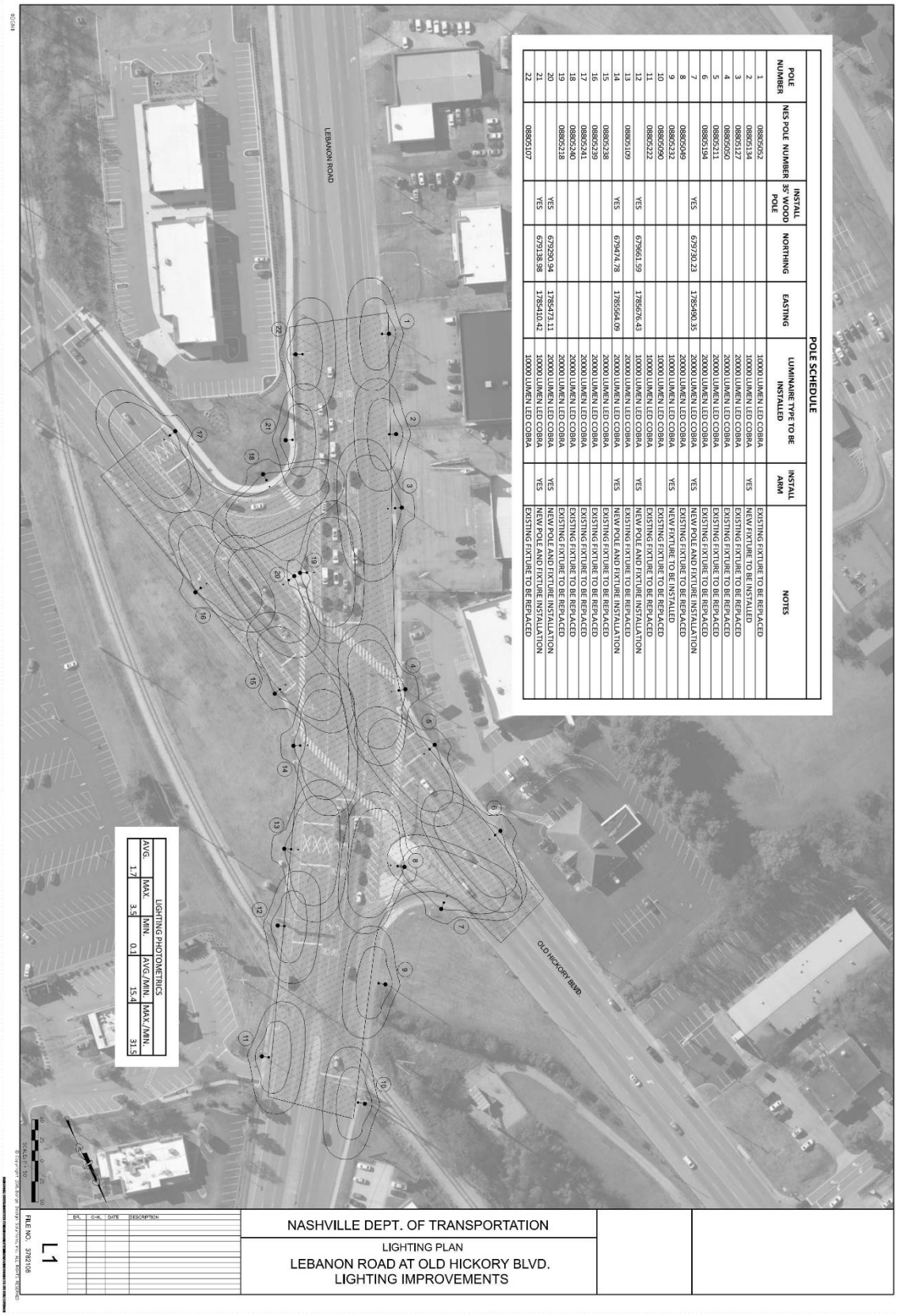
NDOT

NDOT Temporary Lighting Removal or Deenergize Request Form

Requested By (Company Name)	Click or tap here to enter text.
Contact Name	Click or tap here to enter text.
Email address	Click or tap here to enter text.
Phone Number	Click or tap here to enter text.
Project Name	Click or tap here to enter text.
Who will fund the temporary lighting?	Click or tap here to enter text.
Project Location (Street names)	Click or tap here to enter text.
Pole Numbers (to be Deenergized or Removed)	Click or tap here to enter text.
Is the removal permanent?	Yes ☐ No ☐
Pole Numbers (Installed)(If existing poles)	Click or tap here to enter text.
Deenergize Dates	Click or tap here to enter text.
ROW Permit Number (Metro Permit Office)	Click or tap here to enter text.
Building Permit Number (Metro Permit Office)	Click or tap here to enter text.
Lighting Region (Section 5.2 Regional Lighting Map)	Click or tap here to enter text.
Roadway Functional Classification	Click or tap here to enter text.
Pedestrian Activity Level	Choose an item.
Is it located on the High Injury Network? (https://www.nashville.gov/sites/default/files/2022-08/HIN_Project_List.pdf?ct=1661961752)	Yes ☐ Choose an item. No ☐
Is it located in an area with a high tendency for crime?	Yes ☐ No ☐
Do you have a layout showing the location of the lights being removed and temporary lights?	Yes ☐ No ☐

Please attach documentation demonstrating the equivalent lighting levels will remain while the lights are deenergized or traffic control plans that show prevention of pedestrian and vehicular movement while the lights are deenergized.

Submit completed form to NDOTStreetlights@nashville.gov



POLE SCHEDULE

POLE NUMBER	NES POLE NUMBER	INSTALL 35' WOOD POLE	NORTHING	EASTING	LUMINAIRE TYPE TO BE INSTALLED	INSTALL ARM	NOTES
1	08805052				10000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
2	08805134				10000 LUMEN LED COBRA	YES	NEW FIXTURE TO BE INSTALLED
3	08805127				20000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
4	08805050				20000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
5	08805211				20000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
6	08805194				20000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
7		YES	679730.23	1785490.35	20000 LUMEN LED COBRA	YES	NEW POLE AND FIXTURE INSTALLATION
8	08805049				20000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
9	08805232				10000 LUMEN LED COBRA	YES	NEW FIXTURE TO BE INSTALLED
10	08805090				10000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
11	08805222	YES	679661.59	1785676.43	10000 LUMEN LED COBRA	YES	NEW POLE AND FIXTURE INSTALLATION
12					20000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
13	08805109	YES	679474.78	1785564.09	20000 LUMEN LED COBRA	YES	NEW POLE AND FIXTURE INSTALLATION
14					20000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
15	08805238				20000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
16	08805239				20000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
17	08805241				20000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
18	08805240				20000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
19	08805218	YES	679290.94	1785473.11	20000 LUMEN LED COBRA	YES	NEW POLE AND FIXTURE INSTALLATION
20		YES	679138.98	1785410.42	10000 LUMEN LED COBRA	YES	NEW POLE AND FIXTURE INSTALLATION
21					10000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED
22	08805107				10000 LUMEN LED COBRA		EXISTING FIXTURE TO BE REPLACED

LIGHTING PHOTOMETRICS

AVG.	MAX.	MIN.	AVG./MIN.	MAX./MIN.
1.7	3.5	0.1	15.4	31.5