11-1-1 Initial System Approval **April 2024**

PURPOSE

This policy describes the requirements for approval to install WisDOT owned and maintained roadway lighting facilities on the Wisconsin State Highway System.

POLICY

All lighting on the State Trunk Highway system that is owned and maintained by WisDOT **shall** require approval in accordance with this policy.

PROCEDURAL REQUIREMENTS

The State Lighting Systems Engineer in the Bureau of Traffic Operations **shall** approve all proposed new roadway lighting system installations on the State Trunk highway system except for systems as described in FDM 11-50-60 that do not require approval. When there is a possibility a project *may* include the installation of roadway lighting, the WisDOT project manager for design **shall** work with the Region Lighting Engineer in the traffic section to submit a DT1198 Roadway Lighting System Approval Request, supported by an investigation report, to the State Lighting Systems Engineer. These documents **shall** be submitted and approved before any commitments are made concerning the installation of roadway lighting systems. Roadway Lighting Systems Approval Requests *should* be completed and approved prior to the 60% design level of completion and the submittal of the Design Study Report (DSR) for a project.

The investigation report provides an objective description and analysis of the roadway/project for the State Lighting Systems Engineer to use in recommending installing and maintaining a roadway lighting system.

The report **shall** include (as applicable):

- DT1198 Roadway Lighting System Approval Request.
- Description/discussion of the project and plan drawing(s) of the roadway project under consideration.
- Data pertinent to determine the need for roadway lighting that includes, but not limited to:
    - Traffic volumes minimally broken down into day vs. night, but more specific time periods when pertinent to the investigation.
    - Crash history on the existing road including type of crash and if darkness was a pertinent factor.
    - Evaluation of other crash avoidance measures (geometric, signing, striping, etc.) being considered and/or implemented and how roadway lighting relates to this overall safety evaluation.
    - Analysis based on the minimum warranting conditions as minimum thresholds for further consideration of roadway lighting as described in the current AASHTO Roadway Lighting Design Guide.
    - Other factors such as pedestrian and bike use, adjacent land uses, environmental conditions, and other pertinent aspects of the project area for determining whether roadway lighting is appropriate.
- Installation cost and maintenance/energy costs.
- Discussion, correspondence, recommendations from local jurisdictions, and any written agreements relating to roadway lighting on the project.
- Preliminary design criteria, classification data, and recommended lighting levels.
- Alternative analysis *may* be appropriate if multiple layout configurations are being considered.
- A recommendation with supporting discussion based on the above evaluation.

Roadway lighting warrant thresholds established by AASHTO and IES have been classified based on geometric, operational, environmental conditions, and accident history, which address existing facilities only. Roadway lighting warrants do not provide sufficient guidance for determining the requirement for roadway lighting on new facilities. Designers **shall** apply engineering judgement when using warrants to justify installing roadway lighting.

The State Lighting Systems Engineer will evaluate the proposal based on the information in the investigation report along with consideration of any additional items pertinent to the specific project and provide approval for acceptable projects.

Regardless of the need for approval, all WisDOT maintained roadway lighting systems **shall** follow the design process described in other TEOpS sections.

EXEMPTIONS

Roadway lighting on connecting highways and permitted roadway lighting maintained by local municipalities on State Trunk highway system are exempt from submitting a DT1198 request for approval. However, in these cases a separate approval process *may* be required, and the project manager **shall** work with the Regional Lighting Engineer to accommodate coordination and oversight of the design.

APPLICABLE FORMS

- DT1198 – Roadway Lighting System Approval Request

11-1-2 Roadway Lighting System Design Approval April 2024

PURPOSE

The purpose of this policy is to prescribe guidelines and procedures that will help ensure consistent roadway lighting system designs statewide and clarify the review requirements.

POLICY

All WisDOT maintained Roadway Lighting System designs **shall** follow the process described in this document.

PROCEDURAL REQUIREMENTS

For all Projects covered under this policy, after receiving the necessary Roadway Lighting System Approval described in TEOpS 11-1-1.

The designer **shall** send a copy of all submittals to the Regional Lighting Engineer.

LOCALLY OWNED ROADWAY LIGHTING SYSTEMS

All locally owned and maintained roadway lighting systems on the State Trunk Highway system **shall** be based on Connecting Highway agreements, or otherwise will require a permit in accordance with TEOpS 11-2-1.

APPLICABLE FORMS

- DT1886 – Continuous Lighting Illumination Application
- Signalized Intersection Illumination Form (see TEOPS 11-4-2)
- Roundabout Illumination Form (See TEOPS 11-4-3)

CONTINUOUS LIGHTING ILLUMINATION APPLICATION

DT1886 4/2015 s.84.02(4)(c) Wis. Stats.

Wisconsin Department of Transportation
State Project Number

Submit to the Regional Office of the Wisconsin Department of Transportation, including:

- ☐ This completed DT1886 Continuous Lighting Form. Provide additional forms as necessary when there are multiple Roadways and/or Roadway Types.
- ☐ Engineering drawing of the Roadway Plan, or typical section, showing edge of pavement, curb lines, shoulders, etc.
- ☐ Brief description of the project

Design Information (Provide additional forms as necessary for multiple roadways and/or roadway types)

Highway	Lighting Limits

Project Lighting Engineer Name, Mailing Address and Telephone

County	Posted Speed Limit mph	ADT	Cross Section Rural / Urban	Roadway Width ft

Road Class		Area Class		Pavement Class	
☐ Major	☐ Minor Arterial	☐ Commercial	☐ Residential	☐ R1	☐ R3
☐ Collector	☐ Other	☐ Intermediate		☐ R2	☐ R4

Based on Roadway information above, provide Design Criteria Values in accordance with AASHTO 2005 Roadway Lighting Guide, Table 3-5a.

Luminaire LED Category	Mounting Height Above Pavement

Target Illuminance Values		Target Luminance Values			
Average FC	Uniformity Ave/Min	Average cd/m sq	Veiling Luminance Ratio Lv(max)/Lavg	Uniformity Ave/Min	Max/Min

The designated engineer requests permission to begin the design of highway lighting within the limits of the right of way of the state trunk highway, all as described above.

X _____
(Lighting Engineer) (Date – m/d/yy)

APPROVAL

Permission is granted to begin the highway lighting design as described above and per the attached drawings and specifications.

CONTINUOUS LIGHTING

Approved for Division of Transportation System Development

X _____
(Signature) (Date Reviewed – m/d/yy)

11-2-1 Permitted Roadway Lighting System Approval April 2024

PURPOSE

This policy describes the requirements for approval of roadway lighting facilities install and maintained by local agencies (or other entities) within the limits of the public highway rights-of-way on the State Trunk Highway System.

POLICY

All locally owned and maintained roadway lighting systems installed on the State Trunk Highway System **shall** require a permit in accordance with this document.

The provisions of this policy **shall** apply to all cities, villages, counties, and towns (i.e., local agencies) which desire to use or occupy rights-of-way on the State Trunk Highway System for locally owned and maintained roadway lighting and other types of lighting facilities. Public, private, and municipal utilities, cooperatives, and private citizens who desire to use or occupy rights-of-way on the State Trunk Highway System for roadway lighting **shall** apply to the city, village, county, or town in which the State Trunk Highway is located.

This policy does **not** apply to lighting systems proposed for installation on **local roadways or connecting highways**. These are the responsibility of the local municipalities. This document *may* be used as a reference for the design of such systems.

PROCEDURAL REQUIREMENTS

For all Projects covered under this policy, an application for approval to install roadway lighting **shall** be submitted to the WisDOT Regional Office by or on behalf of the local agency that will be paying for the maintenance and energy costs associated with the lighting system. Funding and participation limits between the local agency and WisDOT region *should* be defined prior to submitting any permit documents in accordance with the WisDOT Program Management Manual (PMM).

The application **shall** be submitted on the appropriate current forms and **shall** include all items outlined in this document. The forms are available on the WisDOT web site and are linked below in the Applicable Forms Section.

Permit applications that require State Lighting Engineer approval **shall** be submitted to the attention of the Regional Office. The WisDOT Regional office will review before forwarding it to the State Engineer for approval.

APPROVAL AUTHORITY

The State Lighting Engineer **shall** review and approve all permits involving new continuous lighting systems, as well as applications on the State Trunk Highway system that include:

- Ornamental street lighting
- Pedestrian and trail lighting
- Underdeck lighting
- Receptacles for Festoon Lighting

New permits are also required any time an agency wishes to upgrade or otherwise modify an existing continuous system, including altering or moving lighting equipment, or altering equipment associated with a lighting transition zone.

The Regional Office has the approval authority to review, and issue permits for isolated lighting on the State Trunk Highway System. This includes the installation of a luminaire and arm added to an existing or new utility pole. The Regional Office *may* review and issue a permit for continuous lighting when an agency wishes to add lighting units to an existing continuous system if the new lighting units match the existing equipment and generate equivalent lighting levels.

MODIFYING A PERMITTED SYSTEM

Any changes to an existing permitted installation that result in the following alterations, **shall not** be made until a new permit authorizing such changes is issued (note: excludes routine maintenance activities):

- Pole locations
- Pole heights and types
- Luminaire and lamp types
- Receptacles for festoon lighting
- Operating conditions such as lighting curfews/dimming
- Other items affected by this policy

ISOLATED LIGHTING PERMIT APPLICATION

The Applicant **shall** contact the Regional Office at project conception to begin the Isolated Lighting permit process. Isolated Lighting typically involves lighting of a single intersection of a non-illuminated roadway, or periodic lighting along a roadway where IES defined light level standards or average Illuminance and uniformity are not applicable. Form DT1885 **shall** be submitted to the WisDOT Regional Traffic Operations Section for review and approval.

CONTINUOUS LIGHTING PERMIT APPLICATION

The applicant **shall** follow the two-part process outlined below for Continuous Lighting permit applications, consisting of a preliminary and a final application form:

1. Prior to the 60% submittal, the Applicant **shall** contact the Regional Office to coordinate the submittal of a preliminary permit application. The name and address of the project electrical and lighting designer **shall** appear on the form. The applicant **shall** provide catalog cut sheets for proposed poles and luminaires. Photometric design and pole layout *should not* be completed until the preliminary application is submitted and approved. The Regional Office *may* review the basic project information and coordinate with the State Lighting Engineer on acceptance of lighting levels, pole locations, and luminaire type.
   As part of this preliminary process, the applicant **shall** describe the purpose for the proposed lighting system, such as:
   a. Roadway safety lighting in accordance with AASHTO requirements
   b. Decorative lighting for urban areas
   c. Public safety for areas with sidewalks and paths
2. Prior to submitting draft PS&E, the Applicant **shall** submit the final permit application to the Regional Office. Lighting and electrical plans, special provisions, photometric and voltage drop calculations, and pole and luminaire cut sheets **shall** be submitted with the final permit application. The name and address of the project electrical and lighting designer and appropriate signatures **shall** appear on the form. After initial review, the Regional Office **shall** forward the application to the State Lighting Engineer for approval.
3. When replacing existing light poles with new light poles to allow for the mounting of other equipment (cameras, small cell antennas) to the poles, the applicant must refer to the applicable section that covers replacing existing lighting poles https://wisconsindot.gov/Documents/doing-bus/real-estate/permits/09-15-41r_0621.pdf.The new light pole must be of the same type of materials to match the adjacent light poles, a WisDOT approved mast arm must be provided with an approved LED luminaire must be mounted to the new pole. The new pole **shall** be installed in the same general location (within 5 feet) as the existing light pole it replaces.

Other required information related to the Final Permit Submittal:

- Summary Tables that include both the design parameter target illumination values and calculated results
- Computer Design Computations for illumination and spacing of completed roadway sections.
- If banners, holiday decorations or festoon receptacles are to be installed or attached to the poles, the dimensions and locations **shall** be included and shown on a detail drawing in the plans (Festoon receptacles **shall** be set up on their own circuits, separate from the lighting)
- The designer **shall** include in the project plans the necessary SPV verbiage that ensures the final luminaires provided on the project will meet the design parameters of the permit.

The Project Electrical/Lighting Engineer and Applicant **shall** sign and date the final permit application.

ISOLATED LIGHTING PERMIT APPLICATION
The Applicant **shall** contact the State Lighting Engineer at project conception to begin the Isolated Lighting permit process. Isolated Lighting typically involves lighting of a single intersection of a non-illuminated roadway, or periodic lighting along a roadway where IES defined light level standards or average Illuminance and uniformity are not applicable. Form DT1885 **shall** be submitted to the WisDOT Regional Traffic Operations Section for review and approval.

APPLICABLE FORMS

- DT1878 – Preliminary Continuous Lighting Permit Application
- DT1879 – Final Continuous Lighting Permit Application
- DT1885 – Isolated Lighting Permit Application
- Signalized Intersection Illumination Form (see TEOPS 11-4-2)
- Roundabout Illumination Form (See TEOPS 11-4-3)

11-2-2 Private Light Trespass on State Right-of-Way April 2024

Privately owned lighting installations adjacent to the State Trunk System *may* require approval from WisDOT if light trespasses beyond the private property and onto State-owned rights-of-way. Locations where light trespass is identified in a significant capacity on a State-owned right-of-way *may* be subjected to evaluation, including the request for photometric measurements and documentation of system justification. Light trespass which creates significant glare on State-owned rights-of-way **shall** be evaluated with respect to the safety of roadway users. Permitting for private lighting sources trespassing on State-owned right-of-way **shall** follow the same approval process as an isolated lighting installation. Form DT1885 **shall** be submitted to the WisDOT Regional Traffic Operations Section.

11-2-3 Other Lighting Categories (Requiring Special Permits) April 2024

Flood lighting for bridges and retaining walls, work with BTO Lighting as this type of lighting is addressed on project-by-project basis. For aesthetic lighting on structures, refer to TEOPS 11-3-8.

When, LED Advertisement Signs are installed in WisDOT right-of-way near or on STH systems, the designer **shall** refer to policy set forth in HMM 9-5-1 Outdoor Advertising,

a. *No sign **shall** contain, include or be illuminated by any moving, flashing or intermittent lights.*
b. *No sign **shall** emit or reflect beams or rays of light on any portion of the traveled way or **shall** emit or reflect light of such intensity or brilliance as to cause glare or to impair or otherwise interfere with a driver's vision.*
c. *No sign **shall** be so lighted as to obstruct or interfere with an official traffic sign, device or signal.*

Refer to TEOPS 11-3-9 for navigation lighting.
Refer to TEOPS 11-3-10 for roadway lighting equipment installed near airports.

11-3-1 Preliminary Design Considerations and Parameters – Roadway Lighting April 2024

POLICY

Unless described otherwise, all roadway lighting designed for the State Trunk highway system that is owned and maintained by WisDOT **shall** follow the preliminary design guidelines described in this section.

TYPES OF ROADWAY LIGHTING

There are several different types of roadways and facilities involving the consideration of lighting, most all of which are covered in more detail in the ANSI/IES RP-8-22 and AASHTO Roadway Lighting Design Guide. In general, the following categories are covered in this document:

- Continuous lighting systems, including continuous (corridor) freeway lighting; complete interchange lighting; partial interchange lighting; and rural interchanges.
- Streets and highways other than freeways, including expressways and urban streets, and rural highways, including spot locations involving special considerations.
- Intersections, including isolated (standalone) intersections; signalized intersections; and roundabouts. These could include transition lighting and/or coordination with a continuous segment lighting system.
- Non-standard interchanges and intersections

Continuous lighting is defined as a lighting system incorporating lighting units with overlapping distribution patterns that meet average and uniformity levels as defined by IES for the appropriate roadway area classification and use.

Isolated lighting is defined as lighting at the intersections of non-illuminated roadways or periodic lighting along a roadway where IES defined light level standards for average and uniformity are not applicable.

Transition lighting is defined as a gradual increase or reduction in lighting levels when entering or leaving a lighting system, most typically at freeway ramps, isolated systems, and roundabouts, when the roadway is not continuously illuminated.

PRELIMINARY DESIGN PARAMETERS AND CALCULATIONS

The following design parameters pertain to all “standard” roadway lighting systems:

1. Lighting systems **shall** be designed in accordance with ANSI/IES RP-8-22 and AASHTO’s Roadway Lighting Design Guide, October 2018.
2. Pavement classifications of R1 (concrete) or R3 (asphalt) *should* be used depending upon the permanent roadway surface.

The most restrictive and/or applicable policy, code, standard, or guide **shall** govern. Bureau of Traffic Operations will make the final decision on the interpretation of conflicting policies, codes, or standards.

ROADWAY AND LAND USE (AREA) CLASSIFICATIONS

There are numerous documents that define roadway classifications. Roadway classifications used to determine lighting standards **shall** reference the applicable section(s) of the following guidelines:

- ANSI/IES RP-8-22 (Lighting Roadway and Parking Facilities)
- AASHTO Policy on Geometric Design of Highways and Streets (Green Book)
- WisDOT Facilities Development Manual (FDM) 4-1-15
- FHWA Highway Functional Classifications

WisDOT policy specifies using the ANSI/IES guide RP-8-22 and AASHTO Roadway Lighting Design Guide. However, it is the responsibility of the designer to use the available resources to evaluate the section of roadway where the proposed lighting system will be installed. The functional classifications used to design the road do not necessarily address the issues that are important for lighting. Evaluation metrics include:

- Is this section of roadway primarily used for through traffic or access, or more to local properties?
- What is the speed limit and volume of traffic?
- What is the level of development and access to the surrounding area?
- What is the pedestrian conflict?
- Any unique roadway geometry or complex intersections/interchanges?

This type of basic evaluation will help determine which of the IES Table classifications provides the best fit for the project.

Table 1 below contains some of the key points from the ANSI/IES RP-8-22 and AASHTO Roadway Lighting Design Guide as an example to the designer. AASHTO utilizes similar roadway classification nomenclature under varying parameters. The designer **shall** refer to the appropriate reference manual as selected for use with the project.

Table 1. Classification Descriptions

Highway Classifications	**Description**
Freeway	A divided highway with full control of access. *Freeway Class A:* Roadways with great visual complexity and high trafic volumes. This type of freeway will usually be found in major metropolitan areas in or near the central core, and will operate at or near design capacity through some of the early morning or evening hours of darkness. *Freeway Class B:* All other divided roadways with full conrol of access.
Expressway	A divided highway with partial control of access.
Roadway Classifications	**Description**
Major (Arterial) Street	That part of the roadway system that serves as the principal network for through-traffic flow. These routes connect areas of principal traffic generation and important roadways entering and leaving the city. They are sometimes subdivided into primary and secondary classications; however, such distinctions are not necessary for the purpose of street lighting. These routes primarily serve through-traffic and secondarily provide access to abutting property.
Collector Street	A road servicing traffic between major and local streets. These are streets used mainly for traffic movements within residential, commercial, and industrial areas. Collector streets may be used for truck or bus movements and give direct service to abutting properties.
Local Street	Local streets are used primarily for direct access to residential, commercial, industrial, or other abutting property. They make up a large percentage of the total street system but carry a small proportion of vehicular traffic.
Pedestrian Activity Classifications	**Description**
High Pedestrian Activity Areas	More than 100 pedestrians during the highest nightly average one-hour volume period. For example, this would include downtown areas with dense urban development (typically over 3,000 pedestrians per square kilometer), areas around major arenas.
Medium Pedestrian Activity Areas	Between 11 and 99 pedestrians during the highest nightly average one-hour volume period.
Low Pedestrian Activity Areas	10 or fewer pedestrians during the highest nightly average one-hour volume period. In low activity areas, it is recommended that the jurisdiction define whether sidewalk lighting is required, as lighting will typically have lower value in this application.

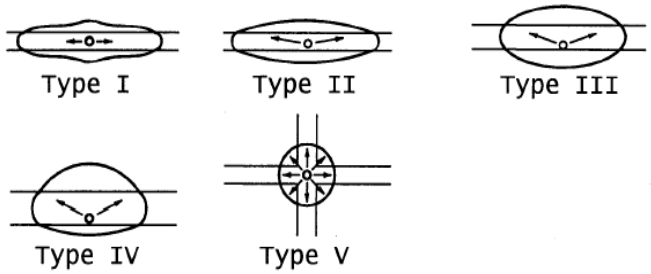
GENERAL REQUIREMENTS FOR LUMINAIRES

LED Luminaires **shall** be used for WisDOT maintained lighting systems and **shall** be selected from the

Department's Electrical Qualified Product List (QPL) whenever possible. The QPL provides products that contain a Type 3 light distribution only. Any other distribution types would need to be approved before use and require a modification to the standard specification.

Understanding the characteristics of the luminaires used on the project is critical when laying out lighting to ensure proper coverage is provided while maintaining a cost-effective approach. For permitted locally maintained systems, the luminaires **shall** be selected based on their distribution characteristics as they apply to the roadway geometry to ensure adequate illumination and minimum glare. They **shall** meet the roadway illumination requirements specified in this document. Type 2 or 3 roadway lighting distribution patterns **shall** be used for all standard applications. See typical distribution patterns in Figure 1.

Figure 1. Standard Luminaire Distributions



WisDOT QPL approved luminaires also adhere to predetermined criteria for control of light trespass for **B**ack-light, **U**p-light, and **G**lare (B.U.G). For permitted locally maintained systems, the luminaires *should* be selected based on their B.U.G. rating performing within the limits specified by the WisDOT LED Luminaire Material Specification. B.U.G. ratings are a required performance metric specified by the manufacturer for nearly all modern luminaires. These metrics are calculated based on the different distribution of light within each zone.

WisDOT currently permits the use of 4K luminaires. Luminaires with significantly different color temperatures **shall** be approved before use. For permitted locally maintained systems, the color temperature **shall** be selected based on coordination with the local agency. For example, urban districts will often utilize lower color temperatures to maintain a warmer and less stark setting.

No luminaire **shall** be proposed for use on the State Trunk Highway System that cannot meet the Illuminance and/or Luminance criteria or the Veiling Luminance Ratio required for the lighting system unless approved by the Regional and State Lighting Engineer.

A Light Loss Factor (LLF) **shall** be applied to initial lamp lumen output to calculate maintained illumination as prescribed in this section.

- The LLF for Luminaires on WisDOT's QPL **shall** be the value indicated on the List. This value includes an adjustment for luminaire dirt depreciation.
- When luminaires other than those identified on the QPL are specified for permitted locally maintained systems, the designer **shall** identify the proposed LLF and furnish justification for it with the permit application.

POLICY REVISIONS

The requirements of this policy *may* be updated to reflect changing technology or other conditions appropriate at the time. Such additions, revisions, and modifications will not be made retroactive to lighting installations covered by existing permits.

WisDOT *may* require the updating of all or part of an existing installation to conform to the latest criteria in the event damage to an installation, highway reconstruction, or other reasons requiring the replacement or relocation of all, or part of an existing lighting installation offers an opportunity to upgrade the installation.

CURFEWS

Curfews are defined as the switching off or dimming of lights during certain off-peak hours. WisDOT does not currently utilize curfews of lighting systems on WisDOT maintained lighting installations. The Department will consider allowing curfews of a permitted lighting system if the maintaining agency can demonstrate that it will not violate the AASHTO table lighting levels. This would include:

- Evaluation of the conditions during the proposed curfew hours showing that the roadway/area is different than the normal hours such that a reduction in illumination is justified if dimming is proposed. Such an evaluation typically would include such items as reductions in traffic volume and/or pedestrians.
- A statement from the local agency supporting that full illumination is not necessary during the proposed curfew hours.

11-3-2 Photometrics and Illumination Modeling April 2024

PHOTOMETRIC MODELING

The calculation of roadway lighting levels for WisDOT projects *should* be performed using Lighting Analysts AGI32 software. This will enable the designer to share the design files generated by the software with the Department for in-depth review when necessary. Unless indicated otherwise, the following methods of calculation **shall** be used:

- The Luminance Method of calculation **shall** be used to determine the average maintained luminance (in candelas per meter squared), the average-to-minimum (average uniformity), and the maximum-to-minimum (maximum uniformity) lighting levels for straight roadway segments with continuous lighting.
- The Illuminance Method of calculation **shall** be used to determine the average maintained illumination (in footcandles) and the average-to-minimum (uniformity) lighting levels for intersections and roundabouts. This can also be used on curved roadway segments with continuous lighting, but the luminance method **shall** govern when applicable.
- The designer/engineer **shall** also perform the Maximum Veiling Luminance Ratio calculation for all continuous lighting systems. The specified Maximum Veiling Luminance Ratio *should not* exceed that

defined in the ANSI/IES guide RP-8-22 and AASHTO Roadway Lighting Design Guide.

The designer *should* be prepared to provide the WisDOT Regional Lighting Engineer with a technical summary of the photometric modeling, including:

- Classification of all lighting segments within the project limits according to ANSI/IES guide RP-8-22 and/or AASHTO's Roadway Lighting Design Guide
- Other lighting design criteria according to the specified classifications and roadway characteristics
- Luminaires used in modeling and their defining characteristics:
    - Mounting height
    - Arm length
    - Maximum wattage
    - Lumen output
    - Light Loss Factor
- Photometric output and performance results for all segments of a project.

11-3-3 Standard Overhead Roadway Lighting (Intersections and Continuous Segments) April 2024

POLICY

Unless described otherwise, all standard overhead lighting installations on the State Trunk highway system **shall** follow the design guidelines described in this section.

FEASIBILITY CONSIDERATIONS

Standard overhead lighting **shall** be installed at all locations as specified in FDM 11-50-60, and as approved according to TEOpS Chapters 11-1 and 11-2. Exceptions include alternative systems as described in the following subchapters and decorative lighting as requested by the local maintaining authority.

MATERIALS

Designers **shall** refer to the QPL for a list of multiple luminaires that are pre-approved for use on WisDOT facilities. Designers *should* also consider which QPL luminaire to use for photometric design, and they *should* consult with the Regional Lighting Engineer to confirm whether specific luminaire(s) from the QPL are preferred. Designers *should* select the luminaire model and distribution type based on the WisDOT Region's typical practices and the type that is most efficient and best performing overall to provide the necessary lighting levels with the fewest number of poles.

Table 2. Lighting Infrastructure Compatibility

Concrete Base	Compatible Poles	Compatible Luminaire Arms	Compatible Luminaire Types	Typical Applications
Type 2	Type 3 (30-Ft) Type 4 (30-Ft)	Truss Type 4-Inch Clamp 10-15 FT Single Member 4-Inch Clamp 6-8 FT	A, B, C	Traffic Signals - Standard
Type 5	Type 5 (30-Ft)	*Aluminum:* Single Member 4 ½-Inch Clamp 4-8 FT Truss Type 4 ½-Inch Clamp 10-15 FT	A, B, C	Intersections / Continuous
		Steel: Single Member 4-Inch Clamp 6-8FT Truss Type 4-Inch Clamp 10-15 FT		Intersections / Continuous
Type 6	Type 6 (35-Ft)	*Aluminum:* Single Member 4 ½-Inch Clamp 4-8 FT Truss Type 4 ½-Inch Clamp 10-15 FT	B, C, D	Intersections / Continuous
		Steel: Single Member 4-Inch Clamp 6-8 FT Truss Type 4-Inch Clamp 10-15 FT		Intersections / Continuous
Type 7	Type 17 (40-Ft)	*Aluminum and Steel:* Single Member 6-Inch Clamp 4-15 FT Truss Type 6-Inch Clamp 10-20 FT	B, C, D	Milwaukee Freeway
Type 10 Type 10 Special	Type 10 Type 10 Special Type 10-Over Height	Steel 6-15 FT Steel Type 10 Pole Clamp 15 FT*	A, B, C	Traffic Signals - Monotube
Type 11	Lighting Units Walkway	NA – Post top style unit		Rest Areas / Waysides / Pedestrian Areas
Type 13	Type 13 Type 13-Over Height	Luminaire Arms Steel 6-15 FT Steel Type 13 Pole Clamp 15 FT*	A, B, C	Traffic Signals - Monotube
Freeway Median Barriers & Structural Parapets	Type 7 (35'-10")	Single Member 6-Inch Clamp 4-10 FT Truss Type 6-Inch Clamp 10-20 FT	B, C, D	STH Median / Side Mount
Freeway Median Barriers & Structural Parapets	Type A (47'-6")	Single Member 6-Inch Clamp 4-10 FT Truss Type 6-Inch Clamp 10 FT	C, D	Freeway Median Ground / Structure Mount
Freeway Median Barriers & Structural Parapets	Type E (49'-0")	Single Member 6-Inch Clamp 4-15 FT Truss Type 6-Inch Clamp 10 FT	C, D	Freeway on/off Ramp; Slope Mount
Freeway Median Barriers & Structural Parapets	Type F (46'-0")	Single Member 6-Inch Clamp 4-15 FT Truss Type 6-Inch Clamp 10-20 FT	C, D	Freeway Barrier Wall Median Mount
** This luminaire arm type is only intended for use with traffic signal detectors and cameras*				

Lighting units and compatible infrastructure **shall** be verified with the WisDOT standard specifications and Standard Detail Drawings (SDD's) to ensure compatibility.

Specification of lighting infrastructure **shall** be verified with the respective WisDOT Regional Lighting Engineer. Acceptable mounting heights are generally dictated by the reach of available maintenance equipment in the respective Region. In general, a taller pole height provides greater coverage and a more efficient design than shorter poles. The luminaire arm length *should* be as short as possible, except when the offset to the roadway requires a longer arm to aim the light where needed. Evaluating the performance of twin luminaires and single luminaires *should* be compared when lighting a divided roadway and for intersections with channelizing islands. Twin luminaires are rotated 180 degrees from each other and cannot be adjusted.

WisDOT's list of standard bid items and QPL include both aluminum and steel pole types for some categories. Aluminum poles **shall** be used as standard practice with exceptions for steel in cases where a more rigid pole type is required. Poles combined with freeway ramp gates are one example.

Refer to Table 2 above for multiple potential combinations of concrete bases, poles, and luminaire arms available for use on WisDOT projects.

LOCATING LIGHTING UNITS

The following criteria **shall** be used to ensure that the placement of poles and other lighting appurtenances adjacent to the roadway will provide an acceptable degree of safety to the public and comply with good

illumination practices. The selection of pole types and their offsets from the traveled portions of the roadway is of considerable importance in minimizing the number and severity of fixed object collisions by errant vehicles. Light poles installed along curves *should* be located on the inside of the radius of curvature unless not possible due to unique circumstances. As much as possible, the number of poles *should* be as limited as possible to decrease impact on roadway operations, potential "run-ins", and maintenance purposes. The TEOPS Chapter 4 and TEOpS 11-4 herein give additional information related to pole locations and co-locations for luminaires, etc.

Lighting poles *should* be located to minimize conflict with utilities, including both underground and overhead. Special consideration *should* be given to overhead lines, as the survey is not always accurate to the actual envelope created by multiple lines stacked horizontally. Furthermore, utility companies will have minimum offsets that must be maintained from their lines to ensure stray voltage does not become a safety concern for installation or maintenance crews. Establishing safe offsets to high voltage transmission lines is especially critical.

Where lighting projects are being considered near an active airfield or airport, consider the impact the height of the light tower has on navigable airspace during and after construction. Any need for aviation obstruction warning luminaires on highway structures will be coordinated with the Federal Aviation Administration (FAA).

POLE BREAKAWAY REQUIREMENTS

Poles permitted on the rights-of-way of the State Trunk Highway System for the sole purpose of roadway lighting fall into one of two categories:

1. *Breakaway Poles:* This type of lighting support is defined as a pole and/or foundation which when struck by a vehicle will fracture or slip away under the conditions prescribed by the current edition of AASHTO Standard Specifications for Structural Supports for Highway Luminaires. No portion of the concrete footing **shall** be allowed to protrude above the ground level more than 4 inches.
2. *Non-Breakaway Poles:* Rigid lighting standards are defined as those poles and mountings which under impact conditions do not break away within the criteria specified for breakaway poles. Under normal conditions, the use of lighting pole designs conforming to the breakaway requirements above is required for all lighting installations except in certain circumstances:
    - Salvaging and reinstalling existing non-breakaway poles
    - Poles located on concrete barrier or parapets
    - Where direct bury poles are necessitated by the project
    - High pedestrian traffic areas, such as school zones

MINIMUM LATERAL OFFSET

Table 3 below is attached as a reference for the minimum lateral offset for lighting poles on the State Trunk highway system. The values indicated in Table 3 are based upon the current policy related to objects in clear zones as specified in FDM 11-15-1. All designs **shall** comply with the FDM. Offsets greater than those prescribed *should* be provided where feasible and where special traffic and highway conditions warrant. The designer **shall** coordinate with the Project Manager regarding all pole placement considerations.

Table 3. Minimum Lateral Offsets

Facility Type	Speed Limit (MPH)	Traffic Volume (ADT**)	Minimum Rigid (FEET)	Offset Breakaway (FEET)
Rural				SHOULDER width plus
	35 or less	ALL	12	2
	40	0 - 1,500	14	2
		1,500 - 6,000	16	2
		over 6,000	18	2
	45-50	0 - 1,500	20	2
		1,500 - 6,000	26	2
		over 6,000	28	2
	55	0 - 1,500	24	2
		1,500 - 6,000	30	2
		over 6,000	30	2
Urban				
	40 or less	ALL	2 from face of curb	2 from face of curb
	45 and higher	ALL	Offsets same as rural section	(Measured from the edge of thru lane) the greater of 12 or 2 from face of curb

Offset distances are in feet, from edge of the adjacent through traffic lane to the face of the pole; or as indicated for urban sections.

1. The preceding table is based upon pole location in a flat area or without fill slope steeper than 4:1. If rigid poles are contemplated on a slope of greater steepness and significant width, advice *should* be sought from Bureau of Traffic Operations. Placement of rigid poles in this situation is discouraged.
2. Where the offsets given in the above table would place rigid poles off the highway right-of-way, they *may* be permitted at or as near the right-of-way line as practical if it would not result in a significant added hazard to the public.
3. Where the offsets given in the above table require a pole to be in a ditch line, the pole *should* be located beyond the ditch line, but *may* be permitted in front of the ditch line if it would not result in significantly increased hazard.
4. Where the offsets given in the above table would require a pole to be within a sidewalk area, poles *should*, if conditions permit, be located behind the sidewalk. Locations between the sidewalk and roadway *may* be permitted in the event no other alternative is feasible.
5. Where a tree line exists closer to the roadway than permitted by Table 2 above, lighting poles *may* be placed in that tree line if such poles will not constitute significant additional hazards to the public.
6. Rigid poles *may* be permitted inside the limits shown in the table where they are adequately protected by barriers such as guardrails or retaining walls erected for other purposes. There *should* be at least 4 feet clearance between the guardrail and the pole to allow for deflection at higher speed locations. Designers **shall** avoid placing poles within guardrail end terminal sections.
7. Offset requirements for poles in the medians of divided highways along added left turn lanes **shall** be measured from the edge of the through traffic lane. A right turn lane is not considered a through lane.
8. For pole installation locations where there is a pronounced backslope rising directly from the shoulder, a reduction in minimum offset requirement from the preceding table by as much as 1/3 *may* be followed, no value **shall** be less than 24 feet for 40 mph or more.

11-3-4 High Mast Roadway Lighting April 2024

POLICY

Unless described otherwise, all high mast lighting installations on the State Trunk highway system **shall** follow the design guidelines described in this section.

FEASIBILITY CONSIDERATIONS

This section is used to differentiate between standard overhead mounting heights (50 feet or less) and high mast lighting (80 feet or more). When deciding whether to use conventional lighting or high mast towers, the following sections **shall** be taken into consideration to compare the advantages and disadvantages of conventional and high mast lighting.:

1. *Installation Cost:* Depending on the application, the cost comparisons between high mast and conventional lighting systems can vary widely. High mast towers to illuminate interchanges are often less expensive to install than conventional lighting. This is due to reducing the installation cost associated with conduit, wiring, and considerably fewer poles required.
2. *Maintenance Cost:* Conventional lighting requires the use of a bucket truck and can require traffic control, such as signs, cones, and lane closures. When poles are mounted on concrete traffic barriers or single slope concrete barriers, the inside lane usually must be closed, resulting in significant traffic disruptions. High mast towers are generally located outside of the roadway footprint and require one or two persons with a pickup truck who can usually perform maintenance on a high mast lighting system.
3. *Safety Considerations:* High mast lighting *may* eliminate the risks involved with having personnel working near high-speed traffic. Generally high mast towers will not require lane closures for maintenance. High mast lighting also removes the opportunity for vehicle collisions with light poles placed within the clear zone.
4. *Accessibility:* High mast poles are commonly located within interchange infield areas. This can become difficult for maintenance vehicles to access the lighting systems. Constructing separate maintenance routes is often required for staff to access high mast towers.

5. *Utility Service:* High mast lighting systems are commonly located far from utility connections. Consideration *should* be given to the proximity of utility connections and the ability to access and connect to the lighting systems.
6. *Land-Use Considerations: Light Trespass can be a disadvantage when considering High Mast Lighting with adjacent residential areas.*

MATERIALS

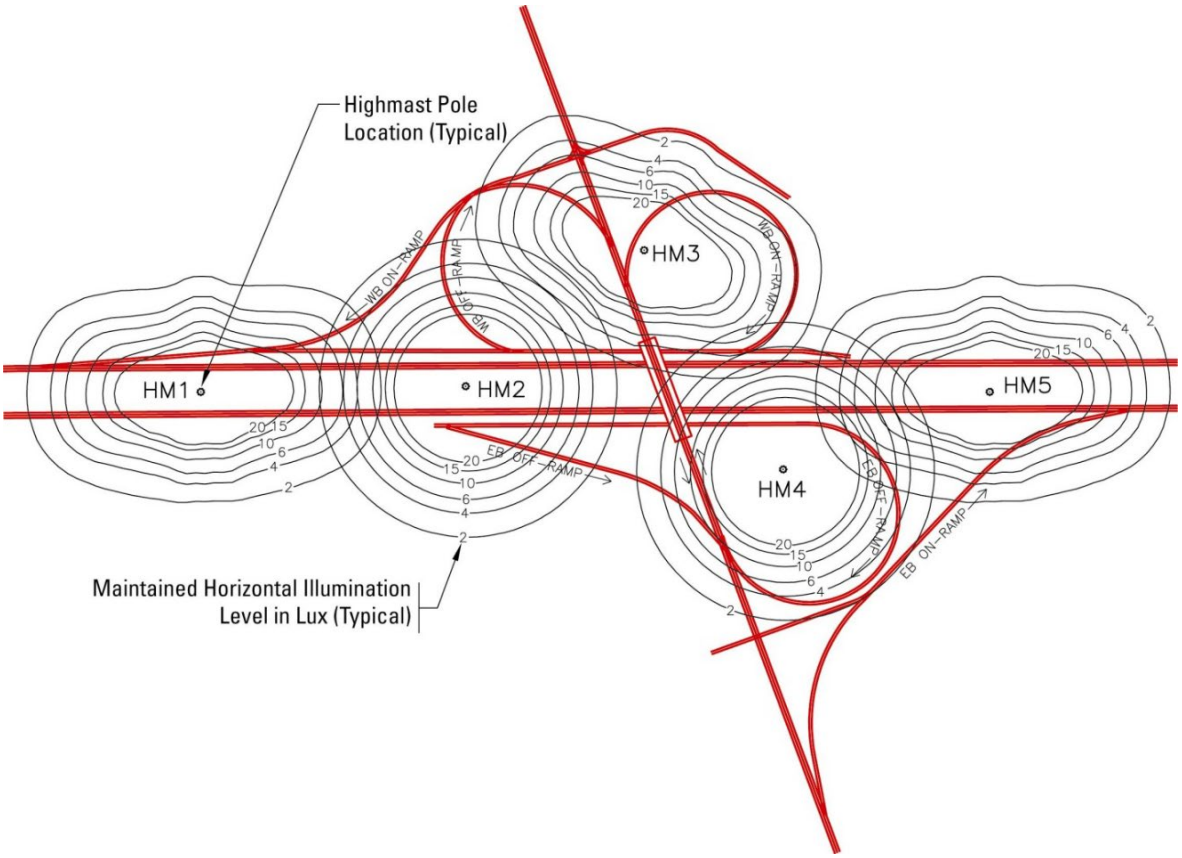
Designers **shall** refer to the QPL for multiple pre-approved luminaires. The number of luminaires required will be determined by the area to be lighted. As a general starting point, for new installations it can be assumed that up to four (4) luminaires will be used at each high mast tower location.

LOCATING LIGHTING UNITS

In determining the location of light towers, review the plan and profile view of the area to determine the critical areas requiring lighting. In selecting tower locations, consider the following:

1. *Critical Areas:* Locate light towers so that the highest localized levels of illumination fall within the critical traffic areas (e.g., freeway/ramp junctions, ramp terminals, merge points).
2. *Roadside Safety:* Locate light towers outside the roadside clear zone and a sufficient distance from the roadway so that the probability of a collision is virtually eliminated.
3. *Signs:* Locate light towers so that they are not within the driver's direct line of sight to highway signs.
4. Where lighting projects are being considered near an active airfield or airport, consider the impact the height of the light tower has on navigable airspace during and after construction. Any need for aviation obstruction warning luminaires on highway structures will be coordinated with the Federal Aviation Administration (FAA).
5. Where lighting projects are being considered near residential land uses, consider the impact of light trespass into the residential areas.
6. For interchange areas, use the typical interchange high mast tower layout shown in Figure 4.

Figure 4. Typical Interchange High Mast Tower Layout



DESIGN CONSIDERATIONS

Mounting heights in high-mast lighting applications range from 80 ft to 160 ft. Heights typically ranging between 100 ft to 150 ft provide the most practical designs. Greater mounting heights generally require more luminaires to maintain illumination levels. However, greater heights will provide a broader light distribution and better light uniformity resulting in fewer towers. As a general starting point, it is a good practice to identify optimal tower height and location to illuminate critical areas before adding additional poles and greater heights to cover the same area.

11-3-5 Underdeck Roadway Lighting April 2024

POLICY

Unless described otherwise, all underdeck lighting installations on the State Trunk highway system **shall** follow the design guidelines described in this section.

FEASIBILITY CONSIDERATIONS

The decision of whether to include underdeck lighting with a design is typically based on engineering judgement. Generally, these installations are included to maintain continuous lighting throughout a corridor. Other factors to consider include pedestrian utilization and public security.

MATERIALS

WisDOT currently permits the use of 4K wall mounted luminaires for underdeck installations. Designers **shall** refer to the QPL for multiple pre-approved luminaires. Designers *should* also consider which QPL luminaire to use for photometric design, and they *should* consult with the Regional Lighting Engineer. Designers *should* select the luminaire type based on the WisDOT Region's typical practices and the type that is most efficient overall to provide the necessary lighting levels.

Current WisDOT standards and practices are not based on using overhead or ceiling mounted luminaires. Circumstances which require luminaires to be mounted overhead from the ceiling require a special provision for contractor procurement of a unique product. The Regional Lighting Engineer **shall** approve all model(s) of ceiling mounted luminaires specified for projects.

Lighting units and compatible infrastructure **shall** be verified with the WisDOT standard specifications and detail drawings to ensure constructability. Structural characteristics govern the lighting system design and whether the infrastructure will be surface mounted or embedded.

Conduit type for underdeck lighting systems will vary depending on application and **shall** be sized as necessary for wire fill capacity of proposed conductors according to the National Electrical Code.

1. Reinforced Thermosetting Rigid Conduit (RTRC) or Rigid Galvanized Steel (RGS) Conduit are typically used when infrastructure is surface mounted.
2. PVC conduit is typically utilized when the infrastructure is to be embedded in concrete. Schedule 80 *should* be considered where conduit transitions from structure to ground for added strength.

Underdeck bid items are quantified under a single bid item, accounting for all conduit, junction boxes, joints, elbows, brackets, and other miscellaneous items as necessary to complete the installation. Underdeck luminaires and conductors are not included with underdeck lighting bid item. The limits dictating where this quantification begins, and ends **shall** be specified in the plans to ensure accurate estimating and bidding of the completed installation.

LOCATING LIGHTING UNITS

Exact location and orientation for mounting underdeck luminaires will be governed inherently by structure type and ability to route infrastructure to the location. Luminaires *should* be mounted as high as practical for the structure to optimize light dispersion and minimize glare. Luminaires are typically mounted on the abutment of the bridge or on a pier cap for each direction of travel on the roadway. If such mounting would lower light levels to a non-acceptable level, then the luminaire is typically mounted on the bottom of the diaphragm. If luminaire mounting is restricted to overhead, the designer **shall** consult with BOS and BTO to determine the optimal mounting position and electrical routing.

DESIGN CONSIDERATIONS

Luminaires positioned adjacent to the underdeck can often provide adequate lighting without supplemental underdeck lighting. As a rule, for continuously lit roadways, underdeck lighting *should* be installed for structures

greater than 50 feet in length. For underpasses that exceed 200 feet in length, the underdeck lighting *should* be on continuously, day and night.

To the best of the designer's ability, the lighting level of the underdeck **shall** match the lighting levels on the adjacent roadways in accordance with ANSI/IES guide RP-8-22 and AASHTO Roadway Lighting Design Guide. Higher lighting levels *may* result due to luminaire mounting height and spacing limitations. The underdeck lighting **shall not** exceed twice the lighting level of roadway adjacent to the underdeck.

Luminaires attached to the structure along the roadside **shall** be wall mounted in a manner that minimizes glare to the drivers. To reduce the amount of glare, the use of several lower output luminaires is generally better than providing one or two high output luminaires. The use of lower output luminaires tends to improve the uniformity of lighting while maintaining lighting levels. Wall mounted luminaires are generally easier to maintain and are less affected by structure vibration. Additional considerations to mounting locations include susceptibility to vandalism and bird nesting.

All underdeck lighting locations are typically unique in design and **shall** require separate installation details. Details **shall** include plan view, elevation views, installation notes and critical dimensions. Details **shall** clearly indicate all conduit, junction box, and luminaire locations. For new underdeck locations, the conduit and junction boxes *should* be embedded in the concrete structures. Lighting installations for existing underpasses **shall** be surface mounted.

11-3-6 Tunnel Roadway Lighting April 2024

POLICY

Unless described otherwise, all tunnel lighting installations on the State Trunk highway system **shall** follow the design guidelines described in this section.

REFERENCE TO STANDARDS

Tunnel lighting design **shall** comply with the requirements of the latest edition of the following:

- ANSI/IES RP-8-22 (Lighting Roadway and Parking Facilities)
- AASHTO Roadway Lighting Design Guide

FEASIBILITY CONSIDERATIONS

Warranting criteria for the implementation of tunnel lighting is provided in ANSI/IES RP-8-22 and AASHTO Roadway Lighting Design Guide. The decision of whether to include lighting with tunnel structures is unique to each location. Warranting criteria *should* be based on engineering judgement according to the traffic volumes, posted speeds, proposed users, and geometric features of the tunnel. Lighting control technology and managing energy usage **shall** be carefully evaluated when designing tunnel lighting installations. The State Lighting Engineer **shall** approve the design criteria for any tunnel lighting systems.

MATERIALS

The WisDOT QPL does not specify pre-approved luminaires for tunnel lighting. Tunnel lighting installations **shall** require a special provision for contractor procurement of a unique product. Designers *should* select the luminaire based on the WisDOT's typical practices and the type that is most efficient overall to provide the necessary lighting levels while minimizing glare for drivers.

11-3-7 Pedestrian Scale Lighting April 2024

POLICY

Unless described otherwise, all pedestrian scale lighting installations on State Trunk highway rights-of-way **shall** follow the design guidelines described in this section.

FEASIBILITY CONSIDERATIONS

Pedestrian scale lighting is most often installed for roadside facilities, i.e., rest areas and weight enforcement areas, to illuminate areas accessible to pedestrians. The decision of whether to include pedestrian lighting *should* be based on coordination with the respective WisDOT Regional Lighting Engineer, the respective Bureau of Highway Maintenance (BHM) official, and engineering judgement according to the proposed users and unique features of the site.

MATERIALS

WisDOT currently permits the use of 4K post-top mounted luminaires for pedestrian scale lighting. Designers *should* refer to the QPL for pre-approved luminaires and consider which QPL luminaire to use for photometric design. Designers *should* select the luminaire type based on the WisDOT Region's typical practices and the type that is most efficient overall to provide the necessary lighting levels. Designers **shall** confirm luminaire model(s) with the BHM project manager and Regional Lighting Engineer.

11-3-8 Aesthetic Lighting on Structures April 2024

DEFINITION

This policy applies to decorative lighting on structures for aesthetic purposes using a dynamic lighting system that can be operated and controlled by a central computer using fiber optic and data cable lines and software that can project a variety of colors and patterns on bridges and other transportation structures. The colors can be changed at an interval or remain constant. The intensity of the lighting fixtures can be controlled from 0 to 100 percent. Typical systems have the capability to be pre-programmed so that the lighting color selections and color schemes can be approved and controlled. These systems do not provide roadway lighting and **shall not** negatively impact the illumination level of the roadway.

POLICY

Aesthetic lighting *may* be installed only under conditions referenced in the WisDOT Bridge Manual and Division of Transportation Investment Management cost-share policies in the Program Management Manual 3-25-15. The provisions of this policy **shall** apply to all cities, villages, counties, and towns (i.e., local agencies) which desire to use or occupy rights-of-way of the State Trunk Highway System for locally owned and maintained lighting and electrical facilities. Public, private, and municipal utilities, cooperatives, and private citizens who desire to use or occupy rights-of-way of the State Trunk Highway System for roadway lighting **shall** apply to the city, village, county, or town in which the State Trunk Highway is located.

FEASIBILITY CONSIDERATIONS

Aesthetic lighting is not typically installed or maintained by WisDOT and would be completely at the discretion/desire of the project sponsor with agreement from the Department. The decision of whether to include aesthetic lighting **shall** be based on coordination with the WisDOT State Lighting Engineer and engineering judgement according to the proposed aesthetic function and features of the site.

MATERIALS

The installation, including all wiring, supports, equipment, and roadway clearance **shall** be in accordance with pertinent statutes, codes, and regulations as well as good trade and engineering practice and **shall** be properly maintained.

DESIGN CONSIDERATIONS

All electrical components of the system, including conduit, cabling, and pedestals, **shall** be separate physically from WisDOT electrical system infrastructure. All electrical systems **shall** be designed under the oversight of the State Lighting Engineer and **shall** be documented as under the operational control of WisDOT Bureau of Traffic Operations.

The operation and maintenance of the lighting system **shall** be at the expense of the maintaining agency. Removal of the system or alterations in any part of the installation that are required at any time by WisDOT **shall** be made by the maintaining agency at no expense to the Department. Immediate action will be required if a hazardous aspect to the lighting system arises.

Construction and maintenance operations **shall** be performed without closing the highway to traffic except as *may* be specifically authorized by authorized representatives of the agency maintaining the highway. A work on right-of-way permit will be required from the appropriate regional office prior to any work being done on the right-of-way.

Aesthetic lighting schemes **shall not** present a distraction to the traveling public. The lighting system **shall** be designed to minimize light trespass. When programmed to do so, the colors will remain fixed for no less than 10 seconds. When lighting is near the traveling public, certain colors (i.e., red, blue, amber), text, or images *may* be prohibited. At no time **shall** the lights or colors flash or blink. WisDOT will require field testing and validation prior to securing full approval to operate the lighting system.

Any requests from the public for change in operation of the aesthetic lighting system **shall** be approved by

WisDOT's Bureau of Traffic Operations.

WisDOT *may* require the aesthetic lighting be turned off under conditions or circumstances of adverse weather like heavy snow, fog or accidents which could have a negative impact on the traveling public.

11-3-9 Navigation Lighting April 2024

POLICY

Bridge navigation lighting systems **shall** be installed under State Trunk highway system bridges over navigable waters to delineate the structure and provide guidance for vessels traversing the waterway. Unless described otherwise, all navigation lighting installations **shall** follow the US Coast Guard standards and the design guidelines at the following path https://www.ecfr.gov/current/title-33/chapter-I/subchapter-J/part-118

MATERIALS

The installation, including all wiring, supports, equipment, clearance, etc. **shall** be in accordance with pertinent statutes, codes, and regulations, as well as good trade and engineering practice and **shall** be properly maintained. All bridge navigational lighting system materials **shall** follow and be approved by the US Coast Guard Bridge Lighting and Other Signals as included in the following path https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5pw/Office%20of%20Bridge%20Programs/Lighting.pdf

DESIGN CONSIDERATIONS

The bridge navigational lighting system installation **shall** conform to all standards and requirements set forth by the US Coast Guard, Office of Bridge Administration.

11-3-10 Roadway Lighting Equipment Installed Near Airports April 2024

State Trunk highway system roadway lighting equipment installed near airports **shall** be installed per the Federal Aviation Administration (FAA) Advisory Circular for Obstruction Marking and Lighting - AC_70_7460-1L located at the following path. https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_70_7460-1L_-_Obstuction_Marking_and_Lighting_-_Change_2.pdf

11-4-1 Design Applications – Roadway Lighting April 2024

POLICY

Unless described otherwise, all roadway lighting designed for the State Trunk highway systems that is owned and maintained by WisDOT **shall** follow the design application guidelines described in this section.

All luminaires on state-maintained highway systems **shall** be LED and selected from the WisDOT's Qualified Electrical Products List (QPL) except in special cases.

REFERENCE TO STANDARDS

The design of highway roadway lighting **shall** conform to applicable provisions of Chapter 11, Section 50 of the WisDOT Facilities Development Manual (FDM), except as modified herein. In addition, the highway roadway lighting design **shall** comply with the requirements of the latest edition of the following:

- WisDOT Standard Specifications
- WisDOT Standard Detail Drawings
- WisDOT Standard Bid Items
- Wisconsin Bicycle Facility Design Manual
- Wisconsin Guide to Pedestrian Best Practices
- ANSI / IES Roadway Lighting RP-8-22 (Lighting Roadway and Parking Facilities)
- AASHTO Roadway Lighting Design Guide
- AASHTO Guide for Park and Ride Facilities
- National Electrical Code
- Wisconsin Electrical Code
- Local codes and ordinances

11-4-2 Roadway Lighting – Signalized Intersections April 2024

APPLICATION

This policy and the related information apply to all WisDOT maintained signalized intersections, including single point interchanges (SPI), double diverging diamond interchanges (DDI), and other non-standard signalized intersections and interchanges on the State Trunk highway systems.

POLICY

All WisDOT maintained signalized intersections **shall** include roadway lighting in accordance with this document.

Power for the roadway lighting of WisDOT maintained signalized intersections *should* be fed from circuits from the signal cabinet. If the total amperage and/or number of circuits of the proposed intersection roadway lighting exceeds the capacity of the traffic signal cabinet, installing a separate roadway lighting cabinet **shall** be evaluated.

When slotted left turn lanes and other complex signalized approach geometry are illuminated, these *should* be considered part of the intersection and be fed from the signal cabinet, subject to coordination with WisDOT or locally maintained continuous roadway lighting where applicable.

DESIGN CONSIDERATIONS

Several factors can affect the design of roadway lighting for signalized intersections. The required illumination level and the constraints of pole locations are the most important factors and are sometimes incompatible. he designer is responsible for balancing all the design considerations and applying engineering judgment to produce a safely illuminated, fully operational, and constructable system.

The decision to signalize an intersection is based on the results of a signal investigation study of safety and operational factors. These factors typically relate to important visual tasks, and to conflicts with other vehicles and pedestrians. These are important when considering roadway lighting and are discussed in IES RP-8-22 and AASHTO Roadway Lighting Design Guide, which is a reference for this document.

Often signalized intersections are in urban areas along continuously illuminated streets. Intersections of roadways with continuous roadway lighting are considered full intersections. The IES recommended illuminance levels for full intersections of continuously illuminated urban streets are the sum of the recommended values for the intersecting roadways. Intersections of roadways without continuous roadway lighting are considered partial (isolated) intersections and follow a separate set of criteria as defined by IES RP-8-22 and AASHTO Roadway Lighting Design Guide. Table 1 below, based on roadway and pedestrian classifications, summarizes these values for full intersection lighting of continuously illuminated roadways. Table 2 summarizes these values for partial (isolated) intersection lighting.

Note: AASHTO refers to the pedestrian area classifications as commercial, intermediate, and residential land uses (Versus “High / Medium / Low” Pedestrian Activity, respectively).

Table 1. Pavement Illuminance Criteria for Full Intersection Lighting (Lux/Fc)

	Pedestrian Activity Level Classification			
Functional Classification	**High**	**Medium**	**Low**	E_{avg}/E_{min}
Major/Major	34/3.2	26/2.4	18/1.7	3:1
Major/Collector	29/2.7	22/2.0	15/1.4	3:1
Major/Local	26/2.4	20/1.9	13/1.2	3:1
Collector/Collector	24/2.2	18/1.7	12/1.1	4:1
Collector/Local	21/2.0	16/1.5	10/0.9	4:1
Local/Local	18/1.7	17/1.3	8/0.7	6:1

Table 2. Pavement Illuminance Criteria for Partial (Isolated) Intersection Lighting

	Pavement Classification			Uniformity Ratio
Road Classification	**R1 lux/fc**	**R2 & R3 lux/fc**	**R4 lux/fc**	E_{avg}/E_{min}
Major	6/0.6	9/0.8	8/0.7	3.0
Collector	4/0.4	6/0.6	5/0.5	4.0
Local	3/0.3	4/0.4	4/0.4	6.0

CALCULATION BOUNDARIES

Engineering judgement **shall** be used when designating calculation boundaries for intersections. In general, calculation boundaries *should* be drawn to include the footprint of all intersecting movements, bicycle and pedestrian crossings, and areas with merging/diverging/conflicting movements. The calculation boundary shown in the figures below are the areas to which the intersection illumination levels apply. This boundary area includes at a minimum the area bound by the far side of the pedestrian crosswalks on all approaching roadways. If a pedestrian crosswalk is not present, the calculation area **shall** be the area enclosed by the intersection stop bars extending across the departure lanes. In the absence of both pedestrian crosswalks and stop bars, the calculation area **shall** be the area enclosed by the connection of the radius return of each intersection leg, like that identified in the figures below.

Figure 1. Signalized Intersection Illumination Calculation Boundary

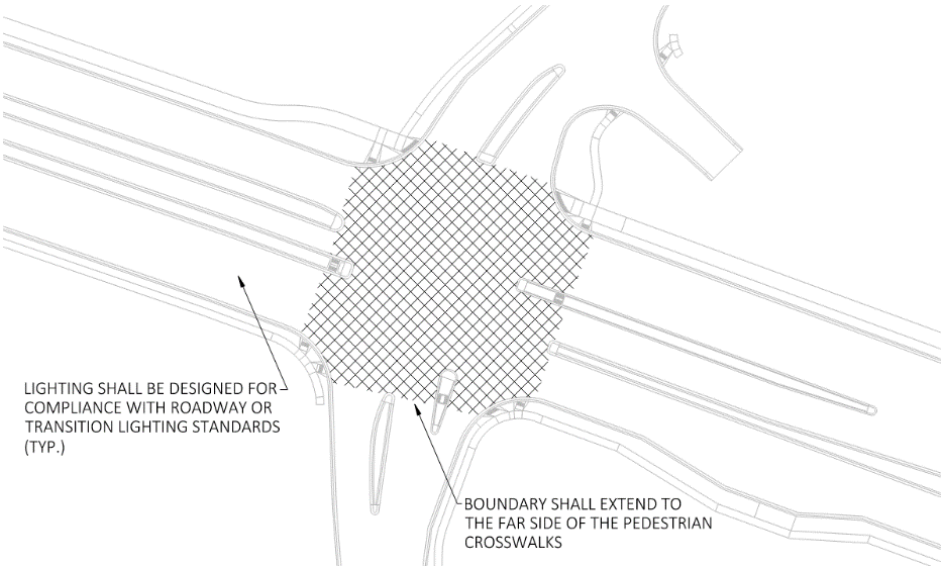


Figure 2. Single Point Urban Interchange (SPUI) Illumination Calculation Boundary

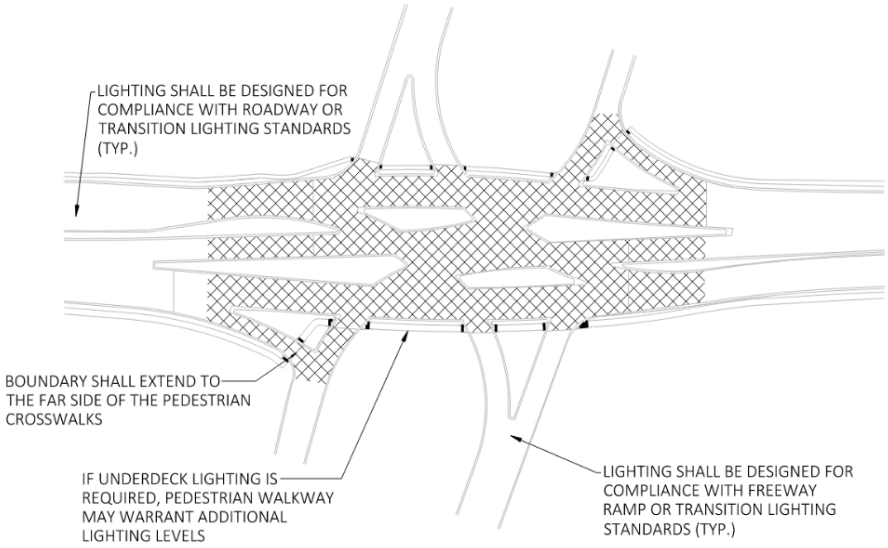
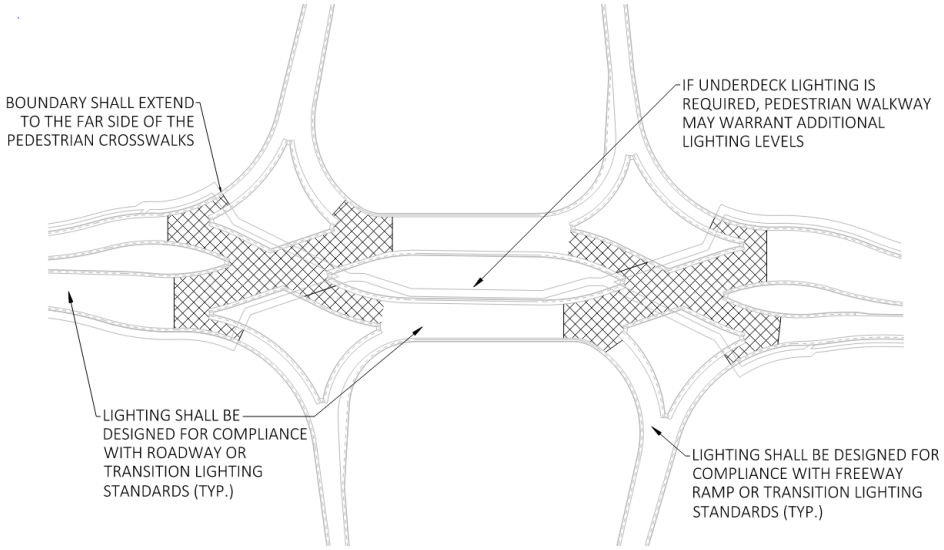


Figure 3. Diverging Diamond Interchange (DDI) Illumination Calculation Boundary



LIGHTING LAYOUT

WisDOT's best practices have illustrated the importance of minimizing poles within the intersection boundary. For this reason, the lighting designer **shall** install luminaires on traffic signal poles whenever possible. The designer **shall not** begin the roadway lighting layout before obtaining the signal plan.

Particularly for large or otherwise complex intersections, it *may* be difficult to achieve the illumination and uniformity levels recommended without additional poles beyond those required for the signals. Use engineering judgment to add stand-alone poles when supplemental illumination is a priority. In such cases, the designer **shall** consider and prioritize the following design considerations:

- Poles **shall** be combined whenever possible to reduce the number of objects near the roadway.
- Poles *should* meet the design criteria as presented in TEOpS 11-3.
- Prioritize illuminating the far side of the intersection to help clearly identify fixed elements in the path of the vehicle, whether turning or continuing straight.
- Pedestrians in crosswalks are dark objects and difficult to see, particularly when the vehicle is making a right turn. Illuminating crosswalks is a high priority, providing positive contrast whenever possible.
- Horizontal lighting levels *should* be considered for pedestrian crosswalks and movements, especially on roadways with high speeds or high pedestrian activity.

- Designers **shall** avoid placing light poles where prone to over tracking of freight movements and potential off tracking by errant vehicles and in slippery conditions.
- Designers *should* evaluate access management, sight distance, transitions to adjacent intersections, and other pertinent factors when determining whether to include roadway lighting for approaches to signalized intersections. This is especially true in high-speed environments.
- For large intersections it *may* be difficult to achieve uniformity due to large offsets to light poles. Non-standard uniformity results *may* be justified by excluding small and hard to reach areas near the middle of large intersections.
- For divided roadways, designers *should* consider using both twin luminaires located in medians and channelizing islands instead of using single luminaires on the roadside to determine the optimum design.
- Where illumination of slotted left turn lanes is included, the poles *should* be located in the raised median on the driver's side.

DESIGN PROCEDURAL REQUIREMENTS

The designer **shall** contact the Regional Lighting Engineer to verify roadway and pedestrian/land use classifications prior to beginning the design for signalized intersection illumination.

A Signalized Intersection Illumination Form is included to assist in identifying the appropriate roadway and pedestrian/land use classifications and subsequent light levels.

The designer *should* prepare intersection illumination calculations using AGI32 software and the calculation boundaries described in this document.

SIGNALIZED INTERSECTION ILLUMINATION FORM

(To be completed prior to design)

GENERAL INFORMATION:
Location: _____
Street 1: _____ ADT: _____
Street 2: _____ ADT: _____
Pedestrian Count (1Hr): _____

ROADWAY AND AREA CLASSIFICATION:
Street 1: _____
Street 2: _____

DETERMINATION OF ILLUMINATION VALUES:
Use values from Illuminance Levels for Intersections Table in 11-4-2
Illuminance Value: _____ **Avg/Min Value**: _____

11-4-3 Roadway Lighting – Roundabouts April 2024

APPLICATION

This policy and the related information apply to all WisDOT maintained roundabouts on the State Trunk highway systems.

POLICY

All WisDOT maintained roundabouts **shall** include roadway lighting in accordance with this document.

Any local requests for special roadway light poles or fixtures will be reviewed by the Department. If allowed, the roadway lighting **shall** be operated and maintained by the local government through the Standard Lighting Permit Process.

DESIGN CONSIDERATIONS

The roundabout intersection illumination area **shall** be calculated by using the illuminance method.

TEOpS 11-3-1 explains roadway and pedestrian area classifications used to determine the recommended illuminance levels outlined below in Table 1. Note: AASHTO refers to the pedestrian area classifications as commercial, intermediate, and residential land uses (Versus “High / Medium / Low” Pedestrian Activity).

The recommended illuminance levels at roundabouts are, essentially, the sum of the recommended values for continuously illuminated approaching roadways.

Table 1. Illuminance Levels for Roundabouts (Lux/Fc)

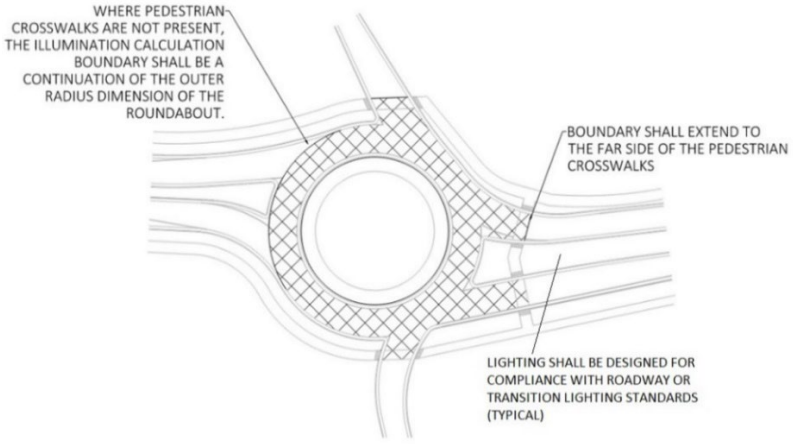
Functional Classification	Pedestrian Activity Level Classification			E_{avg}/E_{min}
	High	Medium	Low	
Major/Major	34/3.2	26/2.4	18/1.7	3:1
Major/Collector	29/2.7	22/2.0	15/1.4	3:1
Major/Local	26/2.4	20/1.9	13/1.2	3:1
Collector/Collector	24/2.2	18/1.7	12/1.1	4:1
Collector/Local	21/2.0	16/1.5	10/0.9	4:1
Local/Local	18/1.7	17/1.3	8/0.7	6:1

For roundabouts along low-volume roadways with low pedestrian activity that are not continuously illuminated, the values for Local/Local *should* be used. Special consideration *should* be given to roundabouts in rural areas and in areas where roadway lighting was not present prior to an intersection improvement project. Coordination with local officials and property owners *may* be required to address concerns with light trespass and glare.

CALCULATION BOUNDARIES

Engineering judgement **shall** be used when designating calculation boundaries for roundabouts. The calculation boundary is the area to which the illumination levels in Table 1 apply. This boundary *should* include the traffic conflict area extending to the far side of the pedestrian path on each of the approaching roadways. If a pedestrian path is not present, the calculation area extends to the outside radius of the roundabout entrance and exit including the entire traffic conflict area. Refer to the figure below for a visual depiction. When bypass lanes are used, they *should* be included within the calculation boundary.

Figure 1. Roundabout Illumination Calculation Boundary



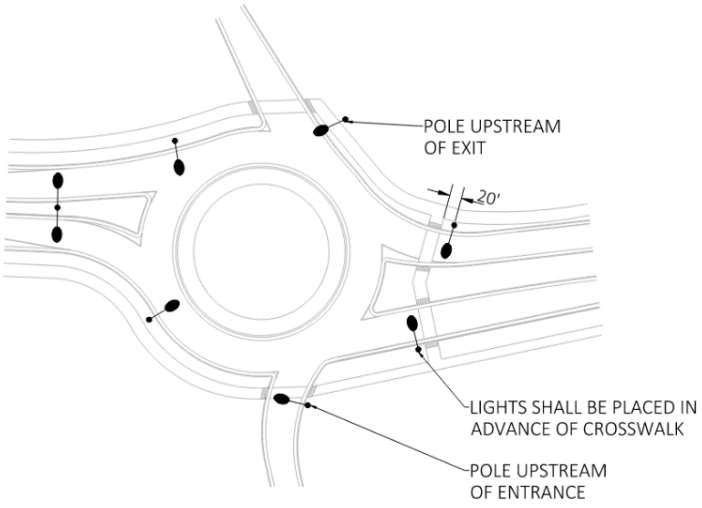
ROADWAY LIGHTING LAYOUT

The designer **shall** consider and prioritize the following design considerations:

- Poles **shall** meet the design criteria as presented in TEOpS 11-3.
- Minimize the impedance of roundabout approach signage sight lines.
- Place roadway light poles on the right-hand perimeter just upstream of entrance and exit points.
- Pedestrians in crosswalks are dark objects and difficult to see, particularly when the vehicle is making a right turn. Illuminating crosswalks is a high priority, providing positive contrast whenever possible.
- Horizontal lighting levels *should* be considered for pedestrian crosswalks and movements, especially on roadways with high pedestrian activity.
- Designers **shall** avoid placing light poles where prone to over tracking of freight movements and potential off tracking by errant vehicles and in slippery conditions.
- For large multi-lane roundabouts, it *may* be difficult to achieve uniformity due to large offsets to light poles. Non-standard uniformity results *may* be justified by excluding small and hard to reach areas near the middle of large roundabouts.

For divided roadways, to determine the optimum design, designers *should* consider using both twin luminaire poles located in medians and bypass islands instead of using single luminaire poles on the roadside.

Figure 2. Roundabout Typical Lighting Layout



DESIGN PROCEDURAL REQUIREMENTS

The designer **shall** contact the Regional Lighting Engineer to verify the classifications for the roadway and pedestrian/land use prior to beginning the roadway lighting design.

The designer *should* prepare illumination calculations using AGI32 software using the calculation boundaries described in this document.

A Roundabout Illumination Form is included to aid in identifying the appropriate roadway and pedestrian classifications and subsequent light levels. The designer **shall** complete this form and submit it to the Regional Lighting Engineer for approval prior to beginning the lighting design for a roundabout on the state highway system.

ROUNDABOUT ILLUMINATION FORM

(To be completed prior to design)

GENERAL INFORMATION:
Location: _____
Street 1: _____ ADT: _____
Street 2: _____ ADT: _____
Pedestrian Count (1Hr): _____

ROADWAY AND AREA CLASSIFICATION:
Street 1: _____
Street 2: _____

DETERMINATION OF ILLUMINATION VALUES:
Use values from Recommended Illuminance Levels at Roundabouts, Table 1 in 11-4-1
Illuminance Value: _____ **E**avg/**E**min **Value**: _____

11-4-4 Roadway Lighting – Restricted Crossing U-Turn (RCUT) April 2024

APPLICATION

This policy and the related information apply to all WisDOT-maintained RCUTs on the State Trunk highway and US highway systems.

POLICY

All WisDOT-maintained RCUTs **shall** include roadway lighting in accordance with this document.

DESIGN CONSIDERATIONS

The FHWA provides the following guidance on roadway lighting for RCUT intersections:

Roadway lighting standards and specifications outlined in AASHTO's Street Lighting Design Guide, FHWA's Lighting Handbook, and the Illuminating Engineering Society (IES) publications including American National Standard Practice for Street Lighting can be used to determine optimal roadway lighting for RCUT intersections.

Based on national roadway lighting guidance, agencies establish street lighting design guidelines along their facilities based on the road functional classification and pedestrian conflict area classifications. Intersection lighting is typically 1.5 times the street lighting levels along the approaches, or the street lighting levels of the two crossing streets are added together to determine the roadway lighting guidelines for the intersection.

Generally, signalized RCUT intersections are constructed on streets with high traffic volumes likely meeting the corridor volume criteria for roadway lighting. It is desirable to light the main and crossover intersections according to the determined intersection light levels. Depending on the intersection spacing, the light levels for the road segments between the intersections may *be reduced to street segment light levels. If there is no roadway lighting along the approaches, then transition lighting coming from dark into light and vice versa* may *enhance user experience and performance. Even with sufficient roadway lighting provided for the overall intersection, additional supplemental roadway lighting could be added in the median to illuminate the pedestrian refuge area.*

Roadway lighting at a stop- or merged-controlled RCUT intersection will follow similar roadway lighting criteria as conventional intersections. These types of RCUT intersections are more likely to be located on a street without continuous roadway lighting.

The RCUT intersection area **shall** be calculated by using the illumination method.

TEOpS 11-3-1 explains roadway and pedestrian area classifications used to determine the recommended illuminance levels outlined in TEOpS 11-4-2 Table 2 for Isolated Intersections. Note: AASHTO refers to the pedestrian area classifications as commercial, intermediate, and residential land uses (Versus “High / Medium / Low” Pedestrian Activity).

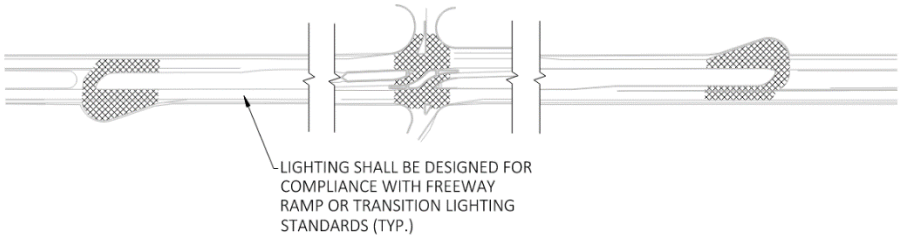
For RCUTs along roadways without pedestrian accommodations and that are not continuously illuminated, the partial (isolated) intersection illumination values for Local *should* be used.

For values along roadways that are continuously illuminated, the values *should* represent the roadway of each direction of travel where the RCUT is installed.

CALCULATION BOUNDARIES

The calculation boundary is the area to which the illumination levels in Table 2 apply. Calculation boundaries for RCUTs *should* be based on the unique characteristics of each location and confirmed with the Regional Lighting Engineer. Refer to the figure below.

Figure 1. RCUT Illumination Calculation Boundary



ROADWAY LIGHTING LAYOUT

Light poles **shall** be located according to these considerations:

- Poles **shall** meet the design criteria as presented in TEOpS 11-3.
- Pole placement **shall** ensure illumination of conflict areas and merge points.
- Minimize the impedance of approach signage sight lines.
- Use engineering judgment to determine appropriate light pole locations to ensure that decision points are illuminated.
- Coordinate all clear zone and roadside sloping issues.

DESIGN PROCEDURAL REQUIREMENTS

The designer **shall** contact the Regional Lighting Engineer to verify the classifications for the roadway and pedestrian/land use prior to beginning the roadway lighting design.

The designer *should* prepare illumination calculations using AGi32 software using the calculation boundaries described in this document.

11-4-5 Roadway Lighting – Freeways and Metered Ramps April 2024

APPLICATION

This policy and the related information apply to all WisDOT maintained metered ramps, and any freeways and expressways approved by WisDOT for continuous or partial roadway lighting installations on the State Trunk highway, US highway, and Interstate highway systems. The guidance in this section applies to segments of freeway and ramps that have been approved for installation of roadway lighting in accordance with TEOpS 11-1-1.

POLICY

All WisDOT maintained metered ramps and approved freeways or expressways **shall** include roadway lighting in accordance with this document.

DESIGN CONSIDERATIONS

Straight segments of freeways and metered ramps **shall** be calculated using the luminance method, while curved segments **shall** be calculated using the illuminance method. TEOpS 11-3-1 explains roadway classifications used to determine the recommended luminance levels outlined below in Table 1.

Table 1. Lighting Design Criteria for Highways

Highway Classification	Average Luminance L_{avg} (cd/m^2)	Average Uniformity Ratio L_{avg}/L_{min}	Maximum Uniformity Ratio L_{max}/L_{min}	Maximum Veiling Luminance Ratio $L_{v,max}/L_{avg}$
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

Partial interchange roadway lighting *may* be installed on freeways and highways when continuous roadway lighting is not warranted (per AASHTO warranting conditions). Partial roadway lighting consists of a roadway lighting system that is put in place to provide illumination at points of potential conflict. It is not considered continuous, but some of the rules that apply to continuous roadway lighting will apply in the design of partial roadway lighting, such as pole placement and calculation procedures. Recommended illuminance levels for partial interchange roadway lighting are outlined below in Table 2.

Table 2. Illuminance Criteria for Partial Interchange Roadway lighting

Highway Classification	R1 Lux (fc)	R2, R3 Lux (fc)	R4 Lux (fc)	Uniformity Ratio E_{avg}/E_{min}
Freeway Class A	6.0 (0.6)	9.0 (0.8)	8.0 (0.7)	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 (0.8)	8.0 (0.7)	3.0

For metered ramps along roadways that are not continuously illuminated, transition lighting *should* be considered.

CALCULATION BOUNDARIES

The calculation boundary is the area to which the illumination levels in Table 2 apply. Illuminance calculation zones **shall** be created for reference to the following figures.

Figure 1. Entrance Ramp Illumination Calculation Boundary

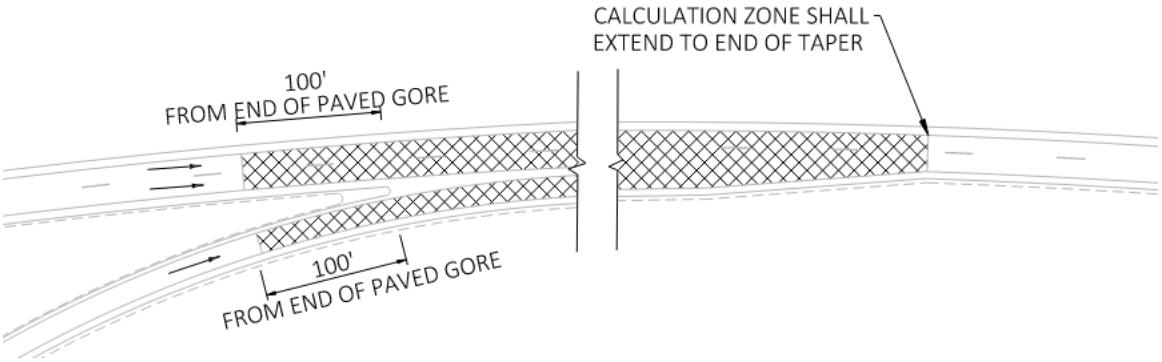


Figure 2. Exit Ramp Illumination Calculation Boundary

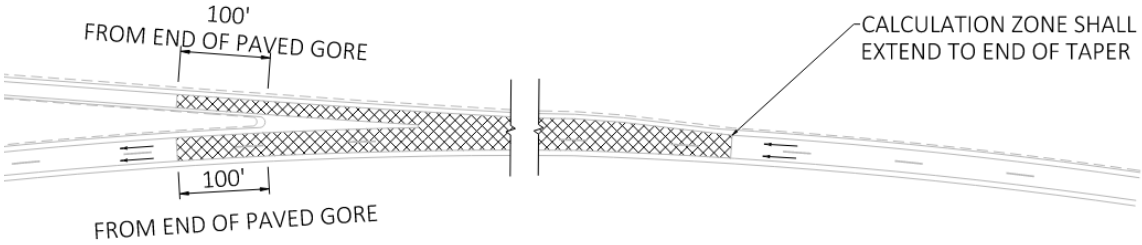
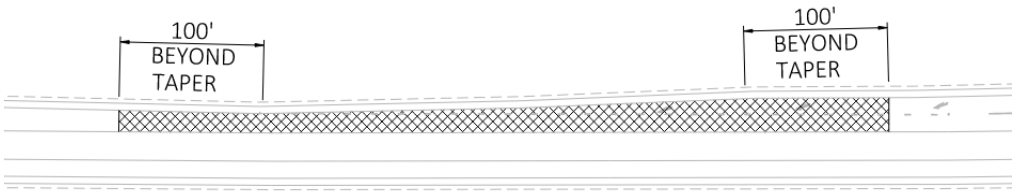


Figure 3. Lane Reduction Illumination Calculation Boundary



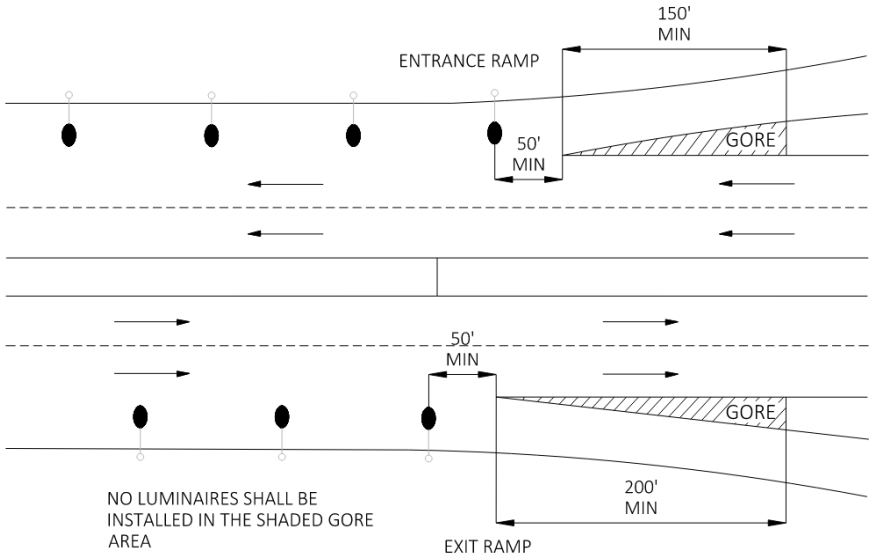
ROADWAY LIGHTING LAYOUT

Light poles *should* be located according to these considerations:

- Poles **shall** meet the design criteria as presented in TEOpS 11-3.
- Pole placement *should* ensure illumination of conflict areas and merge points.
- Minimize the impedance of approach signage sight lines.
- Use engineering judgment to determine appropriate light pole locations that *may* be too close to errant vehicle paths.
- Coordinate all clear zone and roadside sloping issues.

When auxiliary lanes or exit and entrance ramps adjacent to the mainline roadway require additional luminaires, the first luminaire is generally placed within 50 feet from the point of taper from the mainline roadway. The designer *should* avoid locating luminaires inside the gore area of an entrance ramp within 150 ft from the tip of the gore, as well as inside the gore area of an exit ramp within 200 ft of the tip of the gore, see the figure below.

Figure 4. Freeway Typical Roadway lighting Placement at Interchanges



DESIGN PROCEDURAL REQUIREMENTS

The designer **shall** contact the Regional Lighting Engineer to verify roadway and pedestrian/land use classifications prior to beginning the roadway lighting design.

The designer *should* prepare illumination calculations using AGI32 software using the calculation boundaries described in this document.

The designer **shall** submit the completed illumination design to the Regional Lighting Engineer for review and approval. The illumination design **shall** include:

- Design layout
- Photometric calculations with summary information showing compliance with illumination and uniformity criteria.
- Product cut sheets for any luminaires not listed on the QPL.
- Documentation of any alternatives considered.

11-4-6 Roadway & Pedestrian Lighting Roadside Facilities April 2024

APPLICATION

This policy and the related information apply to all WisDOT maintained weigh stations, rest areas, park and rides, crash investigation sites, and waysides on the State Trunk highway systems.

POLICY

All WisDOT maintained roadside facilities **shall** be illuminated.

The designer **shall** coordinate with the WisDOT Bureau of Highway Maintenance (BHM) and Regional Lighting Engineer to determine power supply requirements for the roadway lighting system. Roadside facilities *may* be maintained by multiple WisDOT entities, and an independent power supply for outdoor roadway lighting, buildings, and other uses *may* be necessary.

DESIGN CONSIDERATIONS

The designer **shall** work with the BHM and respective Regional Lighting Engineer to determine whether high mast or conventional roadway lighting *should* be installed at the roadside facility. Larger facilities such as rest areas and weigh stations *may* justify the installation of high mast roadway lighting to illuminate large, paved areas with minimal space for conventional light locations.

Roadside facility illumination areas **shall** be calculated by using the illuminance method. Illuminance calculation areas **shall** be defined separately for parking areas, pedestrian areas, internal circulation routes, and entrance/exit ramps.

There *may* be multiple sources for obtaining illuminance target criteria depending on the facility type. The designer **shall** refer to the appropriate reference manual(s) as selected for use with the project.

Roadside facilities **shall** consider both vehicular and pedestrian traffic with the roadway lighting design. Some facilities *may* necessitate walkway lighting units to provide illumination for pedestrians. Lighting designs **shall** also consider that these facilities are often open to the public 24/7, so pedestrian security must be a factor when determining appropriate lighting levels at each site.

CALCULATION BOUNDARIES

The calculation boundary is the area to which the illumination criteria levels apply. Areas *should* be determined using engineering judgement to define boundaries between parking areas and ramps.

ROADWAY LIGHTING LAYOUT

Light poles *should* be located according to these considerations:

- Pole placement *should* ensure illumination of parking areas, internal roadways, conflict areas and merge points, high pedestrian traffic areas, such as walkways, and building entrances.
- Minimize the impedance of approach signage sight lines.
- Use engineering judgment to determine appropriate light pole locations that *may* be too close to errant vehicle paths.
- Coordinate all clear zone and roadside sloping issues.

DESIGN PROCEDURAL REQUIREMENTS

The designer **shall** contact the BHM and Regional Lighting Engineer to verify roadway and pedestrian/land use classifications prior to beginning the roadway lighting design.

The designer *should* prepare illumination calculations using AGi32 software using the calculation boundaries described in this document and in other pertinent manuals.

11-4-7 Transition Lighting - Roadways April 2024

APPLICATION

This policy and the related information apply to isolated roadway lighting segments on the State Trunk highway systems.

POLICY

Transition lighting *should* be provided at all roundabouts, isolated intersections, and isolated roadway segments requiring illumination where the approach roads are not illuminated, and have posted speeds greater than or equal to 35 mph.

DESIGN CONSIDERATIONS

Transition lighting is implemented to allow the users' eyes to adjust from the non-illuminated to the illuminated roadway surface. This gradual roadway lighting adjustment is accomplished incrementally based on the posted speed of the roadway. Recommended transition lighting distances between illuminated intersections and/or roadway segments *should* be based on Table 1.

Table 1. Transition Lighting Lengths

Posted Speed Limit (MPH)	30	35	40	45	50	55
Minimum Transition Lighting Distance (Feet)	150	175	200	250	275	325

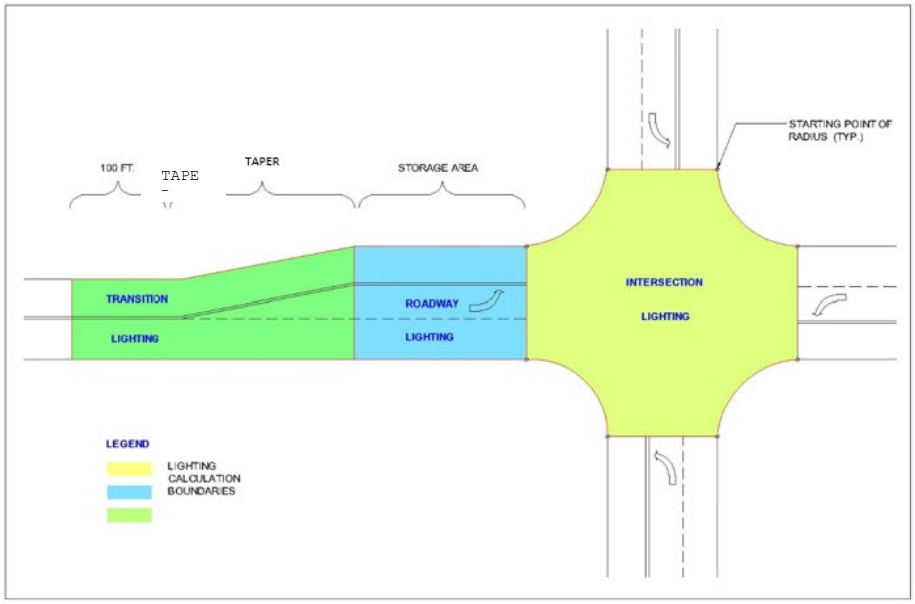
Transition lighting *should* be measured from the outside limits of the intersection and/or roadway calculation boundary when applicable.

Transition lighting for highway on/off ramps *should* be a minimum 275 feet or as dictated by design speed considerations.

Recommended distances for transition lighting can sometimes extend beyond WisDOT right-of-way. Local municipalities electing not to extend transition lighting to the recommended distance *should* address this condition in the local agreement.

Transition lighting levels *should* be designed based on the adjacent roadway lighting levels as summarized in Figure 1.

Figure 1. Intersection with Transition Lighting Calculation Areas



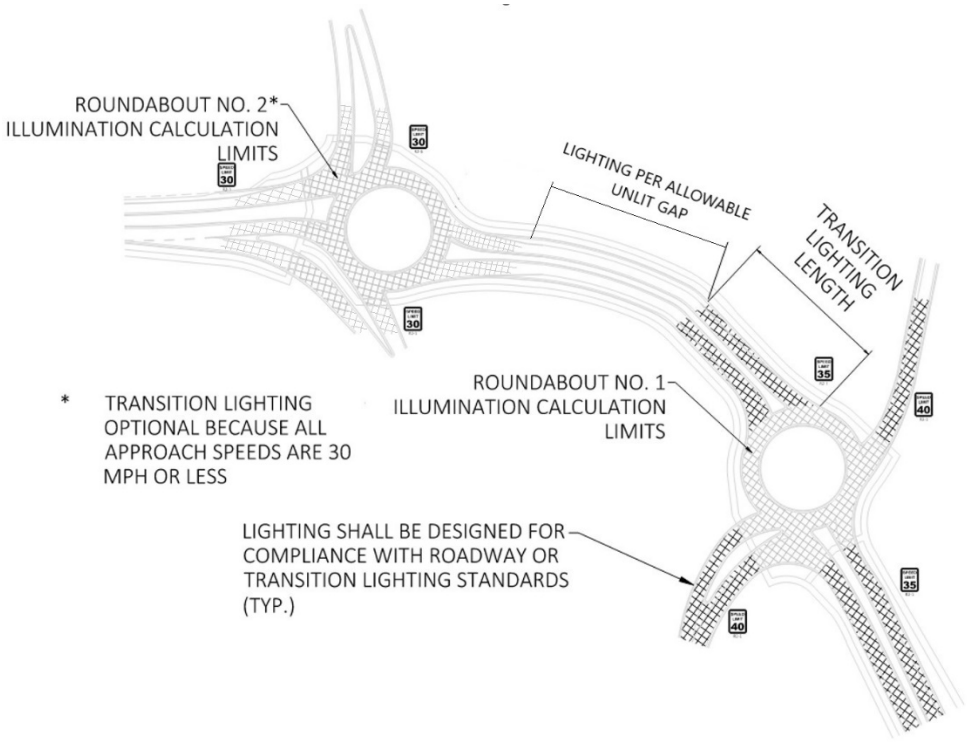
ROADWAY LIGHTING BETWEEN ADJACENT INTERSECTIONS

If multiple illuminated roundabouts or signalized intersections are placed adjacent to each other, e.g., freeway on/off ramps, the area between the intersections *should* be illuminated if the distance is less than or equal to that shown in Table 2. Illumination levels for the span of roadway between the intersections *should* be based on the illumination of the intersections. Include transition lighting if applicable.

Table 2. Allowable Unlit Gap Between Intersections

Allowable Unlit Gap			
Posted Speed Limit (MPH)	≤ 30	30 -45	> 45
Distance (feet)	500	750	1500

Figure 2. Sample Transition and Connection Distance Lighting Areas



11-4-8 Roadway Lighting – Temporary Lighting April 2024

APPLICATION

This policy and the related information apply to roadway segments requested for temporary roadway lighting on the State Trunk highway systems.

POLICY

The designer **shall** identify the need for any temporary roadway lighting as early in the project process as possible. Ideally, requirements for temporary roadway lighting will be identified during the scoping process and not later than during the TMP and be included in the 60% approval process. All temporary roadway lighting **shall** be approved by the Regional Lighting Engineer.

WisDOT generally reserves the use of temporary roadway lighting in work zones for the following cases:

- High volume freeways, roadways, and intersections that are currently illuminated.
- Complex work zones requiring unexpected maneuvers and conflict points.
- Signalized intersections and roundabouts
- Temporary lighting **shall** be provided for roundabouts that are open to traffic during construction staging. If practical, sections of the proposed permanent lighting *may* be installed and used for segments of the temporary lighting system.
- Urban roadways with significant concerns for pedestrian mobility and safety
- Roadside facilities

Temporary roadway lighting design **shall** be coordinated with the construction staging and maintenance of traffic planning for the project. The design **shall** include any temporary roadway lighting and/or relocated luminaires and all wiring required to maintain continuous operation of the existing roadway lighting systems.

DESIGN CONSIDERATIONS

This work **shall** be coordinated with the roadway design team and the maintaining authority. The extent of the proposed temporary roadway lighting system on a project **shall** be addressed as early in the submittal process as possible.

All modifications to the existing roadway lighting systems **shall** comply with WisDOT guidelines and design criteria.

In cases where temporary roadway lighting units on high-speed roadways are not shielded by a guardrail or barrier, the designer *should* consider wiring underground in a raceway to the luminaire location to protect against additional knockdowns from vehicle impact and safety concerns due to downed power lines.

11-5-1 Roadway Lighting Infrastructure April 2024

POLICY

All roadway lighting designs on the State Trunk highway systems **shall** follow the infrastructure design guidelines described in this section. Exceptions to this policy *may* be required for non-standard installations and unique roadway settings.

WisDOT has prepared standard specifications and standard detail drawings which are available to the designer. These standards include typical details such as electrical service, light standards and bases, underground conduit installations, pull boxes, lighting control cabinets, and wiring diagrams to aid in the preparation of the roadway lighting plans.

Whenever possible, the designer **shall** utilize the standards to provide a consistent installation throughout WisDOT's system. Deviations from the standards *may* require detailed installation drawings and special provisions to be created by the designer and included in the roadway lighting plans and other PS&E documents.

REFERENCE TO STANDARDS

The installation of highway roadway lighting **shall** comply with the requirements of the latest edition of the following:

- National Electrical Code
- Wisconsin Electrical Code
- WisDOT Standard Specifications
- WisDOT Standard Detail Drawings
- WisDOT Standard Bid Items
- WisDOT Electrical Qualified Products List (e.g., Approved Products list)
- Local codes and ordinances as applicable

11-5-2 Conduit April 2024

PURPOSE

Conduit is necessary in roadway lighting design to provide a raceway for electrical conductors and access to electrical power. Installing wire in conduit versus other direct bury methods allows for easier replacement or re-routing of conductors when required by future maintenance work.

MATERIALS

Conduit installed with standard roadway projects *should* be rigid non-metallic polyvinyl chloride (PVC) unless otherwise justified for special applications. Typically, schedule 80 *should* be specified for areas with heavy loading, such as under roadways with shallow cover.

Conduit installed embedded in structures *should* be rigid non-metallic PVC schedule 40 and be verified with the standard detail drawings created by WisDOT Bureau of Structures (BOS). Rigid metallic conduit is often used at transition points from structure to ground because of its strength and resistance to shearing and settling.

Reinforced thermosetting resin conduit and rigid metallic conduit are typically used when conduit is mounted externally on structures and specialized applications due to their durability. Consult with BOS and the Region Lighting Engineer to confirm which conduit type is preferred for external structural applications.

High-density polyethylene (HDPE) is typically used for intelligent transportation systems applications only.

DESIGN CONSIDERATIONS

Conduit **shall** be sized as necessary for wire fill capacity of proposed conductors according to applicable tables in the National Electrical Code (NEC) Chapter 9.

Designers *should* attempt to maintain some standardization of conduit sizing throughout the project. This practice allows for more cost-effective bid pricing if the contractor has to purchase fewer types of conduits, allows for easier installation/constructability, and provides consistency for maintenance of conduit systems.

Designers *should* consider using a larger conduit size, as well as including empty conduit runs, when exiting control cabinets to allow for future expansion of the branch circuiting.

Conduit **shall** be connected between each light base to the nearest pull box or light base, from pull box to pull box, from pull box to controller cabinet, and wherever the design requires conductors be installed.

Conduit at major intersections *should* be designed in a ring fashion surrounding the intersection, regardless of whether all runs will include live conductors, to provide sufficient raceways for any future work.

Designers *should* consider providing additional redundant conduit routes with pull wire only occasionally throughout the system so future maintenance can more easily troubleshoot failure points and back-feed from adjacent circuits.

Conduit connections **shall not** be provided between systems with separate electrical services to ensure safety of maintenance staff which could be compromised if one of the systems is not properly decommissioned.

When crossing underneath a railroad, designers **shall** coordinate directly with railroad officials during the 60% design to obtain approval and applicable design standards. Permitted conduit installations below rail lines can reach depths of 15’ and greater depending on the standards set forth by the governing rail agency.

Other considerations for conduit design include:

- The proximity to private and other utility facilities.
- Adjustments *may* be needed to avoid guard rail and sign posts.
- Parallel conduit routing with other WisDOT electrical infrastructure (i.e., signals, ITS).
- Sloping of roadway and drainage into pull boxes.
- Conduit depth when crossing roads with sub-base improvements.
- Minimizing conduit bends to less than 360 degrees between pull points.

CONSTRUCTION

Installation methodology **shall** be considered when designing conduit routing. Conduit to be installed under existing pavement, or with minimal ground disturbance, *may* be installed via directional boring under Conduit Special bid items. Designers *should* consider bore pit and rig locations when including directionally bored conduit with a roadway lighting design. In urban settings, a temporary limited easement *may* be required to accommodate boring operations.

11-5-3 Pull Boxes April 2024

PURPOSE

Pull boxes are necessary in roadway lighting design to serve as pull points between continuous runs of conduit. Pull boxes are also necessary for conductor coiling for future maintenance at poles susceptible to knockdowns and for other various maintenance reasons.

MATERIALS

Roadway lighting designs typically utilize 24” x 42” pull boxes for all applications. If a smaller pull box is desired, sizing must adhere to requirements defined in NEC Article 314. Pull boxes *should* also be sized to ensure compatibility with quantity of entering/exiting conduit, evaluate constructability whenever more than four (4) conduits enter a pullbox, especially with larger conduit sizes, additional pull boxes *may* be required.

Pull boxes are typically non-conductive polymer concrete to eliminate any potential issues with grounding.

Steel pull boxes *may* be used in unique applications per direction from the respective Regional Lighting Engineer. Steel pull boxes must have the ground wire tied into the roadway lighting system ground.

DESIGN CONSIDERATIONS

Along continuous runs of conduit, pull boxes for roadway lighting systems *should* be spaced at a maximum of 300 feet to provide access points to assist with pulling wire. Distance between pull boxes *should* be reduced as wire sizes and conduit bends increase. Significant grade and alignment changes will also warrant closer spacing of pull boxes. Conduit **shall** not turn more than 360° without providing a pull box.

Pull boxes *should* be located to avoid placement in pavement or sidewalk. Final locations *should* attempt to maintain a two-foot minimum clearance from any other infrastructure to allow for compaction after installation, and to provide enough space for grass and landscaping to grow.

Pull boxes *should* be installed in these situations:

- 300-foot maximum intervals along continuous conduit runs.
- On either side of a roadway crossing.
- At the intersection of three (3) or more conduits.
- Immediately exiting a control cabinet.
- For slopes and other areas with non-linear conduit alignment.
- Adjacent to concrete bases for roadway lighting poles susceptible to knock-downs.
- As a provision for future expansion.

11-5-4 Concrete Bases April 2024

PURPOSE

Concrete bases serve as the foundation for above ground electrical infrastructure for light poles and control cabinets.

MATERIALS

Concrete base details and compatible infrastructure are specified in the WisDOT standard specifications, standard detail drawings, and in TEOpS 11-3. Verification of compatibility is essential to ensure structural integrity.

DESIGN CONSIDERATIONS

Standard concrete bases have capacity for two 2-inch conduit and one 1-inch conduit for grounding. Design scenarios with more than 2 or larger conduit than listed above *may* require an adjacent pull box or re-design of conduit routing.

Concrete bases for roadway lighting infrastructure **shall** be located with consideration to the following factors:

- Placed adjacent to the roadway in accordance with all applicable lateral clearance and clear zone standards.
- Designed in accordance with drainage features and grade changes as shown on proposed cross-sections.
- Changes in mounting height on steep slopes.
- Conflicts with utilities.
- Structure mounting attached to bridges, retaining walls, and median barriers.
- Potential rock excavation for shallow bedrock.

Some design scenarios such as restricted geometry, utility conflicts, or bedrock discovery *may* warrant alternative concrete base designs. Any alternative base designs **shall** be approved by the Region and BOS.

11-5-5 Electrical Conductors April 2024

PURPOSE

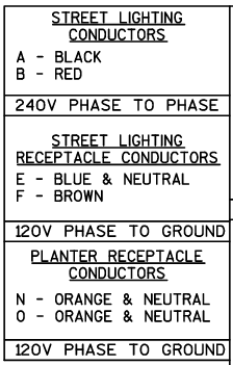
Electrical conductors are necessary to transmit electrical power and operational controls for roadway lighting systems.

MATERIALS

Typical roadway lighting designs **shall** utilize cross-linked polyethylene insulated (XLPE), underground service entrance rated wire as defined in Section 655 of the WisDOT Standard Specifications. Multi-conductor or direct burial cable *may* be required with some design scenarios and *should* be verified with the Regional Lighting Engineer.

Roadway lighting system conductors *should* follow conventional black/red color coding. Subsequent circuiting, such as receptacles, *should* utilize the next available color coding according to the NEC to easily differentiate between circuits. WisDOT Regions *may* have unique preferences for conductor color coding. Figure 1 shows an example of conductor color coding used on a state highway lighting system.

Figure 1. Example Conductor Color Coding



Slack cable **shall** be provided in the following electrical applications per Table 1 below.

Table 1. Cable and Wire Measurement Lengths

CONDUCTOR TYPE	APPLICATION	LENGTH	COMMENTS
SIGNAL CABLE	Cabinet	15'	Vertical rise to enter cabinet, length to terminate cable in cabinet, extra cable as necessary
	Pull Box	15'	2.5' to exit pull box, 2 loops (5' each), 2.5' to re-enter pull box
	Signal Base	8'	5' vertical rise in concrete base to access point, 3' at access point for splicing
	Pole & Arm	8'	3' at access point for splicing, 5' at signal head for termination
LOOP LEAD IN CABLE	Cabinet	15'	Vertical rise to enter cabinet, length to terminate cable in cabinet, extra cable as necessary
	Pull Box	0'	No extra lead in cable required in pull boxes
	Lead in Cable	8'	Slack is only required in the terminus pull box for splicing with loop detector wire
	Loop Detector Cable	8'	Slack is only required in the terminus pull box for splicing with lead in cable
EVP CABLE	Cabinet	15'	Vertical rise to enter cabinet, length to terminate cable in cabinet, extra cable as necessary
	Intermediate Pull Box	0'	No extra EVP cable required in intermediate pull boxes
	Terminus Pull Box	20'	Slack required for potential knockdown
	At EVP	2'	Exiting bracket for termination (pending different types of mounting brackets)
ELECTRICAL WIRE FOR LIGHTING	Cabinet	15'	Vertical rise to enter cabinet, length to terminate cable in cabinet, extra cable as necessary
	Pull Box	15'	2.5' to exit pull box, 2 loops (5' each), 2.5' to re-enter pull box
	Light Base	8'	5' vertical rise in concrete base to access point, 3' at access point for splicing
	Pole & Arm	8'	3' at access point for splicing, 5' at luminaire for termination
	Junction box	Varies	Depends on size of junction box. Typically, 2 times of the largest dimension of the box.

Conductors *should* be minimally sized according to the voltage drop calculations defined in this chapter. Designers *should* attempt to maintain some standardization of conductor sizing throughout the project to allow for more cost-effective bid pricing and to provide consistency for maintenance. If WisDOT is not the maintaining authority, the designer **shall** coordinate with local officials to determine if there is a preferred wire size and circuiting patterns that *may* govern the design.

DESIGN CONSIDERATIONS

The designer *should* consider alternating circuits along each run or branch. This provides a factor of safety in the event of a fault, where every other luminaire *should* remain operable. In providing proper operations of alternate circuiting, 120V circuits *should not* share a neutral, and *should* be terminated on single pole breakers.

Festoon receptacle branch circuits *should* be circuited independently from roadway lighting circuits.

Underground splicing **shall not** be permitted in pull boxes. Splices **shall** be made in poles and/or in aboveground junction boxes.

Wire sizing for roadway lighting circuits *should* be calculated with a target of 3% voltage drop per branch circuit, and a maximum of 5% for the total of service/feeder and branch circuit. Consider any potential for future expansion when calculating voltage drop for a roadway lighting circuit.

The voltage drops and related wire sizing for roadway lighting circuits and festoon receptacles **shall** be calculated in conformance with the NEC, along with any additional requirements of the applicant agency. Designers **shall** maintain documentation of voltage drop calculations of roadway lighting circuits using spreadsheets or other software applications. Use the voltage drop calculation spreadsheet.

Table 2. Voltage Drop Calculations (Example)

VOLTAGE DROP CALCULATIONS

EXAMPLE

Project ID: XXXX-XX-XX
Project Description: Example Voltage Drop
Lighting System # Example L49-2XXX

Date: 8/18/2020
Comps By: Engineer
Checked By:

Note: Example is based on a 250 Watt HPS Fixture in a 240 Volt System (304.8 Watts Input Each Luminaire)

Circuit #	Wire Segment From	Wire Segment To	Conductor Size (AWG)	Adjusted Voltage Through Line (VOLTS)	Total Watts (AT SOURCE)	Length of Cable Run In Segment L (ft)	Current At Source I (AMPS)	M	K	CM	Segment Voltage Drop (VD)	Segment Percentage Voltage Drop (% VD)
1	LCC-A	LP-1	4	240.00	3658	20	15.24	2	12.9	41740	0.19	0.08
1	LP-1	LP-2	4	239.81	3353	175	13.98	2	12.9	41740	1.51	0.63
1	LP-2	LP-3	4	238.30	3048	170	12.79	2	12.9	41740	1.34	0.56
1	LP-3	LP-4	4	236.96	2743	166	11.58	2	12.9	41740	1.19	0.50
1	LP-4	LP-5	4	235.77	2438	173	10.34	2	12.9	41740	1.11	0.47
1	LP-5	LP-6	4	234.66	2134	168	9.09	2	12.9	41740	0.94	0.40
1	LP-6	LP-7	4	233.72	1829	165	7.82	2	12.9	41740	0.80	0.34
1	LP-7	LP-8	4	232.92	1524	175	6.54	2	12.9	41740	0.71	0.30
1	LP-8	LP-9	4	232.21	1219	175	5.25	2	12.9	41740	0.57	0.24
1	LP-9	LP-10	4	231.64	914	170	3.95	2	12.9	41740	0.41	0.18
1	LP-10	LP-11	4	231.23	610	185	2.64	2	12.9	41740	0.30	0.13
1	LP-11	LP-12	4	230.93	305	155	1.32	2	12.9	41740	0.13	0.05
										Totals =	9.20	3.90

Voltage Drop Equation

$$VD = \frac{(M \times K \times I \times L)}{CM}$$

Wire Specifications

Size (AWG)	Area (CM)
4	41740
6	26240
8	16510
10	10380
12	6530

VD = Voltage Drop (- Volts)

M = Phase Multiplier
(Use 2 for Single Phase Alternating or Direct Current)
(Use "Square Root of 3", or 1.732 for 3-Phase Circuit)

K = Direct Current Constant
(Use 12.9 for Copper Wire)
(Use 21.2 for Aluminum Wire)

I = Current of Circuit in (Amps)
(At Source Along Circuit)

L = Length of Circuit (Ft)
(One-Way Length of Segment of Wire - - Source to Source, including anything coiled in Pull Boxes / Bases / Etc)

CM = Cross-Sectional Area of Wire (Circular Mils)
(Circular Mils = kcmil x 1000)

Notes: **1)** The NEC recommends a Maximum of 5% Voltage Drop for a Branch Circuit. It is also suggested in other references to design up to 3% Maximum Voltage Drop, which would then allow for some limited expansion of the Lighting System in the Future.
2) WisDOT's Teops Guide indicates that for Lighting, circuits should be calculated with a Target of 3% Voltage Drop per Branch Circuit, and a Maximum of 5% for the Total of Service / Feeder and Branch Circuits.

11-5-6 Cabinets, Metering and Controls April 2024

PURPOSE

Control cabinets are necessary to distribute electrical power to the roadway lighting infrastructure. Cabinets also typically house the operational controls for the roadway lighting system.

Meter pedestals are necessary to receive power from the utility company to energize the control cabinet.

MATERIALS

Roadway lighting control cabinets are typically ground mounted enclosures that come in a variety of sizes and capacities as warranted by the project. The roadway lighting designer **shall** coordinate with the WisDOT Region Lighting Engineer for the appropriate cabinet size (24" or 30") and voltage (120V/240V or 240V/480V).

Cabinet size *should* be determined by the requirements of the project and potential for future expansion. Typically, a 480V cabinet would be installed on freeways or expressways when circuits must cover larger distances. The use of a 480V voltage cabinet **shall** be approved by the local and utility authorities.

Meter pedestals *should* be included with new roadway lighting control cabinets and *may* have a main breaker, or main lugs only, depending on the application. Meter breaker pedestals are favored in urban settings because they allow for power to be disconnected from the entire control cabinet for safer working conditions during routine maintenance, as well as afford the flexibility of being able to easily change out control cabinets which involve the utility. Typically, electrical service meter breaker pedestals are installed with 120/240V roadway lighting systems, while electrical service main lugs only meter pedestals are most often installed with 240/480V roadway lighting systems. The designer **shall** coordinate with WisDOT on the appropriate type to install.

DESIGN CONSIDERATIONS

Roadway lighting systems **shall** be photocell controlled unless directed otherwise. Photocells are typically installed with the roadway lighting cabinet and will control each circuit via contactor.

Electrical service meters for roadway lighting systems *should* be located in coordination with the local electric utility company and the respective WisDOT Regional Lighting Engineer, with consideration of the following factors:

- The cabinet *should* be located such that it is not vulnerable to traffic. A distance of 20 feet back of curb or 30 feet off the edge of pavement is desirable for offsetting the control cabinet.
- Proximity to electric utility.
- A maintenance vehicle *should* be able to park close to the cabinet and out of the traveled lanes.
- The cabinet **shall not** be in a drainage ditch or in an area which could be under water.
- The cabinet **shall not** obstruct sidewalks, multi-use trails, curb ramps, or driveways.
- The cabinet **shall** be located in right-of-way and accessible to provide maintenance without entering private property.
- Cabinet **shall** be oriented such that the photocell will sufficiently detect light.
- Snow storage and removal *should* be considered when determining cabinet location and orientation.

The local utility **shall** be contacted early in the design stage. Electrical service locations *should* be established by the DT1078 submittal to ensure the local electrical utility has adequate time to review the proposed locations. Verify with the utility the available fault current at each service location prior to final design and installation.

The electrical service **shall** be provided in accordance with the standard specifications and standard details.

Provide service grounding as detailed in the standard specifications and details unless otherwise noted on plans.

CONSTRUCTION

Meter breaker pedestals are typically installed directly adjacent to the control cabinet to minimize the distance between the service lateral and the main breaker, mitigating potential losses due to voltage drop and resistance.

The utility company will dictate the conductor size of the service lateral based on the service requested and distance from their power source. Conduit from the power source to the meter pedestal is typically provided and installed by the utility company unless directed otherwise to be included as part of the project design.

The contractor **shall** provide roadway lighting circuit identification plaques and roadway luminaire sequence decals suitable for outdoor construction for control cabinets, light poles, sign bridges, underdeck luminaires and high mast lighting as the plans show and per WisDOT Standard Detail Drawings: SDD 09H11, SDD 10A2, SDD 10A3 and SDD 10A4.

11-6-1 Plan Production — April 2024

POLICY

Biddable plans for construction **shall** be prepared as set forth by the guidelines in previous TEOpS chapters. The plans and specifications **shall** define the work as complete and accurate as possible, and they **shall** be stamped and signed by the engineer of record. The plans and specifications *should not* leave ambiguity as to bid items used to account for indicated work.

REFERENCE TO STANDARDS

The plan production of roadway lighting **shall** conform to applicable provisions of Chapter 15, Section 1 of the WisDOT Facilities Development Manual (FDM). In addition, the roadway lighting plans **shall** comply with the latest edition of the following:

- WisDOT Standard Specifications
- WisDOT Standard Detail Drawings
- WisDOT Standard Bid Items
- WisDOT Creating Special Provisions Manual
- WisDOT's Electrical Qualified Products List (i.e., Approved Products List)

11-6-2 Plan Production – Roadway Lighting — April 2024

GENERAL

Roadway lighting plans **shall** be stamped by a registered professional engineer in the State of Wisconsin on the title page of the plan or on the first page of the roadway lighting plans with an indication of how many pages were designed.

Each sheet in the set **shall** have the appropriate title block correctly indicating the project information.

WisDOT has prepared standard detail drawings (SDD's) which are available to the designer. The designer **shall** carefully review and apply standard details whenever possible to ensure consistent installation. The designer **shall** create and provide any additional construction details as required for a complete installation that are not covered by the SDD's.

Provide "General Notes" to clearly indicate the responsibilities of the installer to minimize questions during the bidding and installation process. Provide any additional notes required for removal, temporary, and final roadway lighting installations. Notes that apply to all sheets *should* be consolidated to a "Notes and Legend" section in the plan set to reduce redundancies. Notes that apply only to a specific sheet *should* be placed on that respective sheet.

A legend and list of abbreviations used **shall** be provided correctly indicating all symbols used on the project.

Plans **shall** indicate the right-of-way boundaries and include any walkways and bike paths.

All roadways **shall** be labeled and include station alignment identification.

All plan sheets **shall** include a scale for reference. A scale of 1:40 is appropriate for urban roadways and intersections. A scale of 1:100 is appropriate for rural and freeway applications and *should* be considered the maximum scale. One scale *should* be used for all sheets in one plan set.

Plan sheets and details **shall** include all critical dimensions.

A sample roadway lighting plan sheet is located in FDM 15-1-20.11 attachment for reference.

ROADWAY LIGHTING REMOVAL PLANS

Plans **shall** detail all required electrical infrastructure to be removed or abandoned and indicate if any infrastructure **shall** be discarded, salvaged, or relocated.

All plan sheets **shall** accurately indicate the existing electrical infrastructure to remain.

Removals *may* be combined with permanent roadway lighting plan for basic systems. More complex roadway lighting systems *should* have separate removal sheets.

TEMPORARY ROADWAY LIGHTING PLANS

If required, plans **shall** detail temporary roadway lighting including fixture types and locations, installation requirements, and temporary power wiring. Temporary roadway lighting plans *should* indicate work zone locations/stages and show any temporary connections to existing roadway lighting infrastructure and controls. Temporary roadway lighting plans **shall** detail any non-standard bid items used with the design.

Temporary roadway lighting plans *may* be combined with permanent roadway lighting plans for basic systems. More complex roadway lighting systems *should* have separate temporary roadway lighting sheets.

PERMANENT ROADWAY LIGHTING PLANS

Plans **shall** identify the electrical service location, including voltage, phase, and size. Special requirements and notes needed for a complete installation **shall** be included.

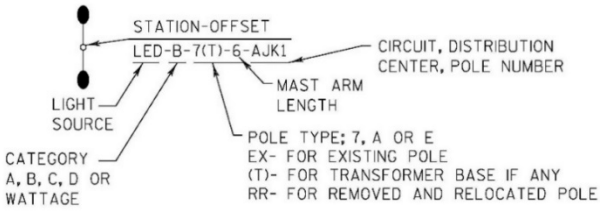
All existing utilities which could pose a conflict with the installation for the proposed roadway lighting **shall** be identified.

All new electrical infrastructure, symbols, conduit and wiring information, right of way lines, and text **shall** be printed in dark black. All other background information **shall** be printed in gray to easily distinguish the electrical information. Designers *should* include background linework for structures, overhead signs, underground pipes, and other pertinent project features.

Plans **shall** show all new roadway light standards, high mast towers, underpass lighting, walkway lighting, and roadway lighting controller locations. Special conduit installation requirements, i.e., installation under existing pavement, **shall** be identified on the plans.

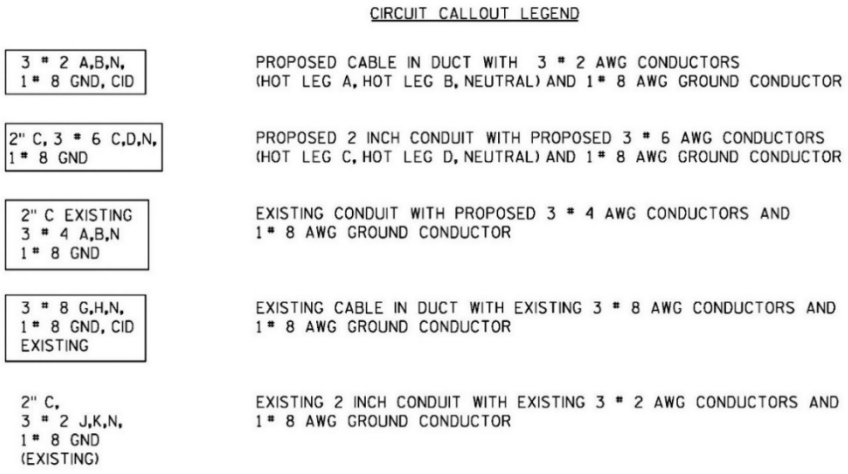
Plans **shall** clearly label all luminaires and pull boxes. See Figure 1 below for an example of luminaire labeling.

Figure 1. Luminaire Labeling Example



Plans **shall** clearly indicate all conduit sizes and locations, and wiring information for each roadway lighting circuit. See Figure 2 below for examples of circuit callouts.

Figure 2. Circuiting Callout Examples



11-6-3 Special Provision Preparation – Roadway Lighting April 2024

WisDOT has prepared standard specifications which are available to the designer. The designer **shall** carefully review and apply the standard specifications whenever possible to ensure consistent installation. The designer **shall** create and provide any additional special provision (SPV) specifications as required for a complete installation.

Designers *may* encounter scenarios where a standard bid item needs to be modified according to the project requirements. In these instances, the designer is permitted to modify a standard specification rather than create a new SPV. Modifications to standard specifications *should* be coordinated with the Regional Lighting Engineer.

Each SPV **shall** be provided with its own unique name and number, description detailing the equipment/devices to be provided and installed, and all associated work to be performed for that specific pay item. Each pay item **shall** include the following: description of work, materials, construction, units of measurement, and basis of payment.

Specifications **shall** be clear, concise, and complete.

Each SPV name and numbering **shall** match those used in the list of quantities.

11-6-4 Quantities and Cost Estimate Preparation – Roadway Lighting April 2024

Each item to be removed, modified, or installed **shall** be accounted for in a list of standard bid items and SPV item quantities to be included in the plan set.

A complete cost estimate based on the list of quantities **shall** be provided for the project. The designer **shall** use the historical data collected by WisDOT and their best engineering judgment to provide an accurate estimate.

11-6-5 Submittal Requirements – Roadway Lighting April 2024

Electrical design documents **shall** be submitted for review and approval by WisDOT at the following stages: 30%, 60%, 90%, and final. The following sections detail the required materials that are typically submitted for each design development stage.

30% PLAN SUBMITTAL

The designer **shall** submit all appropriate request forms, preliminary permit applications, and roadway lighting investigation report as required in TEOpS 11-1 and 11-2. The designer **shall** obtain all necessary approvals prior to completing the full preliminary design.

Preliminary roadway lighting plans *may not* be required at this stage, but designers *should* develop a preliminary estimate of costs. High mast lighting and plans that will incorporate roadway lighting poles mounted on structure or median barriers *should* be considered at this stage.

Designers *should* submit any roadway lighting alternatives analysis to the Regional Lighting Engineer by the 30% submittal.

60% PLAN SUBMITTAL

Plans **shall** be prepared and include the correct title block, appropriate legends, and preliminary notes. Plans **shall** address any comments made during the 30% review process. The plans **shall** incorporate as much detail as possible.

Temporary roadway lighting requirements **shall** be addressed as part of the Transportation Management Plan (TMP), and preliminary layout included if required.

Plans **shall** be coordinated with underground and overhead utilities in the vicinity of each luminaire to ensure there is no conflict. Provide location(s) for roadway lighting control cabinet(s).

The roadway lighting **plans shall** include luminaire station labels, along with circuit and conduit labeling.

The designer **shall** submit the completed illumination design output to the Regional Lighting Engineer for review and approval. The illumination design **shall** include:

- A copy of the approved illumination form (signals and roundabouts).
- The preliminary design layout showing illumination contours (when appropriate).
- Photometric calculations with summary information showing compliance with illumination and uniformity

criteria.
- Transition roadway lighting calculations (as applicable).
- Verification of luminaire cut sheets and .IES files to be used in the design.

The designer **shall** provide a preliminary list of special provisions, pay items, and an updated construction cost estimate.

UTILITY (DT1078) PLAN SUBMITTAL

Plans **shall** address any pertinent comments made during the 60% review process and at a minimum include locations of all light poles, control cabinets, pull boxes, conduit, and other infrastructure necessary to evaluate utility conflicts.

Electrical service coordination *should* begin during this submittal phase. All potential conflicts with utilities *should* be reviewed, identified, and coordinated.

90% DRAFT PLAN SUBMITTAL

Plans **shall** address any additional comments made during the 60% review process, as well as utility conflicts identified from the DT1078 review.

The designer **shall** submit any final permit applications as required in TEOpS 11-1 and 11-2.

Permit applications *should* be approved prior to completing the 90% plan submittal.

Coordination *should* be done with local agencies for cost sharing when applicable.

Temporary roadway lighting (when applicable) **shall** have been coordinated with the construction staging and maintenance of traffic plan.

The plans **shall** include all plan sheets (removal, temporary, and permanent), miscellaneous quantities, SPVs, construction cost estimate, a list of applicable standard detail drawings, and any unique installation construction details.

Voltage drop calculations as required in TEOpS 11-5 **shall** be submitted for review.

FINAL PLAN SUBMITTAL

All final bidding documents **shall** address any comments made during the 90% review process.

Final plans, miscellaneous quantities, and special provisions **shall** be complete and accurate for the intent of bidding and construction.

The plans **shall** include all plan sheets (removal, temporary, and permanent), miscellaneous quantities, SPVs, final construction cost estimate, list of applicable standard detail drawings, and any unique installation construction details.

AS-BUILT DRAWINGS

As-Built record drawings **shall** be submitted by the installation contractor upon final completion of all electrical installations as required on the plans and specifications prior to final payment. The installation contractor **shall** provide a plan redlining any deviations from construction plans made in the field and provide the GIS coordinate information for the final lighting equipment locations for WisDOT use. Final plans *should* be updated to reflect the red-lined changes and be clean and free of revision clouds and triangles.

SHOP DRAWINGS

Shop drawings **shall** be submitted by the installation contractor and reviewed by the construction oversight engineer in accordance with the guidelines described in the WisDOT Construction and Materials Manual (CMM).

CONSTRUCTION CHECKLISTS

Refer to Figure 655-2 of the Construction and Materials Manual (CMM) for the Lighting Installation Checklist which is to be used to inspect system lighting installations in the field. The contractor is required to perform tests and demonstrate that the completed lighting is acceptable.

11-13-1 Incident Management Protocols May 2006

PURPOSE

The purpose of the incident management protocols for Department electrical systems is to provide guidelines for the regional electricians to follow in order to maintain conformity statewide.

The times indicated are the desired Department practices for identified incident response time. It is recognized there *may* be isolated occasions where the Department's ability to meet these guidelines are negatively impacted by certain factors such as: simultaneous calls, inclement driving conditions, and location of the actual incident. On those occasions where the response times are not met, reasons for non-attainment *should* be noted in the service reports.

DEFINITIONS

Response Time – The time from when we receive the initial service request to the time we arrive at the location.

Type 1 (Safety) – Urgent, respond immediately (day, night, weekends, or holidays), within three hours. Safety hazards to the public.

Type 2 (Efficiency) – Repairs *should* be done as soon as practicable or the next business day during normal working hours.

Type 3 (Routine) – Repairs *should* be done as scheduling permits.

QUALIFICATIONS FOR MAINTENANCE AND REPAIR OF SYSTEMS

1. Any and all repairs to the electrical systems **shall** be made by qualified personnel.
2. A qualified person **shall** be an Electrical Journey Person, who has successfully indentured as an apprentice and has completed the required academic curriculum established by DWD. In addition, the Journey must have gained the necessary electrical experience that relates to installation and maintenance of traffic signals, roadway lighting, and structures via on the job training at an established agency.
3. A fourth year DWD indentured apprentice *may* perform repairs under the guidance of a Journey person.

SERVICE CALL GUIDELINES MATRICES

TRAFFIC

Type of call	Primary Response Reason	Procedural Guide	Estimated Response Time
Traffic signal going in and out of flash	Safety		Type 1
Traffic signal on flash	Safety		Type 1
All traffic signal indications dark or out at intersection	Safety	Ask caller to ensure its not just one lamp out where only one signal *may* be without an indication. Check with power company for possible power outage in area. Ask Law Enforcement to call back if signals do not come back on after power is restored in the area.	No response needed if utility power outage. Type 1
Conflicting traffic signal indications on an approach or the same head.	Safety	Ask caller to describe the malfunction	Type 1
Specific/one direction gets too much green time	Efficiency	Ask caller to describe malfunction. Ask caller if it is cycling.	Type 2
Skipping specific traffic movement	Safety	Ask caller to describe malfunction	Type 1
Traffic signal stuck on and/or in single direction	Safety	Ask caller to describe malfunction	Type 1
Too little time to walk across road.	Efficiency	Ask caller to describe malfunction	Type 2
Some traffic signals dim and/or some show multiple indications.	Safety	Ask caller to describe malfunction	Type 1
Traffic signal damage or knockdown	Safety	Ask for the status of damage. Ask caller if the signal is still operating or if it's on flash.	Type 1
Turned signal head.	Safety	Ask caller of the direction and location of signal head.	Type 1
Traffic signal lamp outage	Safety	Ask the caller for specifics on which indication and what color is not working.	

		Red or Yellow not working	Type 1
		Green not working	Type 2
Pedestrian signal lamp outage	Efficiency	Ask caller for specifics on which indication is not working. Ask for the travel direction.	Type 2
Short green time	Efficiency	Ask caller for specifics on what the caller has seen. Ask for the direction of travel.	Type 2
Can't make it from one intersection to another on green. Always get stopped at the next intersection.	Routine	Obtain specifics as to what time of day this problem is noted, the direction of travel at the time.	Type 3

LIGHTING

Type of call	Primary Response Reason	Procedural Guide	Estimated Response Time
Street light (Luminaire) pole damaged or knocked down (if WisDOT maintained)	Safety	Ask the caller for the status of damage. Is the pole still standing or is the pole leaning?	Type 1
All street lights (Luminaires) are out (if WisDOT maintained)	Efficiency	Are the traffic signals still operational? If no, see traffic calls above.	Type 2
Street light (Luminaire) is out (if WisDOT maintained)	Routine	Is it an overhead luminaire outage or a traffic signal indication? If traffic signal, see traffic calls above.	Type 3

FLASHERS

Type of call	Primary Response Reason	Procedural Guide	Estimated Response Time
Traffic signal flasher damage/knockdown	Safety	Ask caller on the status of damage.	Type 1
Traffic signal flasher out	Efficiency	Ask caller if flashers are working.	Type 2

DIGGERS HOTLINE

Type of call	Primary Response Reason	Procedural Guide	Estimated Response Time
Emergency Diggers Hotline locate/repair	Efficiency	If cannot clear via phone, field locate required	Type 2

11-14-1 Electrical Inventory Numbering System Guidelines January 2009

GENERAL INFORMATION

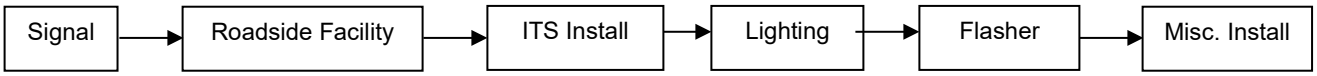
In light of recent inventory tools & new methods of tracking existing equipment, the following outlines the use of installation ID numbers for *state-maintained &/or state-maintained electrical equipment* installed in the field & serviced by WisDOT staff. There are multiple reasons installation numbers are used to track installations internally: plan development, signal timing plan development, management of asset inventories, utility service tracking, service reporting, providing locates, etc.

All electrical installations need to be identified by the appropriate alphanumeric codes. The correct format is indicated in [brackets] & is described for each installation described by this memo. If being viewed electronically, clicking on the specific installation indicated below will direct you to the corresponding section of this memo.

Questions regarding information contained within this policy can be directed to the Bureau of Traffic Operations State Traffic Signal Systems Engineer, (608) 261-5845.

ASSIGNMENT & TRACKING

Installation ID's will be assigned for each electrical device that requires utility service. A hierarchy based on the primary function of the cabinet is also used. The assigned installation hierarchy from left (highest) to right (lowest) is:



For example, if a signal cabinet provides service for the associated intersection lighting & an advanced warning flasher, they will all be tracked under the same "S" number. In the example above, the advance flasher & intersection lighting are essentially incidental to the traffic signal.

Unless noted otherwise below, the State Electrical Shop in BTO – Electrical creates & assigns all relevant information regarding installation numbers.

INSTALLATION ID's FOR TRAFFIC OPERATIONS

The electrical devices described in this section are considered to be fundamental for traffic control (in addition to signing & marking) on the STH system. The following installations are tracked, designed, operated & maintained by WisDOT BTO & Regional staff.

1) **"S" (Permanent Signal) Numbers** – "S" numbers are used for all permanent traffic control signals.

The format for "S" numbers is…[S0000]. The numbering system, represented here by "0000", applies statewide & is sequential in the order the Regional staff request them of BTO – State Traffic Signal Systems Engineer.

2) **"T" (WisDOT Maintained Temporary Signal) Numbers** – "T" numbers *may* be applied to state-maintained installations that typically are not associated with a construction project (i.e. an interim improvement until a grade-separation can be constructed). "T" numbers will provide a tracking mechanism for WisDOT facilities that *may* need field-located or for utility charging.

   The format for "T" numbers is…[T0000]. The numbering system, represented here by "0000", applies statewide & sequential in the order the Regional staff request them of BTO – State Traffic Signal Systems Engineer.

3) **"TC" (Contractor Maintained Temporary Signal) Numbers** – "TC" numbers are applied to contractor-maintained installations that typically are associated with a construction project *on the STH system only* (i.e. as interim intersection traffic control along a detour). "TC" numbers will provide an ID for information to be tracked, specifically related to the appropriate maintenance authority for incident response purposes.

   The format for "TC" numbers is…[TC-00-9999]. The first two-digit number, represented by "00", is given based on the appropriate county code. The second four-digit number, represented by "9999", is applies countywide & is sequential in the order Regional staff assign them.

4) **"U" (Underground Signal Equipment) Numbers** – "U" numbers *should* be used when intersections have been constructed with underground equipment such as conduit & pull boxes for future signalization. "U" numbers will provide an ID for WisDOT facilities when responding/referring to locate requests by Diggers Hotline, etc.

   The format for "U" numbers is…[U0000]. The numbering system, represented here by "0000", applies statewide & is sequential in the order the Regional staff request them of BTO – State Traffic Signal Systems Engineer.

5) **"SS" (Signal System) Numbers** – "SS" numbers are used to track coordinated signal systems. To do so, individual "S" numbers that comprise the system are related to a unique "SS" number. These ID's are assigned to internally track the quantity & types of coordinated systems, as well as streamlining service reports. For example, if time clocks are checked at five time-based controllers, only a single service report will need to be completed.

   The format for "SS" numbers is…[SS0000]. The numbering system, represented here by "0000", applies statewide & is sequential in the order the Regional staff request them of BTO – Electrical.

6) **"L" (Lighting) Numbers** – Historically, the convention for lighting numbers has been established differently between Regional offices. Some offices tracked lighting for Park & Ride lots as "L" numbers; others were tracked under a "PR" ID. Tracking of high mast & highway system lighting installations created some additional differences.

   Any stand-alone highway lighting installations are tracked as "L" numbers. Highway lighting associated with other facilities/installations are tracked under the ID of the primary installation based on the installation hierarchy described above. Examples of this logic include:
   - System highway lighting – tracked by "L" number,
   - Isolated intersection lighting – tracked by "L" number,
   - High mast lighting – tracked by "L" number,
   - Roundabout lighting – tracked by "L" number,
   - Park & Ride lot lighting – tracked by "L" number,
   - Rest Area lighting – tracked by "R" number,
   - Signalized intersection lighting (out of same cabinet) – tracked by "S" number,
   - Signalized intersection lighting (out of separate cabinet) – tracked by "L" number,

   The format for "L" numbers is…[L0000]. The numbering system, represented here by "0000", applies statewide & is sequential in the order the Regional staff request them of BTO – Electrical. Intersection lighting installed under permit to the local city, town or village are not tracked.

   NOTE: *Existing "HL" & "HML" (that represented high mast & highway lighting in some Districts) numbers will be converted to "L" numbers in continued sequential order as described.*

7) **"F" (Flashing Beacon) Numbers** – "F" numbers are be used for all installations of flashing beacons (typically single section signal heads). *Flashing beacons do not include signs with incorporated LED's (i.e. Blinker STOPs).*

   The format for "F" numbers is…[F0000]. The numbering system, represented here by "0000", applies statewide & is sequential in the order the Regional staff request them of BTO – Electrical.

   NOTE: "MF" numbers had been tracked separately due to historic signal maintenance reasons in Milwaukee County (old Transportation District 9). *In the future, flashers in Milwaukee Co. will be tracked as "F" numbers & as described above. Existing "MF" numbers will be converted to "F" numbers in continued sequential order as described.*

8) **"NB" (Navigation Beacon) Numbers** – "NB" numbers are used for all marine & aerial navigation lighting. Typically, this lighting is attached to bridge structures.

   The format for "NB" numbers is…[NB0000]. The numbering system, represented here by "0000", applies statewide & is sequential in the order the Regional staff request them of BTO – Electrical.

9) **"PBS" (Portable Bridge Signal) Numbers** – "PBS" numbers are used for state-owned, trailer mounted, two-way bridge signals.

   The format for "PBS" numbers is…[PBS00]. The numbering system, represented here by "00", applies statewide & is assigned & tracked by BTO – Electrical.

INSTALLATION ID's FOR ITS

The primary responsibility for WisDOT electrical staff related to ITS facilities are for emergency response only. ID's for ITS facilities are assigned & maintained by the Traffic Management Center (TMC). Work performed by WisDOT electrical staff at these locations is tracked based on the installation type, as described:

10) **"CCTV" (Closed Circuit Television) Numbers** – "CCTV" numbers are used to track closed circuit TV installations used for highway surveillance.

11) **"DMS" (Dynamic Message Sign) Numbers** – "DMS" numbers are used to track permanent dynamic message signs installations. These installations are not the same as PCMS devices listed below.

12) **"PCMS" (Portable Changeable Message Sign) Numbers** – "PCMS" numbers are used to track individual portable change message signs (trailer mounted) that are owned by WisDOT & *may* be deployed by State or County crews. These devices are not the same as DMS installations listed above.

13) **"GATE" (Traffic Gate) Numbers** – "GATE" numbers are used to track traffic gates used to perform freeway ramp closures.

14) **"RM" (Ramp Meter) Numbers** – "RM" numbers are used to track individual ramp signal installations at freeway entrance points.

15) **"HAR" (Highway Advisory Radio) Numbers** – "HAR" numbers are used to track equipment related to highway advisory radio functionality. Such equipment *may* include flashing beacon installations (associated with static information signs) or radio transmitters.

16) **"SDS" (System Detector Station) Numbers** – "SDS" numbers are used to track equipment used to collect system traffic data. Such equipment *may* include microwave, video imagining or inductive loops.

17) **"VC" (Vehicle Classification Site) Numbers** – "VC" numbers are used to track equipment used to collect vehicle classification data. Such equipment *may* include overhead microwave detectors or inductive loops.

18) **"RWIS" (Road Weather Information Station) Numbers** – "RWIS" numbers are used to track equipment used to collect & transmit road weather data.

INSTALLATION ID's FOR ROADSIDE FACILITIES

BHM – Maintenance contracts for much of the maintenance activities at roadside locations since they are not critical to highway safety.

The primary responsibility for WisDOT electrical staff at these locations is lighting maintenance only. ID's for roadside facilities are assigned & maintained by BHM – Maintenance. Lighting & any other electrical maintenance performed at roadside facilities are tracked under the following ID's:

19) **"R" (Rest Area) Numbers** – "R" numbers (formerly "RA") are used to track rest area facilities, generally located along freeway routes.

20) **"W" (Seasonal Wayside) Numbers** – "W" numbers (formerly "RSP") are used to track wayside facilities, generally located along conventional highway routes.

21) **"SWEF" (Safety & Weight Enforcement Facilities) Numbers** – "SWEF" numbers (formerly "WS") are used to track weigh scale facilities, generally located along IH routes.

22) **"MRSF" (Miscellaneous Roadside Facility) Numbers** – "MRSF" numbers are used to track work performed by WisDOT electrical staff on other roadside facilities. Examples of these installations include: Welcome Signs, Scenic Overlooks, Tourist Information Centers, etc.

    The format for "MRSF" numbers is…[MRSF-XXX]. The letters, represented here by "XXX", correspond to the regional ID as indicated for "MITS" numbers above. For example, EAU represents the Eau Claire Regional office.

RELEVANT INFORMATION

Relevant information for the various installations described above is collected & tracked in WisDOT database systems. This information will generally include the following data fields:

- Installation type
- Owner/Maintainer (State, County, Local)
- Date unique ID was requested
- Unique Installation ID
- Project ID
- RP Number & offset
- Regional Office ID
- Intersection/Location
- Municipality
- County

NON-CONFORMING INSTALLATION ID'S

Existing installation ID's that do not conform the definitions described above will be allowed to remain until that installation is reconstructed or removed from service. These ID's will be included as an alias ID in WisDOT inventory management systems for the purpose of tracking historical information.

INSTALLATION TYPES

To further aggregate an installation by type, WisDOT electrical inventory systems will have a data field to describe the basic device & function, if needed. For example, L0854 *may* be associated with a roundabout installation on the STH system. In that case the Installation Type will be "Lighting – Roundabout". The following installation types are used to further clarify the application of the various installation ID's described above.