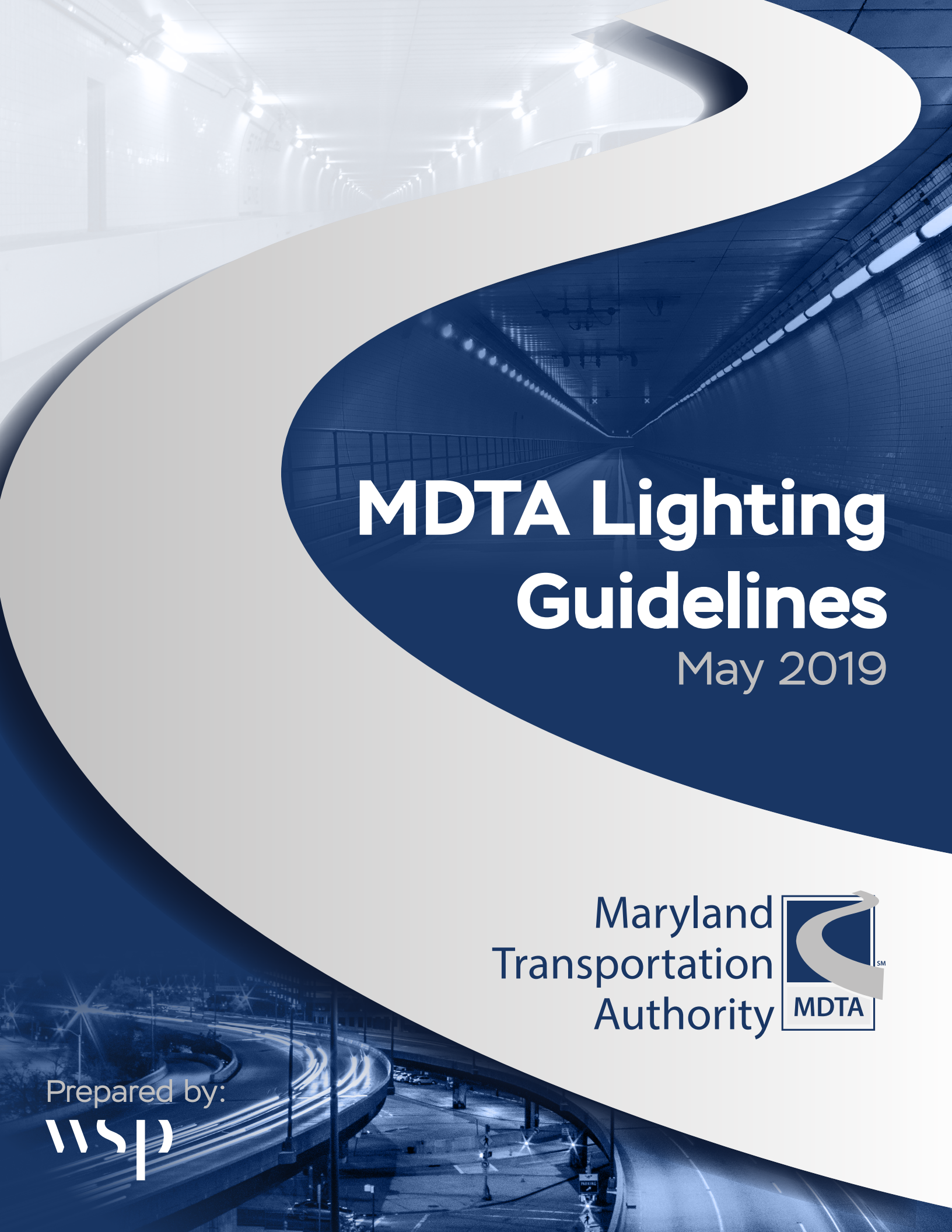

MDTA Lighting Guidelines

May 2019

Maryland Transportation Authority

MDTA

Prepared by:

WSP

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I. INTRODUCTION

The Maryland Transportation Authority (MDTA) lighting guidelines follow the Maryland Department of Transportation Maryland State Highway Administrations (MDOT SHA) lighting guidelines format but is tailored for facilities owned and operated by MDTA. The purpose of these guidelines is to provide safe and efficient facilities for the benefit of the public. Safety and impacts of lighting systems are key factors considered in this guide. On a fundamental level, driving is largely a visual task. Being able to adequately see the road/street ahead, signing, obstacles, observe conflicting traffic, and the behavior of other highway users is integral to the driving task. Lighting significantly improves the visibility of the roadway, increases sight distance, and makes roadside obstacles more noticeable to the driver, and therefore more avoidable.

Roadway lighting is a proven safety countermeasure. The positive safety effects of lighting have been documented in various reports and publications. For example, an FHWA/AASHTO international scan documented that many countries showed a 20 to 30 percent reduction in the number of crashes when lighting was installed. The FHWA Lighting Handbook also cites other studies to show an even greater benefit of lighting with results ranging from a 60-65 percent reduction of fatal crashes, up to a 50 percent reduction in injury crashes, and close to a 20 percent reduction in property-damage-only crashes after roadways are lit.

Exterior lighting systems also have an impact on people and the environment. Light at night creates skyglow from scattered light in the atmosphere, light trespass can impact abutters, and wildlife can also be impacted by nighttime lighting. The key in limiting these impacts is limiting the dosage and duration and at times controlling spectral content of the exterior lighting systems. This guide uses the latest research in the areas of lighting, safety, and impacts to balance the recommendations included herein.

The proper selection of lighting equipment and the location of street lighting will provide sufficient visibility, increased safety, and improved security for motorists and pedestrians while maximizing energy efficiency and minimizing expenditure. Lighting also has adverse effects that include glare, light trespass and sky glow that should be considered when deciding to install roadway lighting. The Local Jurisdiction's commitment to participate in the design, construction, operation and maintenance of the lighting system should also be a consideration.

All new lighting (interchange and intersection), underpass and sign lighting shall be designed using light emitting diode (LED) fixtures. LED fixtures should also be considered for pedestrian lighting. An Engineering study, assessment of site conditions and field testing should be completed to determine appropriate fixture type for tunnels and high mast lighting. LED roadway fixtures shall be selected from the MDOT SHA Qualified Products List (QPL).

This guideline is separated into three sections:

- The ***Criteria for Eligibility*** section defines the circumstances which qualify a roadway to be considered for the installation of lighting
- The ***Typical Lighting Applications*** section describes the common applications of lighting installations
- The ***Special Lighting Applications*** section describes the various applications in relation to the roadways in which lighting shall be considered

II. CRITERIA FOR ELIGIBILITY

To determine the eligibility for lighting installations, MDTA requires an engineering study of local conditions considering such factors as crash data, roadway characteristics and ambient light to support lighting installation decisions and to promote motorists' safety. When there is a history of crashes, the type and circumstances of the crashes should also be considered in a study. Engineering judgment should be used in instances where an operational or safety concern is not indicated by the crash data. Traffic volumes can also be used as a supplemental measure in evaluating lighting eligibility. Further, The American Association of State Highway and Transportation Officials (AASHTO) Roadway Lighting Design Guide (https://bookstore.transportation.org/imageview.aspx?id=633&DB=3) outlines minimum conditions for when to consider lighting shall be used when determining eligibility for all lighting installations. Another resource for use in safety studies is the FHWA Roadway Lighting Handbook (https://safety.fhwa.dot.gov/roadway_dept/night_visib/lighting_handbook/) which discusses AASHTO and other warranting methods which may help in the decision process.

The conditions for eligibility for specific facility types are described in the following sections. Meeting these conditions does not obligate MDTA to provide lighting nor is it a requirement for installation of lighting in special circumstances.

III. TYPICAL LIGHTING APPLICATIONS

Roadway lighting may be provided in areas determined to be eligible in Section II and the extent of the lighting shall be as discussed in AASHTO Roadway Lighting Design Guide for Partial Interchange Lighting (PIL), Complete Interchange Lighting (CIL), or Continuous Freeway Lighting (CFL). The decision concerning which extent to use shall consider the warranting conditions as well as the location, lighting treatment in the surrounding area, and concurrence from MDTA.

A. Interchange Lighting

Partial Interchange Lighting will be installed on all approaches at new and reconstructed grade-separated interchanges across the state. At existing grade-separated interchanges without interchange lighting; lighting will be installed based on an established need including nighttime crash history, site-specific conditions and engineering judgement. Secondary ramp merges and diverges will be treated in the same manner as mainline exits. Figure III-A.1 in the Appendix should be used as a **reference** for lighting placements. The installation of additional lights is at the discretion of the MDTA. For all lighting placements, the entering and/or exiting lane(s) and one (1) adjacent mainline travel lane shall be analyzed when determining proper spacing as shown in Figures III-A.2 and III-A.3 of the Appendix.

Refer to Table III-A.4 of the Appendix for recommended lighting values for interchanges

When proposed lighting designed to meet these guidelines and recommended values results in more than 600 feet between any two light poles, additional lighting may be proposed to decrease pole spacing in that section based on an Engineering Study. Complete interchange lighting shall be considered on facilities with one or more of the following characteristics:

1. Ramps, interchange alignments, or grades which are complex or unusual. This includes ramps with substandard deceleration or acceleration lanes, full loops, compound curves, lane reductions and/or multi-lane ramps.
2. Important decision point(s) or existing roadside hazard areas that would not be covered with partial interchange lighting, e.g. crossovers.
3. An operational analysis indicates the need for lighting. Volume and crash data should be used to support the analysis.
4. Locations with significant pedestrian or bicycle activities during times of darkness.

High mast lighting can be considered along MDTA roadways if lighting levels cannot be achieved with low level lighting and is justified by an engineering study.

B. Intersection Lighting

Intersection lighting should be provided in accordance with the SHA guidelines for intersecting roadways. Other Intersection lighting considerations can include:

1. All signalized intersections will have partial intersection lighting.
2. All roundabouts will have lighting (refer to Appendix Section III-B.1 for the MDOT SHA Roundabout Guidelines for placement and illuminance requirements.)
3. All unsignalized intersections for which a need is determined based on the MDOT SHA Evaluation Form for Intersection Lighting. Refer to Table III-B.2 of the Appendix for the Maryland State Highway Administration Evaluation Form for Intersection Lighting

Lighting should be located on the downstream side of an intersection and coverage may include channelized (free) right turn lanes. See Figure III-A.1 of the Appendix for example lighting configurations. Where possible, the placement of the luminaire on a signal pole is preferred at signalized intersections. The conduit system for intersection lighting shall be dedicated for lighting only and shall not be shared with the signal cable unless the luminaire is mounted on the signal pole or otherwise directed by the MDTA. Further, service pedestals may be shared for lighting and signals at the discretion of the MDTA. Refer to Table III-B.3 of the Appendix for recommended lighting values for intersections other than roundabouts. Additional consideration should be given to intersections where continuous lighting is present; refer to IES RP-8 Standard Practice for Roadway Lighting for more information.

C. Continuous Roadway Lighting

Continuous roadway lighting will only be installed when justified by an engineering study and approved by the MDTA. If approved, it will be installed using the illuminance requirements included in Table III-A.4 or the luminance requirements in Table III-A.5.

D. Sign Lighting

Traffic signs are placed along the roadway in strategic locations and are used to convey specific, consistent messages to motorists. The standards used in the design of traffic signs are described in the *Maryland Manual on Uniform Traffic Control Devices* (MDMUTCD
http://www.marylandroads.com/mmutcd/2011_rev122011_MDMUTCD_Complete.pdf.
The intent of these standards is to ensure that all traffic signs are designed and maintained to provide information that can quickly and accurately convey the necessary information and to provide national sign design consistency. The MDMUTCD states “signs shall be retroreflective or illuminated to show the same shape and similar color by both day and night”.

Nighttime sign legibility can be achieved in one of two ways:

1. Using Type XI retroreflective sheeting materials for the legend and background.
2. Using either internal or external sign illumination.

Almost all signs are made with retroreflective sheeting materials. Only some signs are illuminated, and generally those are overhead guide signs and overhead street name signs. The added sign illumination helps compensate when the vehicle headlamps and retroreflective properties of the sign sheeting materials are inadequate by themselves.
A sign designed to be legible under daylight conditions can be illuminated to fulfill its basic purpose at night. A properly designed sign lighting system can aid motorists with the rapid and accurate recognition of the sign's shape, color, and message. This serves to improve safety by reducing the possibility that motorists will significantly reduce their speed at locations where signs may be otherwise difficult to read.

Overhead signs shall be installed with ASTM Type XI sheeting and shall not require sign lighting. When Type XI retroreflective sheeting is used on signs they generally do not require supplemental lighting. However, overhead sign lighting should be considered under the following conditions:

1. Signs in areas having a high level of visual complexity. This includes areas like toll facilities (e.g. toll rate sign).
2. All overhead signs with unencumbered sight distance of less than 1,000 feet. Unencumbered sight distance exists if all portions of every overhead sign panel on that structure is visible to motorists in all approaching lanes.
    i. Signs beyond sag vertical curves and outside the influence area of vehicle headlamps.
    ii. Signs in horizontal curves that are outside the influence area of vehicle headlamps.
3. Signs in areas where atmospheric conditions create condensation or frost on the sign face and reduce the effectiveness of the retroreflective sheeting. This includes areas adjacent to bridge structures and other areas prone to fog conditions.
4. Additional lighting may be considered and requested as part of an engineering study and/or based on engineering judgement to address site specific conditions.

Sight distance, as noted above, should be considered when selecting locations for new structures.

When sign lighting is provided:

1. Lighting shall consist of LED luminaires.
2. Individual supports for each luminaire is the preferred mounting method; sign lighting maintenance systems should only be used at the discretion of MDTA.
3. All overhead sign panels mounted on a structure shall be illuminated. Lighting only select panels is not permitted even if signs have different ownership.

All new signage requires Type XI sheeting so the need for sign lighting will be determined per the above criteria. If any overhead sign does not require sign lighting it shall use Type XI sheeting which shall be specified on the sign detail sheets. Refer to the *Design Guidance for Incorporating New Sign Lighting Guidelines* in the Appendix for additional information regarding the installation, replacement, removal and design of sign lighting.

E. Minimizing Lighting System Impacts

When installing lighting on any MDTA facility the impacts of the lighting system should be considered specifically addressing the areas of sky glow, light trespass, and any potential lighting and health impact.

In general, the following key actions should be performed as part of the design:

1. Perform a review or walk-through of the site during the pre-design stage. This should include an analysis of adjacent property and nearby developments as well as an investigation into the community desires for lighting systems.
2. Select a luminaire whose candela distribution pattern matches the need. Establish the position of the luminaire precisely. If calculations then show the light distribution will be objectionable, make modifications to wattage or mounting height, or select another luminaire.
3. Consider internal and external shields if necessary to limit the candela in certain directions. Also, consider that internal and external shields will alter the photometric distribution of the fixture and account for such alterations in the lighting system design.
4. Consider pole location, mounting height, spacing, finished terrain, and landscaping as design variables that can be used to mitigate light trespass. Take advantage of natural and man-made obstacles such as tree lines and retaining walls.
5. Remember that glare or visual clutter can be produced by almost any luminaire when observed against a dark background. Choose luminaires and placements with care.

Minimizing Skyglow

The Illuminating Engineering Society (IES) developed a recent simplified method of classifying luminaires beyond the traditional roadway classifications of full cutoff, cutoff, semi-cutoff and non-cutoff. This system was published in the IES Technical Manual, TM-15 Luminaire Classification System for Outdoor Luminaires. This system considers the amount of light emitted by a luminaire and places a light zone value for Backlight, Uplight and Glare. The system (shortened to BUG) was developed alongside the Model Lighting Ordinance (MLO). The MLO defined lighting requirements and restrictions and created lighting zones according to environmental impact. The following lighting zones have been established:

1. LZ0: No ambient lighting – Areas where the natural environment will be seriously and adversely affected by lighting.

2. LZ1: Low ambient lighting – Areas where lighting might adversely affect flora and fauna or disturb the character of the area.

3. LZ2: Moderate ambient lighting – Areas of human activity where the vision of human residents and users is adapted to moderate light levels. Lighting may typically be used for safety, security and/or convenience but is not necessarily uniform or continuous. After curfew, lighting may be extinguished or reduced as activity levels decline.

4. LZ3: Moderately high ambient lighting – Areas of human activity where the vision of human residents and users is adapted to moderately high light levels. Lighting is generally desired for safety, security and/or convenience and is often uniform and/or continuous. After curfew, lighting may be reduced as activity levels decline.

5. LZ4: High ambient lighting – Areas of human activity where the vision of human residents and users is adapted to high light levels. Lighting is generally considered necessary for safety, security and/or convenience and is mostly uniform and/or continuous. After curfew, lighting may be reduced in some areas as activity levels decline.

The BUG system allows a simplified method of generally classifying a luminaire with regard to the amount of light emitted from the front, back, and upward. Lower BUG rating values for backlight (B values) and uplight (U values) will generally produce less impact behind and above the fixture.

For control of skyglow, MDTA projects shall only use luminaires with an uplight rating of U-0 for all environmental zones.

Minimizing Light Trespass

There are methods of quantifying light trespass which are used as part of IES RP-8 Standard Practice for Roadway Lighting and included in IES RP-33 Lighting for Exterior Environments. This method has also been included in the joint IDA-IES Model Lighting Ordinance.

The method includes evaluating light trespass of an exterior lighting system in terms maximum vertical illuminance at any point along a plane at a property line. The limits of vertical illuminance are based on the LZ zone which the lighting system is located. The maximum values are included in the table below.

Lighting Zone LZ-0	Lighting Zone LZ-1	Lighting Zone LZ-2	Lighting Zone LZ-3	Lighting Zone LZ-4
0.05 fc (0.5 lux)	0.1 fc (1.0 lux)	0.3 fc (3.0 lux)	0.8 fc (8.0 lux)	1.5 fc (15.0 lux)

Lighting installations for MDTA shall meet the light trespass values shown above. These limits are the vertical illuminance value along a property line (or at a residence as agreed to by MDTA) at a height of 5'.

In addition to the light trespass limits shown above, there are also cases where fixture brightness can be cited as an issue from abutters. This more commonly occurs with high mast luminaires and at times can be from properties at quite a distance from the installation where no measurable light can be attributed to the roadway lighting system. Generally, this issue is a perceived brightness issue where the bright source being contrasted against the dark sky is found objectionable. In most cases, this issue can only be addressed with shielding the luminaire optics from direct view from the abutter. It cannot always be done while maintaining the required lighting levels on the roadway so it needs to be addressed on an individual basis.

Minimizing Health impacts

There has been a significant amount of discussion concerning potential health impacts of light at night and some of this discussion has included the use of LED streetlights. There is also much disagreement between national groups including the American Medical Association, the Illuminating Engineering Society, the US Department of Energy, and many researchers on various aspects of the topic. Based on these discussions and the current available research the following key points emerge:

1. Light at night has potential health risks based on several factors including dosage (amount of light), duration (exposure time), and spectral content (color content).
2. Streetlighting, particularly when using the light trespass limits prescribed above, does not appear to provide sufficient dosage to be a health impact.
3. Spectral content of light sources has impacts to health and visibility. For example, if the dosage is high enough, sources with a higher blue spectral content have greater impacts (on circadian disruption) than sources with less blue content. From a visibility perspective, when comparing 4000^0K sources (more blue) and 3000^0K sources (less blue), detection distances appear significantly greater with the 4000^0K sources in some early studies.

Current studies however show that properly designed roadway lighting will not have an impact on health and that 4000^0K CCT sources appear to offer longer detection distances than other currently offered CCT LEDs. Considering these key points the Correlated Color Temperature (CCT) for MDTA exterior lighting projects shall be 4000^0K. 3000^0K sources can be considered but may require a slightly higher design value to compensate for reduction in detection distances.

F. Light Loss Factor

The construction of Solid State Luminaires (SSL) can be quite different than High-Intensity Discharge (HID) luminaires. Some optical systems use individual LEDs with individual refractors, others use external lenses, and others use reflector systems or light guides as

part of their design. The amount of dirt depreciation for different types of designs will vary significantly.

The IES produced the document (Illuminating Engineering Society, 2016) RES-1-16 Measure and Report Luminaire Dirt Depreciation (LDD) in LED Luminaires for Street and Roadway Lighting Applications. This document is based on research conducted by VTTI measuring the dirt depreciation of various optical systems and the effect of cleaning on those luminaires. The results of this research offer advice on predicting dirt depreciation for different optical systems. The results of the research compared the light output from the luminaire for installation, after 2 years (Dirty) and then cleaned after 2 years (Figure 8). These results then allowed for the calculation of the light loss due to lumen depreciation and due to dirt depreciation (Figure 9). In this calculation, the results from different optical methods (Glass and reflector and individual optics) can be compared.

Other factors also require consideration when determining the Light Loss Factor (LLF) of SSLs. LEDs are very temperature dependent in terms of output and estimated life. Many LED luminaires also have an automatic output adjustment if internal fixture temperatures get too high. Failure of an LED luminaire often occurs at the LED driver which has an estimated failure rate determined by Mean Time Between Failure (MTBF) calculations. The rated life of an LED luminaire is based on the point in time when the lumen output of the LED has reduced to 70% of its initial lumen rating. Some of these factors are quantified and included in the LED test data performed in accordance with (Illuminating Engineering Society, 2011) Projecting Long Term Lumen Maintenance of LED Light Sources. Other data is usually available from the luminaire manufacturers.

The LLF used for design on an MDTA project will include a calculation of the light loss using actual luminaire data and agreement by MDTA.

Reference Documents

IES RES-1-16 Measure and Report Luminaire Dirt Depreciation in LED Luminaires for Street and Roadway Lighting Application (https://www.ies.org/store/research/measure-and-report-luminaire-dirt-depreciation-ldd-in-led-luminaires-for-street-and-roadway-lighting-applications/)
ANSI/IES RP-8-14 Standard Practice for Roadway Lighting (https://www.ies.org/store/recommended-practices-and-ansi-standards/roadway-lighting/)
IES LM-79 Approved Method for the Electrical and Photometric Measurements of Solid State Lighting (https://www.ies.org/store/measurement-testing/electrical-and-photometric-measurements-of-solid-state-lighting-products/)
IES LM-80 Approved Standard for Measuring Lumen Maintenance of LED Light Sources (https://www.ies.org/store/measurement-testing/measuring-luminous-flux-and-color-maintenance-of-led-packages-arrays-and-modules/)

IV. SPECIAL LIGHTING APPLICATIONS

A. Bridge Lighting

Bridge lighting will be evaluated using the Roadway Lighting criteria provided above, particularly the approach transition areas, with the following exceptions:

1. Existing bridge lighting which will not be impacted by a roadway project may remain in place.
2. Pedestrian Lighting on bridges will be installed in accordance with the MDOT SHA's Pedestrian Lighting Policy.
3. Decorative lighting should not be installed on bridges without sidewalks. When a sidewalk is present, the installation of lighting should be in accordance to the MDOT SHA's Pedestrian Lighting Policy.
4. Areas where surveillance (CCTV cameras), security, identification of disabled vehicles or environmental conditions such as industrial waste or fog may be a concern.
5. If aesthetic lighting is desired by MDTA on a bridge structure the lighting levels on the bridge should be in accordance with IES RP-33 Lighting for Exterior Environments (https://www.ies.org/store/recommended-practices-and-ansi-standards/lighting-for-exterior-environments/)
6. All other lighting applications shall be determined as per the discretion of the MDTA.

B. Rest Area or Park-and-Ride Lots

Provide sufficient illumination for public safety purposes at both rest areas, travel plazas and park-and-ride lots. Refer to Table IV-B.1 of the Appendix for recommended Illuminance Levels for Roadway Rest Areas and Table IV-B.2 of the Appendix for recommended Illuminance Levels for Parking Areas. Access ramps to and from the facility should be treated as interchange ramps and illuminance values as defined in Section III-A of this document.

C. Underpass Lighting

The need for underpass lighting shall be based on an Engineering Study. Nighttime underpass lighting shall be designed to meet the same requirements as for the approach roadways and if a sidewalk is present, in accordance with Table IV-E.2. If the pedestrian area is separated from the roadway by a wall or otherwise isolated, then the values shall be in accordance with Table IV-C.1. Based on the Study, the need for daytime lights shall include consideration of ambient light levels.

D. Tunnel Lighting

Tunnel lighting shall be designed in accordance with the Illuminating Engineering Society RP-22, American National Standard for Tunnel Lighting (https://www.ies.org/store/recommended-practices-and-ansi-standards/tunnel-lighting/**).** The requirements included in RP-22 are generally based on lighting for new longer tunnels. The requirements for short tunnels is included in RP-22 but requires engineering judgement to their applicability. While re-lighting existing tunnels, crash data is often available which can help determine if existing light levels are sufficient for safety or whether changing the levels should be considered. In those existing tunnels, an engineering study can be performed comparing a minimum of 5 years of crash data for the tunnel threshold/transition zones and approach roads (if valid data is available) to determine whether current conditions meet the necessary requirements for visibility and safety at the tunnel entrance.

Control systems for tunnel lighting shall also be adequately studied to determine the best system for minimizing energy consumption, maximizing equipment life, and adjusting light levels for different zones. For LED tunnel lighting systems, these generally include adaptive controls dimming the daytime lighting system based on the brightness of approach condition to the tunnel portal. The equipment selected must be tested for use in a tunnel environment and have a projected operating life equal to the tunnel lighting system.

E. Pedestrian Lighting

The design and installation of pedestrian lighting is directed by the 2008 MDOT SHA's Pedestrian Lighting Policy (Section IV-E.1 of Appendix). For Recommended Values for High, Medium and Low Pedestrian Conflict Areas see Tables IV-E.2, IV-E.3 and IV-E.4 of the Appendix. Where pedestrian lighting is installed along a roadway the veiling luminance along the roadway, per Table III-A.4 of the Appendix, shall not be exceeded.

F. Knock Downs and Removals

When a light pole is knocked down, maintenance forces should verify with the Electrical Discipline Manager if the pole shall be replaced. If replacement of the pole is necessary, the existing fixture shall be upgraded with an LED fixture. If replacement is not necessary, all equipment and the circuits controlling the subject pole need to be verified. Provisions need to be made for the maintenance and continued operation of the equipment if other lighting structures utilize the same circuits. Similarly, if light poles are deemed for planned removal, appropriate measures should be taken to ensure continuous operation of other lighting within the same system.

G. Temporary Lighting

During construction, temporary lighting should be provided for decision points. During design of the project, it should be determined if existing/proposed light poles will

sufficiently illuminate conflict points, otherwise, temporary light poles (typically wood poles with overhead feeds) should be provided. Wood poles must be protected from vehicular traffic.

Lighting for work zones shall meet the requirements of Occupational Safety and Health Administration (OSHA) for worker safety and IES DG-26-16 Lighting the Roadway in Work Zones (https://www.ies.org/store/design-guides/lighting-the-roadway-in-work-zones/).

H. Campus Lighting

Lighting for parking areas shall meet the requirements stated in Section IV.B. Lighting requirements for office building, salt barns, maintenance shops, etc., shall meet the recommendations included in the IES Lighting Handbook (https://www.ies.org/store/lighting-handbooks/lighting-handbook-10th-edition/).

I. Crossover Lighting

Lighting at locations used as crossover areas for diverting traffic from one side of the road to another shall meet all the lighting criteria requirements for roadway interchange lighting. A calculation area should be added for the crossover extending across all active vehicle areas and should provide uniform levels in that section of roadway.

APPROVED:

James Harkness, P.E., PTOE
Maryland Transportation Authority

06/06/2019
Date

LIST OF APPENDICES

Section I-A.1
Maryland State Highway Administration Light Emitting Diode (LED) Roadway Lighting Specifications and Approved Luminaires Memo

Martin O'Malley, *Governor*
Anthony G. Brown, *Lt. Governor*

SHA
State Highway Administration
Maryland Department of Transportation

Darrell B. Mobley, *Acting Secretary*
Melinda B. Peters, *Administrator*

MEMORANDUM

TO: All District Engineers

Mr. Earle Freedman, Director
Office of Structures

Mr. Kirk McClelland, Director
Office of Highway Development

Mr. Russell Yurek, Director
Office of Maintenance

FROM: Gregory D. Welker
Deputy Administrator/Chief Engineer for Operations

DATE: December 7, 2012

SUBJECT: Light Emitting Diode (LED) Roadway Lighting
Specifications and Approved Luminaires

The State Highway Administration (SHA) is working to reduce energy usage in our agency by 20% from our 2011 levels by the year 2015. With advances in technology, the efficiency and compatibility of newer light sources has significantly improved. The use of light emitting diodes (LED's) as a source for roadway lighting can offer energy savings as compared to conventional high intensity discharge (HID) light sources, such as high pressure sodium (HPS) or metal halide (MH).

The SHA's Office of Traffic and Safety (OOTS) initiated an LED Roadway Lighting Pilot Study in October 2011 at the I-83/Warren Road Interchange. The purpose of the study was to research, analyze and document the energy efficiency and operational performance of LED roadway lighting. The study concluded that the LED roadway lighting technology has adequately evolved and can provide energy savings for lighting performance similar to conventional HID light sources. In addition, LED roadway lighting offers advantages such as cooler/natural light output, faster lamp start up time and less maintenance needs as compared to conventional HID light sources.

In view of these benefits, LED luminaires will be required on all future roadway lighting projects. Special Provision Inserts (SPI) 806 and 950.12 shall be included in the information for bid (IFB) package for all future roadway lighting projects. SPI's 806 and 950.12 cover the performance and materials aspect of LED luminaires, respectively.

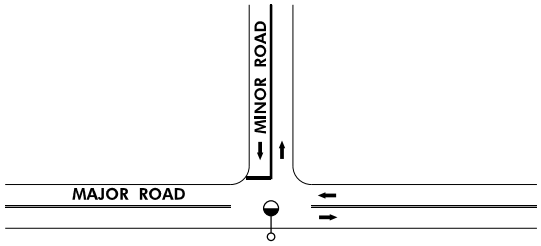
All projects currently in design that include non-LED roadway lighting should incorporate LED luminaires.

LED luminaire bid items will be required on all future roadway lighting maintenance projects. These should include items for repair/replacement of LEDs, and for replacing damaged conventional lighting with LED lighting. For existing lighting maintenance contracts, the respective District Offices may negotiate change orders for the contractors, to furnish and install LED luminaires. LED luminaires shall be used for all maintenance replacements. Maintenance of existing lighting shall be in accordance with SHA standards and any removal of existing, unwarranted lighting shall be coordinated with the OOTS.

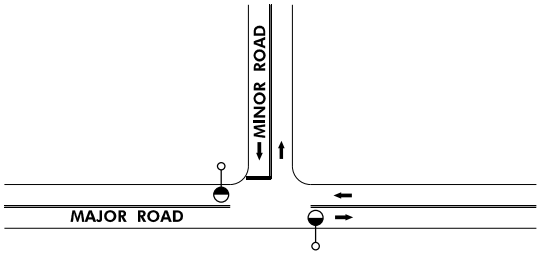
All approved LED roadway luminaires will be included on the Office of Traffic and Safety's Qualified Product's List (QPL). Only LED roadway luminaire models selected from the QPL shall be used on roadway lighting projects.

If you have any questions or require additional information, please do not hesitate to contact Mr. Michael L. Paylor, P.E., Chief, Traffic Engineering Design Division at 410-787-4027 or mpaylor@sha.state.md.us.

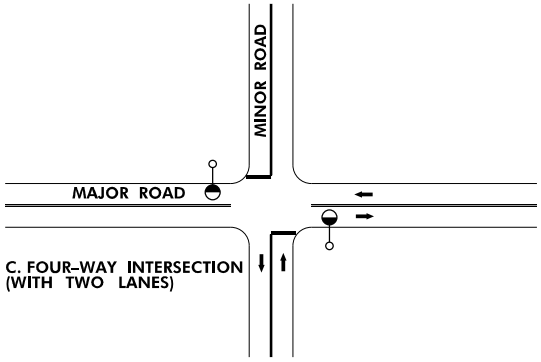
cc: Mr. Steven Marciszewski, Director, Office of Construction, SHA
Mr. Michael L. Paylor, P.E., Chief, TEDD, SHA
Mrs. Melinda Peters, Administrator, SHA
Mr. Douglas Simmons, Deputy Administrator/Chief Engineer for Planning, Engineering, Real Estate & Environment
Mr. Cedric Ward, P.E., Director, Office of Traffic and Safety, SHA



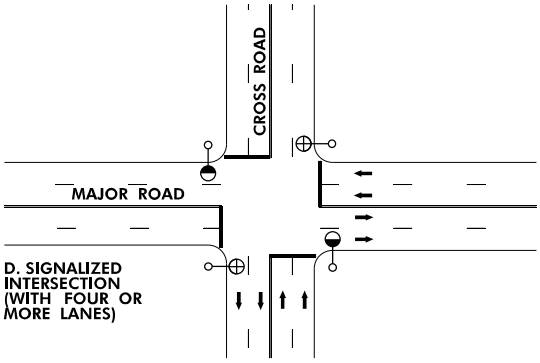
A. T–INTERSECTION



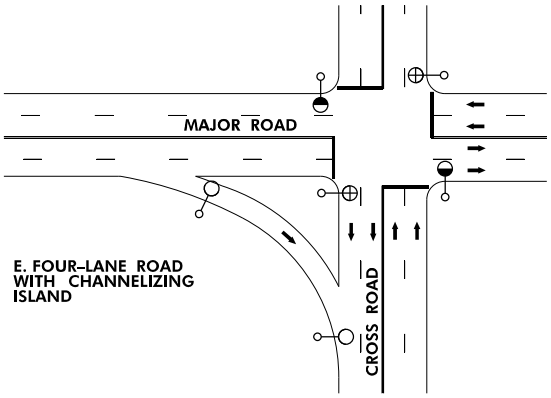
B. T–INTERSECTION (ALTERNATE)



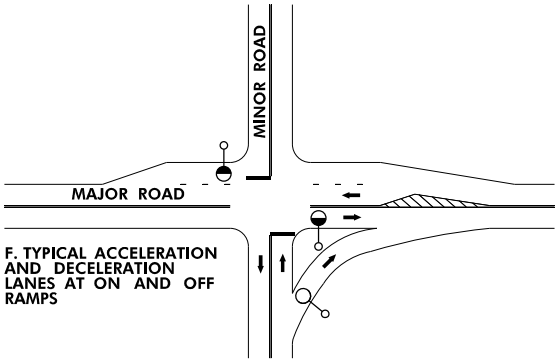
C. FOUR–WAY INTERSECTION (WITH TWO LANES)



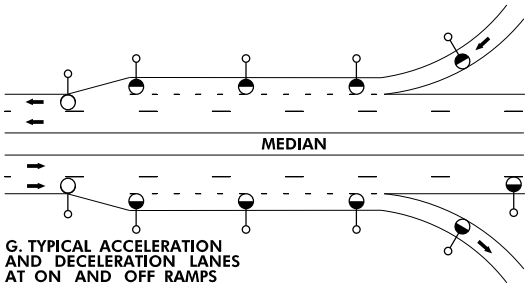
D. SIGNALIZED INTERSECTION (WITH FOUR OR MORE LANES)



E. FOUR–LANE ROAD WITH CHANNELIZING ISLAND



F. TYPICAL ACCELERATION AND DECELERATION LANES AT ON AND OFF RAMPS



G. TYPICAL ACCELERATION AND DECELERATION LANES AT ON AND OFF RAMPS

MDTA – OPTIONAL LIGHTS SHOWN

LEGEND

- UNIT REQUIRED
- UNIT RECOMMENDED
- UNIT OPTIONAL

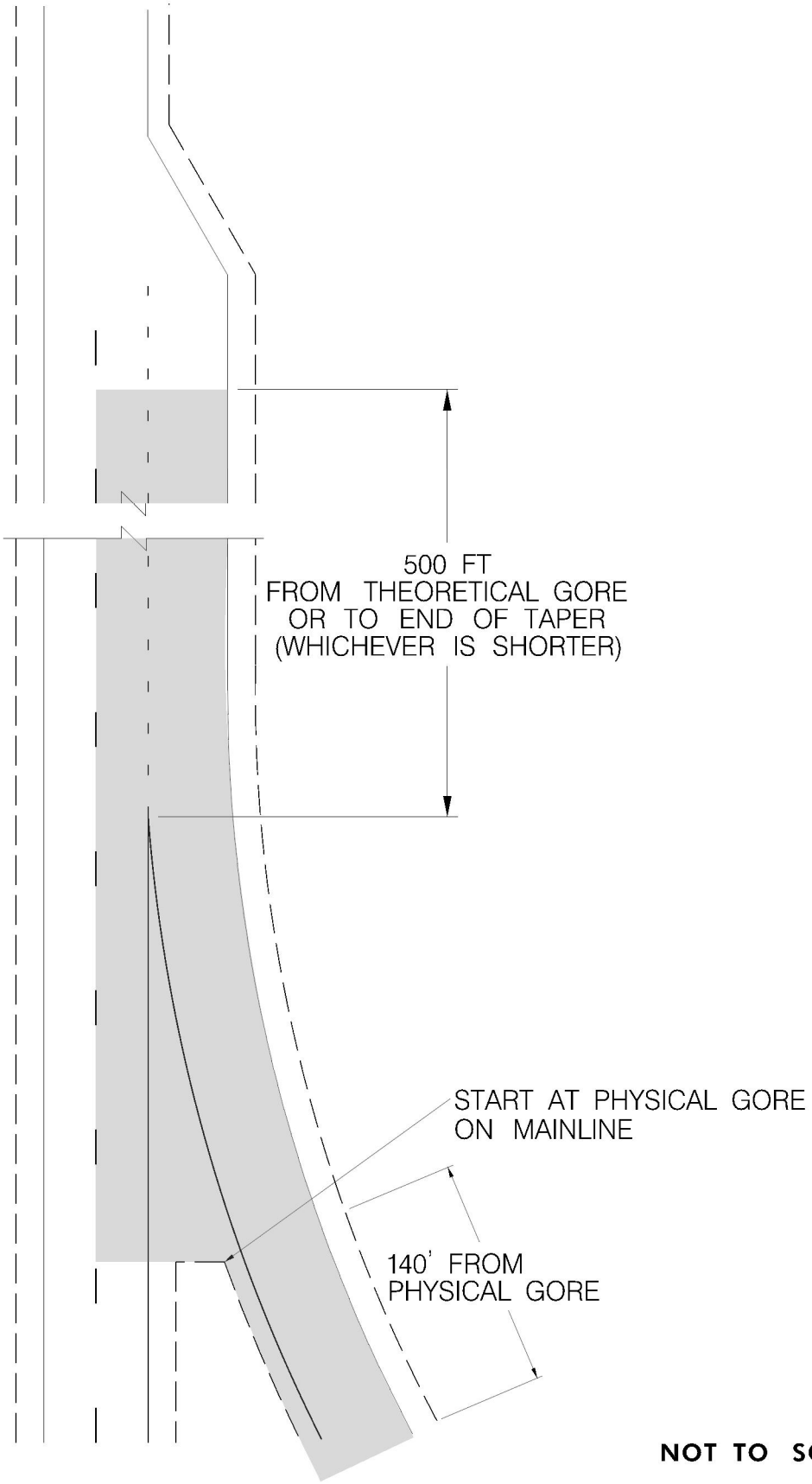
NOTE: DRAWINGS ARE NOT TO SCALE AND THE LIGHT LOCATIONS SHOWN ARE NOT TO BE CONSIDERED COMPLETE IN NUMBER OR BETTER THAN APPROXIMATES IN POSITION.

EXAMPLES OF LIGHTING CONFIGURATIONS

State Highway Administration
Maryland Department of Transportation

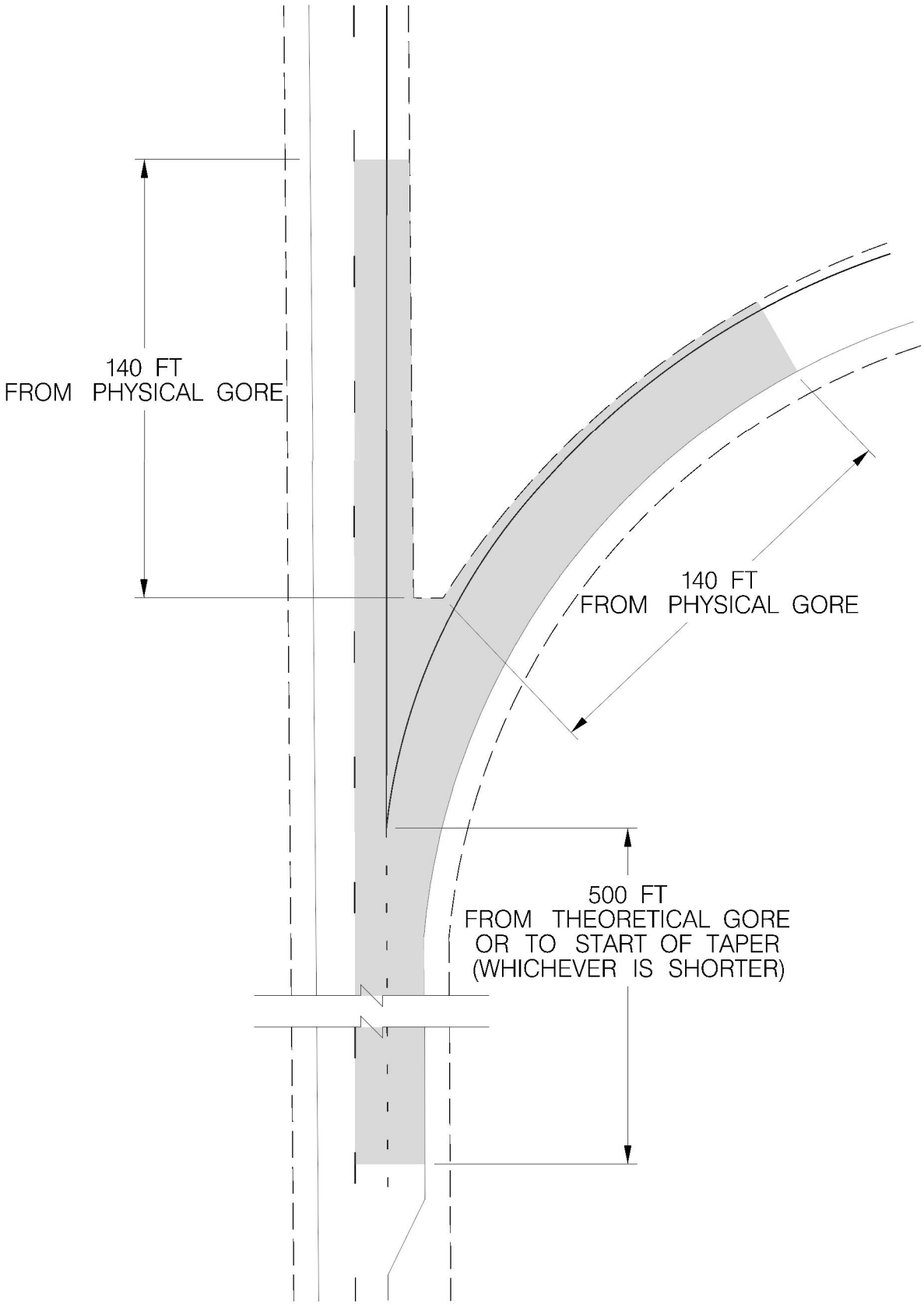
Maryland Department of Transportation
STATE HIGHWAY ADMINISTRATION
STANDARDS FOR HIGHWAYS AND INCIDENTAL STRUCTURES

FIGURE NO.
III–A.1 (MDTA)



NOT TO SCALE

ANALYSIS AREA
FOR ENTRANCE RAMPS



NOT TO SCALE

ANALYSIS AREA
FOR EXIT RAMPS

TABLE III-A.4
Recommended Lighting Levels for Partial and Complete Interchange Lighting and Isolated Intersections

ROAD CLASSIFICATION	PAVEMENT CLASSIFICATION			UNIFORMITY RATIO E_{avg}/E_{min}
	R1 Lux/fc	R2 & R3 Lux/fc	R4 Lux/fc	
ROADWAY LIGHTING				
FREEWAY CLASS A	6.0/0.6	9.0/0.9	8.0/0.8	3.0
FREEWAY CLASS B	4.0/0.4	6.0/0.6	5.0/0.5	3.0
EXPRESSWAY	6.0/0.6	9.0/0.9	8.0/0.8	3.0
STREET LIGHTING				
MAJOR	6.0/0.6	9.0/0.9	8.0/0.8	3.0
COLLECTOR	4.0/0.4	6.0/0.6	5.0/0.5	4.0
LOCAL	3.0/0.3	4.0/0.4	4.0/0.4	6.0

Table III-A.5
Recommended Luminance Values for Continuously Lighting Roadways and Streets

ROAD CLASSIFICATION	AVG. LUMINANCE L_{avg} (cd/m^2)	AVG. UNIFORMITY RATIO L_{avg}/L_{min}	MAX. UNIFORMITY RATIO L_{max}/L_{min}	MAX. VEILING LUMINANCE RATIO Lv_{max}/L_{avg}
FREEWAY CLASS A	0.6	3.5	6.0	0.3
FREEWAY CLASS B	0.4	3.5	6.0	0.3
EXPRESSWAY	1.0	3.0	5.0	0.3

STREET CLASSIFICATION	PEDESTRIAN AREA CLASSIFICATION	AVG. LUMINANCE L_{avg} (cd/m^2)	AVG. UNIFORMITY RATIO L_{avg}/L_{min}	MAX. UNIFORMITY RATIO L_{max}/L_{min}	MAX. VEILING LUMINANCE RATIO Lv_{max}/L_{avg}
MAJOR	HIGH	1.2	3.0	5.0	0.3
	MEDIUM	0.9	3.0	5.0	0.3
	LOW	0.6	3.5	6.0	0.3
COLLECTOR	HIGH	0.8	3.0	5.0	0.4
	MEDIUM	0.6	3.5	6.0	0.4
	LOW	0.4	4.0	8.0	0.4
LOCAL	HIGH	0.6	6.0	10.0	0.4
	MEDIUM	0.5	6.0	10.0	0.4
	LOW	0.3	6.0	10.0	0.4

Table III-A.4:

Recommended Lighting Values for Interchanges

Road and Pedestrian Conflict Area[1]		Pavement Classification[2] (Minimum Maintained Average Values)			Uniformity Ratio	Veiling Luminance Ratio
Road	Pedestrian Conflict Area	R1 (fc)	R2 & R3 (fc)	R4 (fc)	E_{avg}/E_{min}	L_{vmax}/L_{avg}
Freeway Class A		0.6	0.9	0.8	3.0	0.3
Freeway Class B		0.4	0.6	0.5	3.0	0.3
Expressway	High	1.0	1.4	1.3	3.0	0.3
	Medium	0.8	1.2	1.0	3.0	0.3
	Low	0.6	0.9	0.8	3.0	0.3
Major	High	1.2	1.7	1.5	3.0	0.3
	Medium	0.9	1.3	1.1	3.0	0.3
	Low	0.6	0.9	0.8	3.0	0.3
Collector	High	0.8	1.2	1.0	4.0	0.4
	Medium	0.6	0.9	0.8	4.0	0.4
	Low	0.4	0.6	0.5	4.0	0.4
Local	High	0.6	0.9	0.8	6.0	0.4
	Medium	0.5	0.7	0.6	6.0	0.4
	Low	0.3	0.4	0.4	6.0	0.4

[1] Road and Pedestrian Conflict Area as IES RP-8-00 American National Standard Practice for Roadway Lighting.
[2] Pavement Classifications as IES RP-8-00 American National Standard Practice for Roadway Lighting.

Section III-B.1
Maryland State Highway Administration
Roundabout Design Guidelines (Chapter 3)

Chapter 3 - Lighting Guidelines

This section presents recommended guidelines for lighting of roundabouts on facilities within Maryland. The information in this section is based on the following sources:

- FHWA, *NCHRP Report 672: Roundabouts: An Informational Guide - Second Edition,* 2010.
- ANSI / IESNA RP-8-00, *American National Standard Practice for Roadway Lighting*, 2000.
- AS/NZS 1158.1.3:1997, *Road lighting*, Australian/New Zealand Standard, 1997.
- Centre d'Etudes sur les Réseaux les Transports, l'Urbanisme et les constructions publiques (CERTU), *L'Éclairage des Carrefours à Sens Giratoire (The Illumination of Roundabout Intersections),* Lyon, France: CERTU, 1991.

General Requirements

Lighting should be provided at all roundabouts, whether in rural or urban settings. The specific lighting requirements for each setting are discussed below. Lighting is required for roundabouts on the Maryland state highway system.

Lighting should be installed and operational before the roundabout is open to traffic. If a portion of the roundabout will be opened to accommodate traffic on a temporary basis, lighting should be provided. If permanent lighting cannot be installed to meet construction schedules, temporary lighting will be allowed, with the approval of the engineer.

Lighting in Urban and Suburban Areas

The recommended practice for determining proper roadway illumination is provided in ANSI/IESNA RP-8-00, published by the Illuminating Engineering Society of North America. The discussion in this section focuses on the illuminance method, which is commonly used for illumination design at roundabouts. RP-8-00 discusses other methods such as luminance and small target visibility; the reader is encouraged to refer to that document for discussion of those methods, as well as discussion on the proper method to calculate the critical values for each criterion.

The basic principle behind the lighting of roundabouts in urban and suburban areas is that the amount of light on the roundabout should be equal to the sum of the lighting of the two brightest approach roads. This increases nighttime visibility of the intersection by making it stand out from the approach roadways.

Exhibit 3-1 presents the recommended illuminance for roundabouts located on continuously illuminated streets. Separate values have been provided for portland cement concrete road surfaces (RP-8-00 Road Surface Classification R1) and typical asphalt road surfaces (RP-8-00 Road Surface Classification R2/R3). Exhibit 3-2 presents the roadway and pedestrian area classifications used for determining the appropriate illuminance levels in Exhibit 3-1. RP-8-00

clarifies that although the definitions given in Exhibit 3-2 may be used and defined differently by other documents, zoning by-laws, and agencies, the area or roadway used for illumination calculations should best fit the descriptions contained in Exhibit 3-2 and not how classified by others (RP-8-00, Section 2.0, p.3). Note that the predominant surface type should be used for illumination calculations; for example, a roundabout with an asphalt concrete circulatory roadway and portland cement concrete truck apron should be designed using a surface type of R2/R3.

Exhibit 3-1
Recommended Illuminance for the Intersection of Continuously Lighted Urban and Suburban Streets

Pavement Classification[1]	Roadway Classification	Average Maintained Illuminance at Pavement[2]			Uniformity Ratio (E_{avg}/E_{min})	Veiling Luminance Ratio (L_{vmax}/L_{avg})
		Pedestrian/Area Classification				
		High (fc (lux))	Medium (fc (lux))	Low (fc (lux))		
R1	Major/Major	2.4 (24.0)	1.8 (18.0)	1.2 (12.0)	3.0	0.3
	Major/Collector	2.0 (20.0)	1.5 (15.0)	1.0 (10.0)	3.0	0.3
	Major/Local	1.8 (18.0)	1.4 (14.0)	0.9 (9.0)	3.0	0.3
	Collector/Collector	1.6 (16.0)	1.2 (12.0)	0.8 (8.0)	4.0	0.4
	Collector/Local	1.4 (14.0)	1.1 (11.0)	0.7 (7.0)	4.0	0.4
	Local/Local	1.2 (12.0)	1.0 (10.0)	0.6 (6.0)	6.0	0.4
R2/R3	Major/Major	3.4 (34.0)	2.6 (26.0)	1.8 (18.0)	3.0	0.3
	Major/Collector	2.9 (29.0)	2.2 (22.0)	1.5 (15.0)	3.0	0.3
	Major/Local	2.6 (26.0)	2.0 (20.0)	1.3 (13.0)	3.0	0.3
	Collector/Collector	2.4 (24.0)	1.8 (18.0)	1.2 (12.0)	4.0	0.4
	Collector/Local	2.1 (21.0)	1.6 (16.0)	1.0 (10.0)	4.0	0.4
	Local/Local	1.8 (18.0)	1.4 (14.0)	0.8 (8.0)	6.0	0.4

Notes: [1] R1 is typical for portland cement concrete surface; R2/R3 is typical for asphalt surface

[2] fc = footcandles

Source: ANSI / IESNA RP-8-00 Table 9 (for R2/R3 values); R1 values adapted from Table 2

Exhibit 3-2
ANSI / IESNA RP-8-00 Guidance for Roadway and Pedestrian/Area Classification for Purposes of Determining Intersection Illumination Levels

Roadway Classification	Description	Daily Vehicular Traffic Volumes[1]
Major	That part of the roadway system that serves as the principal network for through-traffic flow. The routes connect areas of principal traffic generation and important rural roadways leaving the city. Also often known as "arterials," thoroughfares," or "preferentials."	over 3,500 ADT
Collector	Roadways servicing traffic between major and local streets. These are streets used mainly for traffic movements within residential, commercial, and industrial areas. They do not handle long, through trips.	1,500 to 3,500 ADT
Local	Local streets are used primarily for direct access to residential, commercial, industrial, or other abutting property.	100 to 1,500 ADT
Pedestrian Conflict Area Classification	**Description**	**Guidance on Pedestrian Traffic Volumes[2]**
High	Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the streets during darkness. Examples are downtown retail areas, near theaters, concert halls, stadiums, and transit terminals.	over 100 pedestrians/hour
Medium	Areas where lesser numbers of pedestrians use the streets at night. Typical are downtown office areas, blocks with libraries, apartments, neighborhood shopping, industrial, older city areas, and streets with transit lines.	11 to 100 pedestrians/hour
Low	Areas with very low volumes of night pedestrian usage. These can occur in any of the cited roadway classifications but may be typified by suburban single family streets, very low density residential developments, and rural or semi-rural areas.	10 or fewer pedestrians/hour

Notes: [1] For purposes of intersection lighting levels only

[2] Pedestrian volumes during the average annual first hour of darkness (typically 18:00-19:00), representing the total number of pedestrians walking on both sides of the street plus those crossing the street at non-intersection locations in a typical block or 656 ft (200 m) section. RP-8-00 clearly specifies that the pedestrian volume thresholds presented here are a local option and should not be construed as a fixed warrant.

Source: ANSI / IESNA RP-8-00 Sections 2.1, 2.2, and 3.6

Lighting in Rural Areas

Exhibit 3-3 provides recommended illuminance levels for rural isolated intersections with unlit approaches.

Exhibit 3-3
Recommended Illuminance for the Intersection of Unlit Rural Roadways

Pavement Classification[1]	Average Maintained Illuminance at Pavement[2] (fc (lux)	Uniformity Ratio (E_{avg}/E_{min})	Veiling Luminance Ratio (L_{vmax}/L_{avg})
R1	0.6 (6.0)	4.0	0.3
R2/R3	0.9 (9.0)	4.0	0.3

Notes: [1] R1 is typical for Portland cement concrete surface; R2/R3 is typical for asphalt surface
[2] fc = footcandles

Source: ANSI / IESNA RP-8-00 Table D1

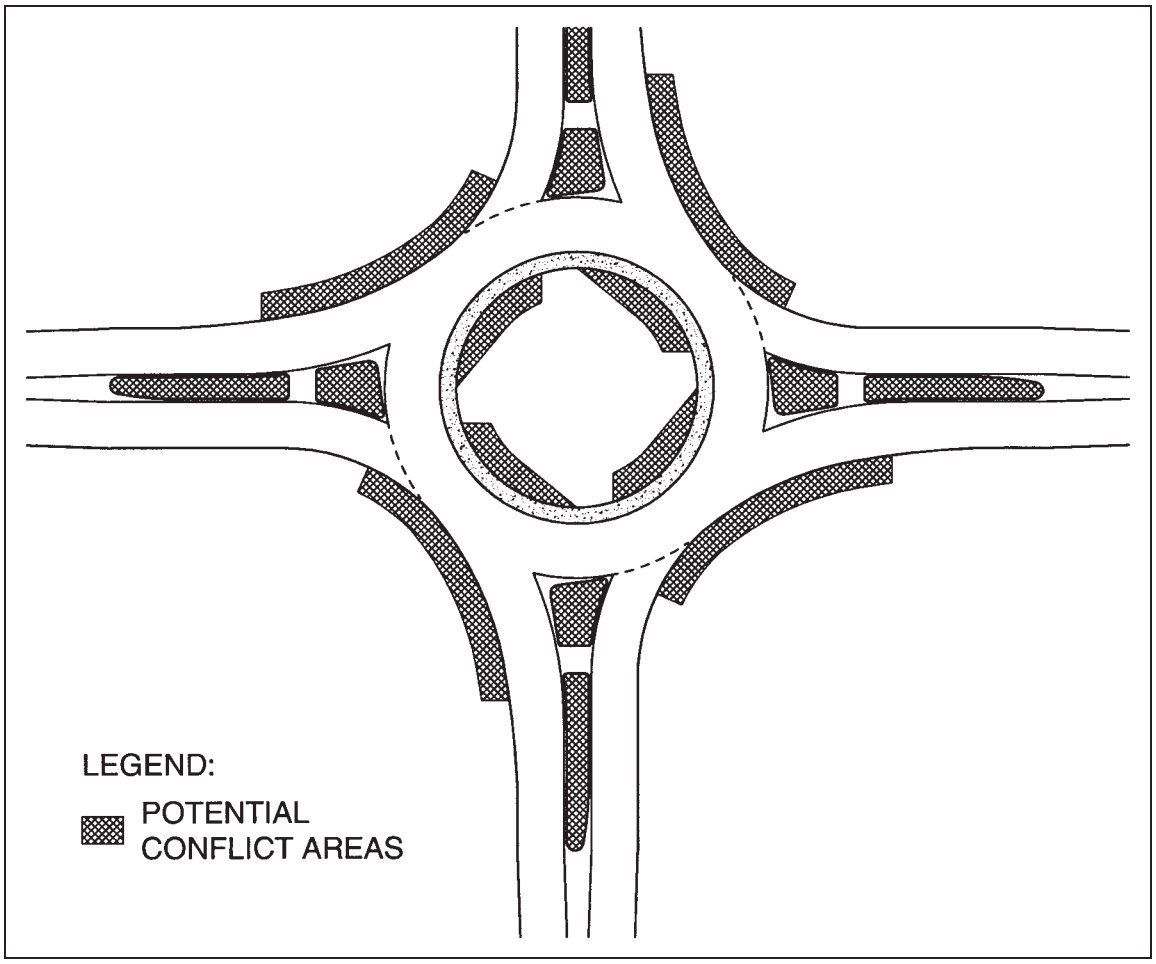
Equipment Type and Location

A photometric analysis is required to determine luminaire wattage, mounting height, luminaire arm length, and pole placement at a roundabout. In general, the use of fewer luminaires with higher wattage mounted on traditional luminaire arms ("cobra-style") is preferable to minimize the number of fixed objects in the public right-of-way, provided that the IES illuminance requirements are met. However, in urban areas where high pedestrian activity is expected or desirable, pedestrian-level illumination at lower mounting heights is often more consistent with urban design goals and should be considered. These types of luminaires may need to be supplemented by strategically located traditional cobra-style luminaires to provide adequate lighting at key conflict areas.

Lighting on SHA facilities should be installed using SHA standard equipment. Generally, this will involve the use of 40-foot poles with 250-W high-pressure sodium (HPS) "cobra-style" luminaires. If light trespass may be an issue, the designer should consider using 30-foot poles. In some instances, it may be necessary to install lease lighting on utility poles to avoid conflicts with utility lines. If the roundabout is to be installed as part of a community revitalization project or streetscape project, then the type of lighting installed should be complimentary to the lighting being installed throughout the rest of the project.

Exhibit 3-4 suggests critical conflict areas where run-off-the-road crashes are most prevalent at roundabouts. In these areas, lighting poles should be placed as far back from the curb face as practical, and no closer than 3 feet beyond the edge of the traveled roadway. In rural areas where pedestrian activity is low, breakaway pole bases are required for poles located in these critical areas. The placing of lighting in the central island should be avoided; instead, lighting should be placed on the periphery of the roundabout.

Exhibit 3-4
Critical Conflict Areas Affecting Lighting Pole Placement



Source: Adapted from AS/NZS 1158.1.3:1997, Road lighting, Australian/New Zealand Standard, 1997, Figure 8.2, p. 39.

Sample Illumination Layouts

The following three exhibits present some sample illumination plans demonstrating layouts using various types of luminaires. Each illumination plan has been customized to the specific geometry of the roundabout, photometric requirements, equipment options, and site constraints. Therefore, the reader is urged to exercise considerable caution if attempting to adapt one or more of these plans to another location.

Exhibit 3-5
Example of Illumination Using Cobra-Style Luminaires

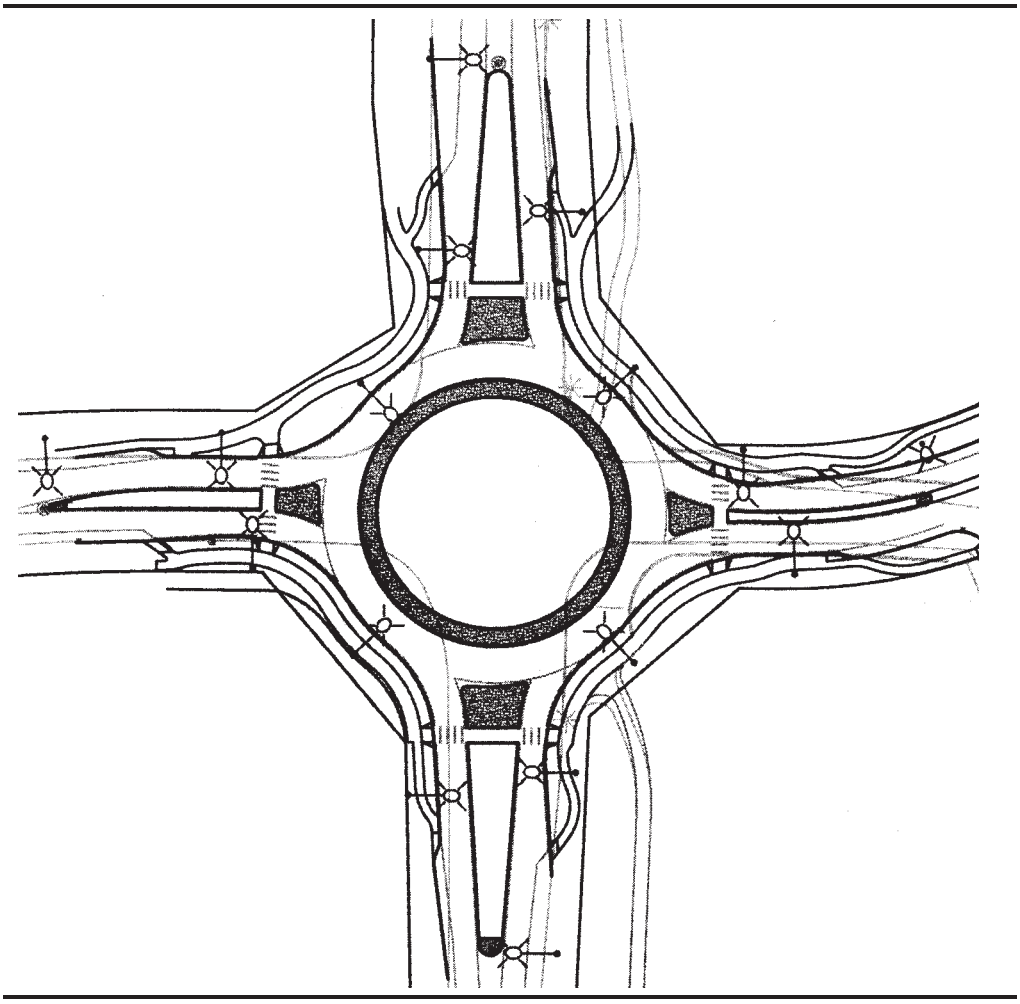


Exhibit 3-6
Example of Illumination Using Pedestrian-Level Luminaires

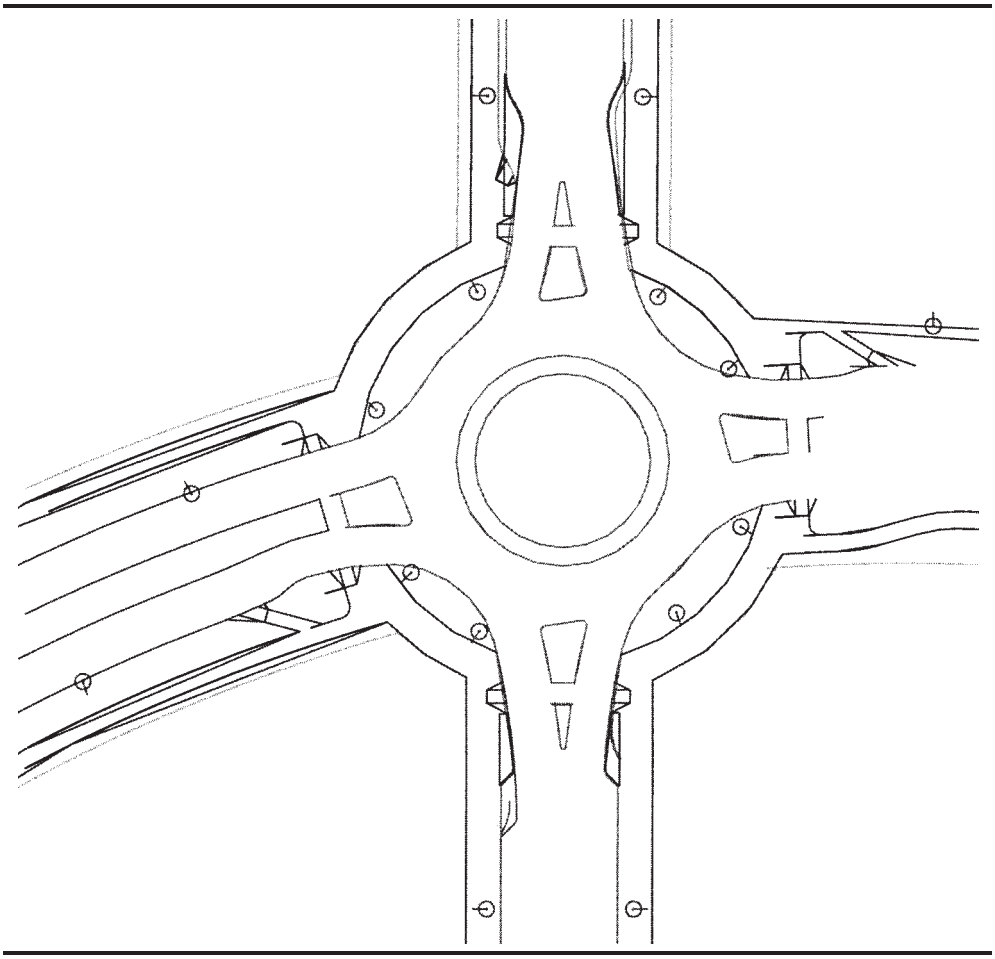


Exhibit 3-7
Example of Illumination Using a Mix of Cobra-Style and Pedestrian-Level Luminaires

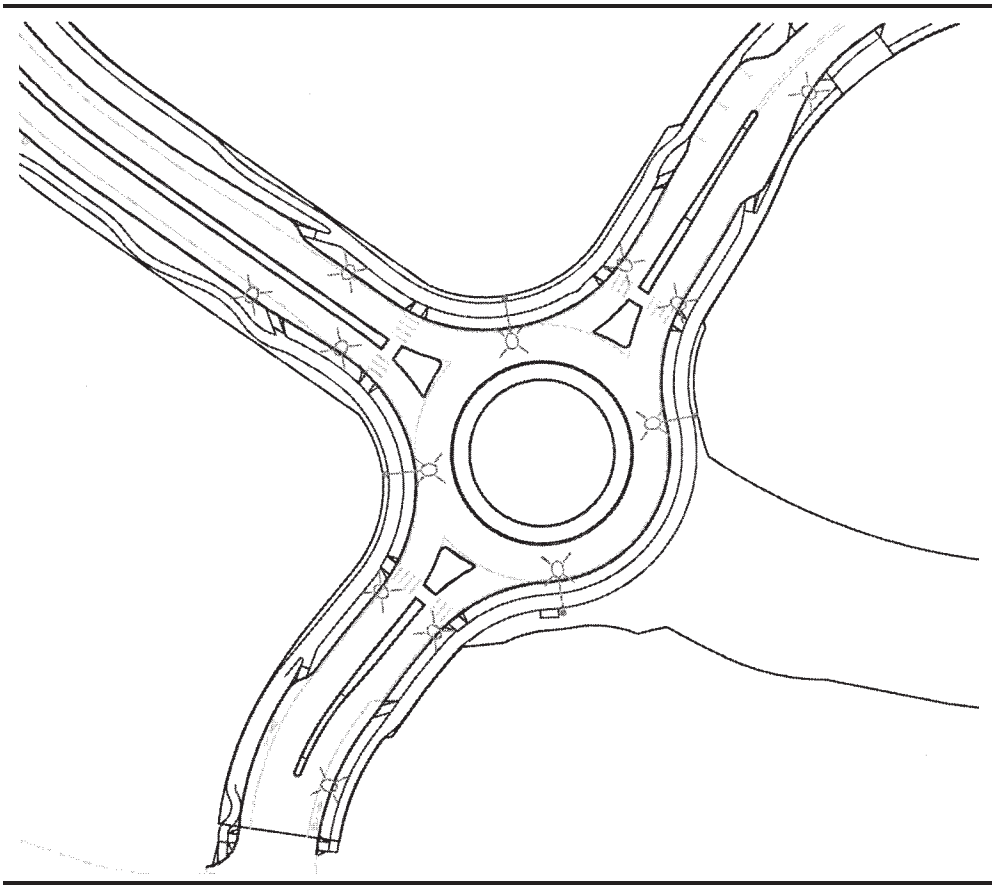


Table III-B.2:

MARYLAND STATE HIGHWAY ADMINISTRATION
EVALUATION FORM FOR INTERSECTION LIGHTING

Location:
Evaluation

	Criteria		Score Met = 1 Not Met = 0 (a)	Weight (b)	Total (a x b)
a.	Is intersection signalized?		0	5	0
b.	Does intersection have medians on any approach?		0	4	0
c.	Does intersection have left turn bays and /or other auxiliary lanes?		0	3	0
d.	Is intersection a freeway ramp terminal?		0	4	0
e.	Is there significant pedestrian volume after dark?		0	3	0
f.	Does intersection involve two or more state maintained highways?		0	1	0
g.	Does ADT of state highway exceed 15,000?		0	2	0
h.	Ratio of Night to total crashes	0.35-0.40	0	1	0
		0.40-0.45	0	3	0
		0.45-0.50	0	5	0
	(Min 5 crashes)	> 0.50	0	8	0
i.	Is intersection at school entrance or children walking to school?		0	3	0
j.	Is operating speed on any road approach greater than 50 MPH?		0	4	0
k.	Is intersection sight distance restricted?		0	5	0
l.	Are there any brightly lighted areas, i.e., parking lots, commercial area, etc. within 300 feet of the intersection?		0	4	0
m.	Are any of the road approaches continuously lighted?		0	4	0
Total					0

1) Intersection lighting is to be considered by a score of 13 or more.
2) Potential for intersection lighting will be prioritized based on score.

Table III-B.3:

Recommended Maintained Illuminance Values for Intersections other than Roundabouts

Road Classification	Pavement Classification[1]			Maximum Uniformity Ratio	Maximum Veiling Luminance Ratio
	R1 *(fc)*	R2 & R3 *(fc)*	R4 *(fc)*	E_{avg}/E_{min}	L_{vmax}/L_{avg}
Intersection Lighting[2]	0.6	0.9	0.8	4.0	0.3

[1] Pavement Classifications as IES RP-8-00 American National Standard Practice for Roadway Lighting.

[2] Refer to Table 9 of IES RP-8-00 For Recommended Illuminance Lighting Values and Intersections with Continuously Lighting Roadways in Urban Areas.

Section III-D.1
Design Guidance for Incorporating New Sign Lighting Guidelines

DESIGN GUIDANCE FOR INCORPORATING
NEW SIGN LIGHTING GUIDELINES

1. **All overhead signs shall be fabricated with Type XI sheeting.**
   Sheeting requirements in SN.1 need to be upgraded for overhead signs.

2. **All new lighting design projects should replace and upgrade any signs within the project limit that are eligible to have the lighting removed**

3. **Work requests can be generated to upgrade OH signs to Type XI sheeting to avoid maintenance repairs to existing circuitry.**

4. **For those cases where existing signs are being replaced the following items must be considered:**

- New sign designs need to assess existing sign legend and shield sizes and upgrade to current standards. Sign structures shall be verified for **ALL** signs that are replaced on existing structures.

- When lighting is no longer required for an overhead sign, the existing sign supports should be cut, cleaned and spray galvanized. A pay item (or negotiable item if not already included in the Contract) will need to be included for Item 803015 "Remove Sign/Luminaire Supports" paid per EACH support.
    - If the proposed sign is larger than the existing, additional aluminum angle vertical support attachments are to be added to the top of the existing support as shown in SHA Standard 813.05. Designers should work with MDTA to determine the appropriate length of extensions. How the aluminum angles are paid must be verified with the contract documents.
    - If new supports are being installed, the same spacing criteria previously used for the Sign Luminaire Supports will still apply.

- New structures shall still be designed for and signs shall still be placed a minimum of 20'9" above high point of roadway grade. The roadway clearance should be based on design sign size not the size of the sign being installed.

5. **Disconnection of existing sign lighting circuits:**

- All equipment on the circuits controlling the subject sign structure needs to be verified. In cases where there are additional sign structures or other lighting structures on the same circuits provisions must be made to keep them operating.
    - The existing circuits to remain in service should be traced back to the point between the last "Y" connection and the cabinet; and new Type 1 connector kits should be installed in place of the "Y"s. On some circuits, this "Y" could be in the

base of the structure itself, a manhole adjacent to the structure, an adjacent light pole or further down the road. Contacting the MDTA maintenance personnel will help in identifying where this disconnection point can be.

- On sign structures that have their own cabinet and independent service feed, arrangements will need to be made with the local power company to have the existing feed turned off. If the existing service is un-metered, make sure they remove the structure from the MDTA account.

6. How are ongoing projects handled?

- **ALL** projects in Final Review or earlier should have accommodations made to incorporate the new requirements
- Projects currently in construction should consider incorporating changes if pertinent bid items are in existing contract and the project status allows for deletion of quantities without financial impact to MDTA. i.e. material for signs, lighting cables, luminaires, luminaire supports, etc…. have not already been purchased. These may require sign sheeting changes on the shop drawings and concurrence from the contractor to provide a higher sheeting. (Typically not an issue if bid item was Type IX or Greater.)

Table IV-B.1:

Recommended Illuminance Levels for Roadway Rest Areas[1]

Rest Area	Average Horizontal Illuminance (fc)	Uniformity Ratio (AVG:MIN)
Entrance and Exit		
Access Lanes	*Refer to Table III-A.4*	
Gores		
Interior Roadways	0.6	3:1
Activity Areas[2]		
Major	1.0	3:1
Minor	0.5	6:1

[1] The illuminance values recommended represent the condition just prior to cleaning and/or group relamping as calculated and planned in the design procedure.

[2] Activity Areas are not a focus of the SHA OOTS lighting design, however if provided shall meet these values.

Table IV-B.2:

Recommended Maintained Illuminance Values for Parking Areas

Rest Area	Minimum Horizontal Illuminance[1] *(fc)*	Uniformity Ratio[2] *(MAX:MIN)*	Minimum Vertical Illuminance[3] *(fc)*
Basic	0.2	20:1	0.1
Enhanced Security[4]	0.5	15:1	0.25

[1] For preliminary design, an average value of 1 hfc for basic illuminance and 2.5 horizontal footcandles (hfc) for enhanced illuminance may be calculated. The minimum points and maximum point are then calculated and the uniformity ratio checked for compliance with the table's values.

[2] The highest horizontal illuminance point divided by the lowest horizontal illuminance point or area should not be greater than the values shown.

[3] Facial recognition can be made at levels as low as 0.25fc. The IESNA Security Lighting committee recommends that for facial identification, the minimum vertical illuminance should be 0.5fc. This should be measured at 5ft above the surface in various directions.

[4] If personal security or vandalism is a likely and/or severe problem, a significant increase of the Basic level may be appropriate.

Table IV-C.1:

Recommended Lighting Values for Pedestrian Portion of Underpasses with Walkways/Bikeways

	E_H (fc)	E_{vmin} (fc)	E_{avg}/E_{min}[1]
Night	4.0	2.0	3.0
Day[2]	10.0	5.0	3.0

E_H = Average horizontal illumination at walkway/bikeway

E_{vmin} = Minimum vertical illumination at 1.5 m (4.9 ft) above walkway/bikeway measured in both directions parallel to the main pedestrian flow.

[1] Horizontal only

[2] Use only when an engineering study indicates that enhanced security lighting is required.

Section IV-E.1
Maryland State Highway Administration
Pedestrian Lighting Policy

PEDESTRIAN LIGHTING POLICY
MARYLAND STATE HIGHWAY ADMINISTRATION

In response to the increasing emphasis on urban revitalization programs, the Maryland State Highway Administration (Administration) is placing a new focus on the issue of pedestrian lighting. This focus also aligns with the Department of Transportation's increased emphasis on multi-modal transportation. Pedestrian lighting, when properly designed and installed, has benefits that include enhancing revitalization projects, increasing nighttime pedestrian use and commerce, increasing safety and security, improving aesthetics, and adding to the sense of pride of a community. Pedestrian lighting may also have adverse effects that include glare, light trespass, increased energy consumption and sky glow that should be considered when deciding to install pedestrian lighting. In some instances it may be preferable not to install pedestrian lighting due to environmental, financial or other considerations.

This policy addresses the issues pertaining to the warranting, funding, design, construction, and maintenance of pedestrian lighting systems in which the Administration will be involved. These issues are touched on below and explained in greater detail on the following pages.

While the Administration is proactively seeking to participate in the installation of pedestrian lighting, the Criteria for Eligibility section addresses certain elements that are considered to determine the extent to which it will participate and the priority it will be given. These include the proximity to transit centers, educational and other similar facilities, nighttime pedestrian and business activities, safety and security issues, and the availability of an Administration project as a construction vehicle. In addition, the Local Jurisdiction's commitment to participate in the design, construction, operation and maintenance of the lighting system is a consideration.

The Financial Responsibility section outlines the respective financial responsibilities for the Administration and Local Jurisdictions for the design, construction, and operation and maintenance of pedestrian lighting systems. Given the large selection of poles and fixtures with an equally wide range in prices, along with the flexibility a designer has to vary the number and spacing of fixtures to obtain a desired result, the extent of the Administration's participation will vary.

It is the intent of the Administration to allow flexibility for the Local Jurisdiction with regard to pedestrian lighting systems within given engineering parameters so that the final product will enhance the image of the community, and where necessary maintain historic and aesthetic sensitivity. This sensitivity to individual historical settings will result in variations in pedestrian lighting costs. The Design Standards and Responsibilities section specifies who will perform the design of the system addressing the selection of fixtures, photometric calculations, integration with roadway lighting systems, material specifications, obtaining permits and easement agreements, as well as the review and final approval process.

The Construction section specifies how pedestrian lighting systems will be constructed including who will perform the construction, inspection, and acceptance of the project, as well as the required coordination between contractors and utility companies.

The effectiveness and benefits of the system depend upon periodic maintenance and quick repair of damaged fixtures. It is essential that the local jurisdiction be committed to the long-term upkeep of the pedestrian lighting systems. The Maintenance and Operations section will address the need for a memorandum of understanding between the Administration and the local jurisdiction regarding the requirements and obligations for the maintenance responsibility and energy costs associated with the pedestrian lighting systems.

CRITERIA FOR ELIGIBILITY

The Administration intends to participate in the design and construction of pedestrian lighting systems that are to be included as part of a proposed highway improvement, streetscape, revitalization or other transportation related project where sidewalks are either present or to be installed. The following criteria are to be considered in determining where pedestrian lighting may be utilized most effectively.

1. The system is within ½ mile of a transit center or ¼ mile of a major transit stop or is along a connection between two or more transit centers.
2. The system falls within a designated urban revitalization area.
3. The system is within ½ mile of an educational or similar facility that generates significant pedestrian traffic during hours of darkness.
4. The total number of pedestrians and/or bicyclists within any one-hour period of darkness is relatively high.
5. The system is within a commercial area with significant nighttime activities.
6. Pedestrian safety issues have been documented.

FINANCIAL RESPONSIBILTY

Administration Financial Responsibilities:

In general, when pedestrian lighting is warranted, the Administration will participate in the costs associated with design and construction of a pedestrian lighting system in one of its transportation related projects. However, due to the wide range of available styles, materials, poles, and fixtures, the Administration has established a limit for participation in the construction/installation. SHA's participation will be contingent upon the local jurisdiction's acceptance of the following conditions:

1. SHA will be responsible for the design costs of the pedestrian lighting system when the lighting system is designed by SHA or its consultants. SHA will not participate in design costs incurred by other entities other than a regulated public utility.

2. SHA will be responsible for the costs associated with the installation of the pedestrian lighting infrastructure. For purposes of this policy, infrastructure is defined as conduits and handboxes.
3. SHA will fund 50% of the actual cost to furnish and install the wiring, light foundations, poles, standard light fixtures, luminaires, and lighting control cabinets, including metered service pedestals. The limits of SHA participation will be based upon a basic lighting system that is in conformance with the design standards noted elsewhere in this policy.
4. The local jurisdiction may select lighting fixtures of a more ornamental style they find in keeping with the local community's environment or theme. Any additional costs associated with the selected lights will be the responsibility of the local jurisdiction. These selections must meet the design standards stated herein.
5. The purchase of the lighting systems and their installation will be accomplished through the State of Maryland Procurement process. Separate purchase by the local jurisdiction will not be subject to participation by the Administration, except as part of an agreement with a regulated public utility for long term maintenance.
6. The local jurisdiction agrees to maintain the lighting system.

The Administration will be responsible for all costs of lighting associated with intersections of public roads where engineering studies indicate there is a significant safety risk involving vehicles. This lighting will be provided using equipment acceptable to the Administration.

Local Jurisdiction Financial Responsibilities

The local jurisdiction will assume operational and maintenance costs for the pedestrian lighting system. This includes energy costs, maintenance and damage repair or replacement. A Memorandum of Understanding or a signed letter of intent from the local jurisdiction must be obtained before the project is advertised.

1. The local jurisdiction will be responsible for funding 50% of the actual cost to furnish and install the wiring, light foundations, poles, standard light fixtures, luminaires, and lighting control cabinets, including metered service pedestals for a basic lighting system.
2. The local jurisdiction will be responsible for funding 100% of the increased cost associated with any ornamental style poles or fixtures.
3. The local jurisdiction will be responsible for any utility connection charges from the local utility company.
4. Should the local jurisdiction elect to purchase and install pedestrian lights subsequent to the construction of the highway improvement project, SHA will install the infrastructure as specified under condition 2 of Administration Financial Responsibilities. The local jurisdiction will be required to install the pedestrian lighting systems within 3 years of the completion of the highway project. Should the local jurisdiction fail to install an operational pedestrian lighting system within this time frame, SHA will make deductions from the local jurisdictions share of Highway User Funds equal to the cost of the installed infrastructure and system design costs incurred by SHA.

5. In some instances, at the request of the local jurisdiction, the local utility company may do the design and construction of the pedestrian lighting. In such instances, the local jurisdiction shall be responsible for all design, furnishing, installation, energy, maintenance, and amortized design and construction costs.
6. The local jurisdiction shall be responsible for any accessory equipment not required for the lighting system. This includes additional wiring and fixtures for the installation of outlets within the poles, banner attachments, etc.

DESIGN STANDARDS

The factors that shall be considered when designing pedestrian lighting are:

- The "theme" of the community as defined by previous projects, by historical considerations, or by the vision of the community.
- The environmental effect of the lighting including glare, light trespass, sky glow, and, energy and maintenance costs.
- The Illuminating Engineering Society of North America recommendations and design levels for pedestrian walkways.
- State and federal safety design guidelines.
- The National Electric Code requirements.
- Adverse effects on vehicles on the traveled roadway including light trespass on the road, and glare or veiling luminance for the driver.
- Local utility company requirements and capabilities.
- Right of way and easement needs.

DESIGN RESPONSIBILITIES

Administration Responsibilities

In all cases, the Administration will review and approve the design of a pedestrian lighting system to be constructed under an Administration Contract, or in Administration right of way.

The Administration will provide design services for the lighting, electrical system and other lighting infrastructure needs where not provided by the local utility company or an agent of the local jurisdiction. As noted above SHA will only participate in design costs provided by a

regulated public utility. SHA design efforts will include coordination with pertinent agencies including the Maryland Historical Trust.

Other agencies that may design pedestrian lighting systems are:

- The local utility company. Many of the local utility companies are proficient in the design and installation of lighting.
- The local jurisdiction or their consultant. Often it is beneficial for the local jurisdiction to engage a consultant who is familiar with the many sources of lighting supplies, and who can guide them in making a choice that is aesthetically acceptable. Many suppliers will provide these services free of charge.

Local Jurisdiction Responsibilities:

The local jurisdiction will be responsible for identifying the style of lighting desired.

The local jurisdiction will be responsible for determining the limits of the lighting provided they meet the criteria noted above. Note that these may not exceed the limits stated in this policy.

The local jurisdiction will be responsible for determining, if they wish, for the local utility company to design and install the lighting.

The local jurisdiction will be responsible for determining how they anticipate having maintenance performed. If the local utility is to maintain the lighting, this may impact the design standards to be used.

The local jurisdiction will be responsible for completing the items above, and requesting that pedestrian lighting be included prior to the completion of 30% plans (Preliminary Investigation) by the Administration. The Administration can not initiate a design or switch from a utility company design to Administration design after the project has reached this level of completion.

The local jurisdiction will be responsible for obtaining needed easements or right of way for the lighting by a sidewalk ordinance or other means. This must be completed before the project is advertised. Failure by the local jurisdiction to obtain the necessary right-of-way prior to the scheduled advertisement date will result in the removal of the pedestrian lighting system from the contract.

CONSTRUCTION

There are three scenarios for installing pedestrian lighting systems:

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1. The Administration's contractor shall install the system as part of their construction contract. The Administration will be responsible for advertising and awarding the contract including plans and specifications for the pedestrian lighting system. It will also administer the contract, approve materials and perform construction inspection of the system. Final acceptance of the system will be the responsibility of the Administration in conjunction with the local jurisdiction.

2. Where available, the local jurisdiction may opt to have the local utility company install the pedestrian lighting system. This is most often accomplished when the lighting is to be leased from the utility company or when the local jurisdiction has made arrangements with the utility company to maintain the system. The Administration will be responsible for the coordination of work by the utility company with that of the prime contractor performing the transportation project.

3. Subject to prior agreement, the SHA will install the infrastructure (handboxes and conduit) as a part of the SHA construction project. The local juisdiction will then contract separately for completion of the system within 3 years of construction completion on SHA's project.

MAINTENANCE

The local jurisdiction will be required to enter into a maintenance agreement with the Administration to assume all associated maintenance costs, and ensure that routine maintenance and damage repair and replacement is performed in a timely manner. The jurisdiction may perform the maintenance with its own forces, through a contract agreement with an electrical maintenance contractor, or through the local utility company where available. Details regarding energy costs, the timeliness of repairs, and the percentage of lights to be operational at all times will be specified in the maintenance agreement.

APPROVED:

Neil J. Pedersen

Administrator
Maryland State Highway Administration

9/9/08

Date

Table IV-E.2:

Recommended Maintained Illuminance Values for High Pedestrian Conflict Areas[1]

	E_H (fc)	E_{vmin} (fc)	E_{avg}/E_{min} *
Mixed Vehicle and Pedestrian**	2.0	1.0	4.0
Pedestrian	1.0	0.5	4.0

Table IV-E.3:

Recommended Maintained Illuminance Values for Medium Pedestrian Conflict Areas[1]

	E_H (fc)	E_{vmin} (fc)	E_{avg}/E_{min} *
Pedestrian	0.5	0.2	4.0

Table IV-E.4:

Recommended Maintained Illuminance Values for Low Pedestrian Conflict Areas[1]

	E_H (fc)	E_{vmin} (fc)	E_{avg}/E_{min} *
Rural/Semi-Rural Areas	0.2	0.06	10.0
Low Density Residential	0.3	0.08	6.0
Medium Density Residential	0.4	0.1	4.0

* Horizontal

**Mixed vehicle and pedestrian refers to those areas where the pedestrians are immediately adjacent to vehicular traffic without barriers or separation. Does not apply to mid-block crossings.

E_H=Average horizontal illuminance at walkway/bikeway

E_{vmin} = Minimum vertical illumination at 1.5 m (4.9 ft) above walkway/bikeway measured in both directions parallel to the main pedestrian flow.

[1] Pedestrian Conflict Areas as defined in IES RP-8-00 American National Standard Practice for Roadway Lighting.

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