Section 11

Highway Lighting Systems

11.1 General

This section of the manual is intended for use as a guide in the planning and design of a highway lighting system that conforms to Department policy. It will provide a means of developing uniformity in the design and plan preparation of highway lighting systems.

Complying with all of the design criteria is sometimes difficult. It will require some judgment on the part of the designer to draw the necessary balance. However, it is necessary that the criteria be followed as closely as possible in order to achieve uniformity of design in highway lighting systems. It is recognized that situations will occur where good engineering judgment dictates deviation from this Department policy. Any such deviation shall be detailed in writing and submitted for approval to the Manager of Traffic Signal and Safety Engineering.

It is not the intent of this section to reproduce all the information that is adequately covered by textbooks and other publications that are readily available to the designer. This section, when used in conjunction with engineering knowledge of highway lighting design and good judgment, should enable the designer to perform their job more efficiently.

The terminology used in this manual, unless stated otherwise, is as defined in AASHTO *An Informational Guide for Roadway Lighting*.

11.2 Reference Publications

- AASHTO, *An Informational Guide for Roadway Lighting*
- FHWA, *Roadway Lighting Handbook*
- FHWA, *Manual on Uniform Traffic Control Devices (MUTCD*)
- Illuminating Engineering Society of North America (IESNA)

  Applicable Lighting Publications.
- SPECIFICATIONS:
  - NJDOT *Standard Specifications for Road and Bridge Construction*
  - NJDOT *Supplemental Specifications*
  - NJDOT *Special Provisions*
- NJDOT *Standard Electrical Details*
- NJDOT *Electrical Material Specifications*
- NFPA *National Electric Code* (NEC)
- NJDOT *Sample Plans*
- NJDOT *CADD Manual*

All publications shall be the latest edition.

11.3 General Design Criteria

11.3.1 Warrants for Highway Lighting

These warrants are for highway lighting only and the warrants for intersection lighting are in Section 11.8.

Step 1

Prior to the actual design of a highway lighting system, the designer must determine if highway lighting at a particular section, area or location is actually warranted. To demonstrate this need a system of warrants has been developed. The American Association of State Highway and Transportation Officials (AASHTO) warrants shall be investigated before a final determination is reached. If highway lighting is warranted based on the following (except for underdeck/tunnel lighting), then the designer shall proceed to Step 2.

A. Continuous Freeway Lighting - One of the following AASHTO warrants must be met to consider continuous lighting:
   - CFL-3
   - CFL-4
   - Special considerations

B. Complete Interchange Lighting - One of the following AASHTO warrants must be met to consider complete interchange lighting:
   - CIL-1 plus CIL-2
   - CIL-3
   - CIL-4
   - Special considerations

C. Partial Interchange Lighting - One of the following AASHTO warrants must be met to consider partial interchange lighting:
   - PIL-1 plus PIL-2
   - PIL-3
   - Special Considerations

D. Underdeck Lighting or Tunnel Lighting - AASHTO warrants must be met to consider underdeck and/or tunnel lighting. If lighting is warranted, the designer shall prepare the design and skip Step 2.

E. Additional Design Considerations - Additional lighting shall be considered warranted for ramps, mainline or acceleration lanes for any of the following reasons:
   1. Ramps
      - Inside radius of entrance or exit ramp is less than 150 feet.
      - Accident data in the ramp area indicates a problem exists.
   2. Acceleration Lanes
      - Stop before acceleration lane.
      - Grade and/or curvature presents a visibility problem, which cannot be corrected through other means.
      - Sidewalks exist to permit pedestrians to cross at the entrance or terminal of a ramp.
   3. Main Line
      - Grade and/or curvature presents a visibility problem, which cannot be corrected through other means.

- Bridges without shoulders.

The designer shall obtain the accident data of the location in order to determine the night to day accident ratio. The ratio could dominate the determination if highway lighting is required.

Step 2

If lighting is warranted based on the AASHTO warrants, then the need for lighting on a particular highway or interchange must be considered utilizing the appropriate evaluation form described below. The designer shall assume the evaluation forms (Lighting Forms 1-8) refer to the mainline highway unless specifically noted otherwise. Any questions shall be directed in writing to the Manager in the Bureau of Traffic Signal and Safety Engineering.

A. Continuous Lighting (Freeway) - If warranted, Lighting Form 1 is to be utilized to evaluate the need for continuous lighting for the actual highway being considered. For new highways or new alignments Lighting Form 3 is to be utilized to evaluate the need for continuous lighting. All highways (traveled lanes) are to be illuminated except express lanes separated from local lanes by concrete island, barrier curb or grass.

B. Complete and Partial Interchange Lighting - If warranted, Lighting Form 2 is to be utilized to evaluate the need for complete or partial interchange lighting for the actual highway and interchange being considered. For new highways or new alignments Lighting Form 4 is to be utilized to evaluate the need for complete or partial interchange lighting.

   - Deceleration lane lighting shall be installed for the safe stopping distance (based on the design speed limit) from the physical gore area. Only two units shall be installed past the physical gore area (one unit in the ramp area and one unit along the main line). See Figure 11-A. The clear zone, as shown on Figure 11-A, is defined as a 30 foot minimum distance.
   - Acceleration lanes are not to be illuminated. Acceleration lanes are considered to begin at the entrance gore area.

C. Non-Controlled Access Facility (Land Service Highway) Lighting - Lighting Form 5 is to be considered. For new highways, or new alignments Lighting Form 6 is to be utilized to evaluate the need for continuous lighting.

11.3.2 Selection of Types of Highway Lighting

The Department currently utilizes two types of highway lighting systems. The designer shall investigate the lighting system options available. The use of either one type or a combination of the following types of lighting systems is acceptable:

- High Mast Lighting System - A system utilizing a mounting height of 100 feet with a cluster of a maximum of eight 400 watt high pressure sodium luminaires.
- Conventional Lighting System - A system utilizing mounting heights of 26 feet with 150 watt, 40 feet with 250 watt high pressure sodium conventional luminaires.

Before choosing a particular system, the designer shall first investigate the various types of lighting listed below:

- Tower lighting shall be considered first for full interchange lighting. A 400.watt cutoff type luminaire is preferred; non-cutoff luminaires can be utilized if the designer can justify their use. A public hearing shall be held to

advise the local residents that tower lighting shall be installed. All design data, including lighting levels, must be available for the public's review and comments.

- Conventional Lighting (full cutoff luminaires) shall be considered as a second choice for full interchange lighting.
- Conventional Lighting (cutoff luminaires) shall be considered as a third choice for full interchange lighting.
- Conventional Lighting (semi-cutoff luminaires) shall be considered as a forth choice for full interchange lighting.
- The use of non-cutoff luminaires is discouraged. If the designer feels their use is warranted, a written justification with the design calculations must be provided.
- Conventional lighting (full-cutoff, cutoff & semi-cutoff) shall be considered first for continuous mainline or partial interchange lighting. A 40 foot mounting height standard for mainline (250 watt luminaire) and a 26 foot mounting height standard for ramps (150 watt luminaire).

Investigate the environmental impact, especially on residences, of each system. The designer shall recommend to the Bureau of Traffic Signal and Safety Engineering of the elimination of any systems that have serious and unacceptable environmental impacts. The use of external luminaire shields may be used to minimize the glare of a conventional lighting system.

Upon approval, the designer shall then address, analyze and compare such determining factors as initial installation cost, maintenance costs, and energy consumption costs of the remaining system(s). All illumination and electrical design shall meet criteria as specified hereinafter. Before work commences on the lighting design, the designer must request approval of all design parameters by the Bureau of Traffic Signal and Safety Engineering.

The designer shall be prepared to present, explain and defend his lighting system choice and design at any public or other meetings, as required. Prepare 30' scale drawings of all systems to be included with the report, and based upon investigations and analyses, and make a recommendation to the Department of the system best suited to the project.

The designer shall not intermix a Department aluminum lighting system within a utility company wood pole transmission system.

The designer is responsible for locating, identifying and certifying the horizontal and vertical clearances of the utility company's primary (750 volts or more) and secondary power lines and shall assure that the minimum clearances are in accordance with the NEW JERSEY ADMINSTRATIVE CODE CHAPTER 25 UTILITY ACCOMMODATION, Section 16:25-5.3 (c). The designer shall coordinate the electrical design work with the present and future plans of the utility companies. All overhead and underground utilities must be shown on the plans. There shall be no conflicts with the lighting installation. The Designer must resolve all utility conflicts.

When utility poles are required to be relocated and wood pole lighting shall be the sole source of illumination for a section of highway, the designer shall space and position utility poles, through the utility agreement in conformance with the NEW JERSEY ADMINSTRATIVE CODE CHAPTER 25 UTILITY ACCOMMODATION, Section 16:25-5.4 (b) and 5.5 (a through i), to produce a suitable lighting design.

11.3.3 Level of Illuminance

Mainline highways and ramps shall be designed to provide an average maintained horizontal illuminance of 0.6 to 0.8 footcandles.

11.3.4 Uniformity of Illuminance

Design for uniformity of illuminance on various highways shall produce a uniformity ratio of 3:1 to 4:1 or better with a 0.2 footcandle minimum level. The ratio is defined as the average to minimum illuminance.

11.3.5 Basis for Lighting Calculation

A. Common Criteria

The following are common for all types of highway lighting systems:

- Photometric Data - The Photometric data utilized in all calculations shall be the latest data available from the Bureau of Traffic Signal and Safety Engineering available upon written request.
- High Pressure Sodium Lamps - High pressure sodium lamps with the following initial lumens shall be used:

Wattage	ANSI Designation	Rated Avg. Life Hours	Initial Lumens
150	S55SC-150	24,000	16,000
250	S50VA-250	24,000	27,500
400	S51WA-400	24,000	50,000

- Maintenance Factors - All lighting Systems depreciate with time. The design values shall consider appropriate reduction in initial illumination values. The maintenance factor to be utilized is 0.75; 0.68 for ambient areas considered dirty.

B. High Mast Lighting Systems

The lighting calculations to determine the required illumination shall be based on the following definitions and criteria:

- Area - only the traveled highway and ramps, including shoulders, shall be considered in the calculations.
- High Mast Lighting Standard Assembly Setback - Minimum 30 feet measured from the face of curb or edge of pavement to centerline of high mast lighting standard. A lesser setback may be used, but must be approved by the Manager of Traffic Signal and Safety Engineering. Should a lesser setback be approved, appropriate protection must be provided.
- Luminaires - High mast type 400 watt high pressure luminaires, as per NJDOT Specification No. EB-LHPS-4. The luminaires shall produce a symmetric, long and narrow, or asymmetric distribution. A maximum of eight luminaires of the same or different distribution shall be clustered to provide the required pattern of light distribution from the high mast lighting assembly.
- Mounting Height- The tower shall be 100 feet. The actual highway elevations shall be used in the calculations.

C. Conventional Lighting System

The lighting calculations to determine the required illuminance shall be based on the following definitions and criteria:

- Roadway Width - Actual width of highway pavement considered in calculations, including shoulders, excluding medians where they exist.
- Lighting Standard Setback - As required, minimum 5'-6" measured from the face of curb or edge of pavement to centerline of lighting standard.
- Luminaire Mounting Height - For 150 watt luminaires, 26 feet. For 250 watt luminaires, 40 feet.
- Lighting Standard Bracket Arm – 8 feet or 15 feet as required. For highway widths up to 24 feet, an 8 feet bracket arm is to be used.
- Luminaire Overhang - As required.
- Luminaires – As specified in section 11.3.2

D. Spacing and Location of the Lighting Standards

Lighting standard spacing and offsets shall be as uniform as possible. If it is necessary to vary the spacing or offset, it shall be done gradually. Since a poor appearance is likely to result, lighting standards shall not be spaced closer than 100 feet except on a ramp. In general, the lighting standards shall be located as follows:

- Mainline Highways - Along outside lanes, spaced opposite or staggered to suit the geometry and to provide the best lighting uniformity. An effort shall be made to illuminate the highway from one side.
- Ramps - In order to facilitate maintenance and relamping, it is desirable to locate the lighting standard along the inside radius. A setback of 5'-6" minimum is recommended.
- Gore Area - It is desirable for a lighting standard to be located within the vicinity of an exit gore area. In no instance shall a lighting standard be located in a roadside recovery area.
- Adjacent to Overpass - Care must be taken to avoid glare from mainline lighting affecting traffic on overpasses. External luminaire shields may be used to minimize the glare, if necessary. For typical (normal vertical clearance) overpass structures, luminaires shall not be located closer than 35 feet from the face of parapets.

E. Other Considerations

The following considerations are to be incorporated in all lighting calculations:

- Selection of proper size of luminaires to accommodate the level and uniformity of illumination.
- Selection of proper length of bracket arms to provide maximum efficiency and uniformity in lighting. It should be noted that in some areas the use of two different lengths of bracket arms may meet the above requirements, but may also produce an objectionable appearance with regard to the luminaire alignment.
- Where the geometry or the uniformity ratio requirements necessitate adjustments in the calculated lighting standard spacing, closer spacing shall be used.

- Contributions from all luminaires which have an effect on the area considered shall be taken into account to obtain the footcandle values. However, luminaires located at a distance greater than eight mounting heights from the area have a very minute effect and shall be excluded from the calculations.
- When adjacent to sign structures, it is desirable to locate lighting standards equidistant from sign structures. The lighting standards shall not be located within 50 feet of the structure. Care must be taken to avoid having a lighting bracket arm and luminaire mounted at 26 feet obstruct the driver's view of the sign-legend.
- Lighting standards shall not be located on the traffic side (in front) of guide rail or any natural or man-made deflecting barrier. The location shall also consider the distance necessary for rail deflection.

11.3.6 Lighting Calculations

A. Methods of Calculation

For the preliminary design, the average point method shall be used. Use only approved lighting design programs. Any questions regarding approved software shall be directed to the Bureau of Traffic Signal and Safety Engineering. The current photometric data to be used in the calculations shall be provided by the Department upon written request. Use specific design software for tunnel lighting.

B. Calculation Guidelines

The following are to be followed when performing the calculations:

- When a portion or section of the highway is under analysis, it shall be analyzed as a self-contained area (main area). Sub-division (sub-area) within the main area is not permitted.
- The self-contained area (main area) of analysis shall correspond to the highway geometry under investigation.
- The point to point interval shall be 5 feet longitudinally and transversely.
- The entire section of highway that is being illuminated shall be analyzed completely. It can be analyzed with many main areas.
- Luminaire layout parameters shall conform to Section 11.3.5.
- The following information shall be included with each analysis:
  1. Project identification.
  2. Plan sheet number involved in calculations.
  3. A station to station identification of the area being analyzed.
  4. The identification of each contributing luminaire being analyzed.
- The following guidelines must be adhered to when submitting the design data for review:
  1. Submit the design files in IES format on CD or DVD.
  2. Submit a hard copy of the design calculations.
- The New Jersey State Plane Coordinate System shall be used, when available for the project, for the lighting design layout.

11.3.7 Underdeck Lighting

Underdeck lighting is not installed to accent the highways beneath structures, but rather to provide the required level of illuminance to accent continuity of uniform lighting. Therefore, underdeck lighting shall only be required where this level of illuminance, due to structural limitations such as the width, skew and minimum clearance, cannot be accomplished by means of lighting standards.

Wall mounted underdeck luminaires shall be installed on pier faces and/or on abutments at a minimal mounting height of 15 feet. The pier faces or the abutment must be parallel to the highway and must be within 10 feet from the curb or edge of the highway, otherwise the luminaires shall be fastened to adapter plates installed between the bridge girders. Wall mounted underdeck luminaires installed at a mounting height of more than 15 feet shall yield better efficiency and uniformity.

Pendant type luminaires shall be mounted from the structural steel. The luminaires shall be located to facilitate maintenance and relamping. If the highway width permits, the luminaires shall be located over the shoulder. When a luminaire is suspended from a bridge structure over the traveling lane, the bottom of the luminaire shall not be lower than the bridge girder. Typical installation of a pendant type luminaire is included in the NJDOT Standard Electrical Details. A special detail may be necessary to detail the conduit layout under the structure.

For calculation purposes, the following data shall be used:

- Mounting Height - As required (15 feet nominal).
- Luminaires- 150 watt wall mounted type and pendant mounted type high pressure sodium luminaires as per the current NJDOT Specification Nos. EB-UHPS-1 and EB-UHPS-2.
- Uniformity Ratio – See Section 11.3.4.

On highways, which are not illuminated, underdeck lighting shall be provided for underpasses having pedestrian traffic. The average maintained illuminance shall be a minimum of 0.8 footcandles.

11.3.8 Conduit

Normally, conduits for all highway lighting circuits shall be 3” diameter. Application of various types of conduits shall be as follows:

A. Rigid Metallic Conduit (RMC)

- Used for underground conduits to be installed in all paved areas, excluding sidewalk areas and private driveways.
- Used for conduits to be installed transversely on side slopes.
- Used for critical areas such as where guide rail will cross the conduit run, or where sign foundations, drainage or other subsurface structures are anticipated to interfere with the conduit raceways.
- Used for conduits embedded in concrete foundations such as meter cabinet foundations.
- Used for all conduits embedded in parapets and abutment walls of structures. An approximate 5 foot section of conduit shall be extended from the wing walls. The conduit shall then be connected into a junction box near the wing walls.
- Used for all exposed conduits.

B. Rigid Non-Metallic Conduit (RNMC)

- Use 3” RNMC for all other underground conduit installations.
- Install ground wire in all RNMC.

11.3.9 Cables and Wire

All cables and wires, including neutrals, to be used for highway lighting circuits and secondary services shall conform to the specifications and shall be fully color coded. The designer shall provide, as part of the circuit diagram, the assignment of the specific color code for the lighting circuits. The designer shall calculate the voltage drop (voltage drop forms 1 and 2) and continuous load of each circuit, and the wire fill of all conduits to ensure conformance to the NEC.

11.3.10 Junction Boxes and Foundations

Junction box foundations and 18” x 36” junction boxes shall be required in a highway lighting system. In order to facilitate cable pulling and splicing, a junction box shall be installed adjacent to each lighting tower or illuminated sign structure foundation and at each end of conduit crossings under highways. Junction boxes shall be spaced at approximately 150 feet, however, if this requirement is found to conflict with the economics of a system, the Department may approve a longer spacing. Junction boxes are designed to carry a maximum of six through conduits. In cases where the number of circuits and cable sizes involved are in excess of the junction box capacity, the design shall be reexamined for an alternate layout. Two junction boxes may be installed in front of the meter cabinet (load center) to accommodate the excess conduits and cables.

11.3.11 Incoming Service

The secondary service obtainable from the local utility company’s pole or manhole shall be used to service the complete installation in each area.

The designer shall prepare an ESI (electric service inquiry) for the local utility company indicating the required service and obtain their written approval including an ESI number. Information on payee of the energy charge shall be provided in the letter. Standard services available from the utility company are as follows:

- Single Phase - 3 Wire: 120/240V and 240/480V, the latter is preferred. The utility company provides this special secondary voltage to the Department exclusively. Utilized voltage shall be 240 volts.
- Three Phase - 4 Wire: 265/460V and 277/480V, dependent on the utility company. Utilized voltage shall be 265 or 277 volts.

The designer shall always consider the Single Phase option as the first choice, since this is the preferred service for the Department.

When service is obtained from a manhole, the designer shall consult the utility company for the size, location, material and termination of the service conduit. The utility company usually furnishes the service wires, however this shall be verified.

Send copies of the service confirmation letter and Electric Service Identifier (ESI ID Number) to the Bureau of Traffic Signal and Safety Engineering.

11.3.12 Load Center Designations

Load centers shall be designated as follows:

- State Highway - Load centers for State highway lighting systems shall be designated with two letters which represent the cross street name, such as

using letters LA or LN for a load center at the intersection of Route 169 and Lincoln Avenue.

- Interstate Highway - Existing load centers and future load centers on certain interstate highways have been alphabetically assigned from one end to the other throughout the highway. Some letters were reserved for the purpose of maintaining the continuity. Obtain the designation from the Bureau of Traffic Signal and Safety Engineering when a load center is added to the interstate highway lighting system.

11.3.13 Circuitry and Other Considerations

In most cases, where the wire fill will permit, all cables for two or more lighting circuits may be installed in the same conduit.

Nominal size of cable for highway lighting circuits shall be #2 AWG. Other sizes, such as #1/0, #4 & #6 AWG, may be used and shall be approved by the Bureau of Traffic Signal and Safety Engineering. It is reminded that, unless necessitated otherwise, variations in cable sizes shall be avoided.

Normally, the highway lighting system for an interchange is to be fed from a load center and shall be controlled by means of a photoelectric control device mounted in the load center. The load center shall conform to the NJDOT Standard Electrical Details.

The designer shall, where feasible, utilize more than one load center at a large interchange to insure that in case of a failure of one load center, the entire interchange shall not be in a total darkness; also, the circuits can be rerouted as desired.

Consecutive lighting shall be connected to alternate circuits to prevent a total blackout of any section of the highway in the event a circuit is out of service.

Each luminaire shall be individually protected by means of a fused connector kit, as indicated on the NJDOT Standard Electrical Details.

Lighting circuits, including the future lighting extensions, where required, shall be designed generally for a maximum of 3% voltage drop at the terminal point of each circuit. It is calculated between the phase and neutral. The lighting circuits shall initially be designed for a maximum of 10 luminaires. For extremely long circuits, where the economy of installation warrants it, the maximum voltage drop may exceed 3% and the maximum load may be increased. However, the Bureau of Traffic Signal and Safety Engineering must approve the design.

All lighting circuits shall be balanced.

Lighting circuits shall be so arranged that in case of failure in one of the circuits, it shall be possible to reroute the failed circuit with minimum work. In order to accomplish this flexibility in the circuitry, an empty conduit shall be provided to connect the conduit systems of adjacent load centers where feasible.

At all mainline highway crossings, a spare conduit shall be provided.

On all highways where imminent widening is contemplated, the locations of the lighting system shall be outside the limits of the future widening.

The system shall be designed so that the permanent lighting installations shall be completed and in operation when a new highway is opened to traffic. If this cannot be accomplished, temporary lighting shall be provided.

11.4 Sign Lighting

The following guidelines shall be used by the Traffic Designer to determine if sign lighting is to be provided for Overhead Signs, Type GO and GOX:

A. The tangent sight distance is less than 1200 feet due to horizontal or vertical curve or other sight obstructions.

B. Geographic and/or geometric conditions may warrant sign lighting for the following situations and an evaluation shall be made:

- Diagrammatic signs
- "Exit Only" lane drops
- High volume interchange (interstate to interstate)
- Areas with high concentration of dew, fog or frost
- Sheeting material retroreflectivity characteristics

When it is determined that overhead sign lighting is to be provided, the lighting level shall conform to the following design parameters:

- The light loss factor 1.00
- The maximum-to-minimum uniformity ratio 6:1 or better
- The average maintained illuminance values as outlined in the AASHTO Roadway Lighting Design Guide

Sign lighting luminaires shall be a 250 watt mercury vapor luminaire conforming to the current NJDOT Specification No. EB-SL-1. Typical installations are included in the NJDOT Standard Electrical Details. The designer shall coordinate the electrical details and the details of the sign structure. A minimum of two luminaires shall be provided for each sign panel.

Where sign lighting is not required, walkways and luminaire supports are not to be provided, but the design of the sign structure shall allow for the future installation of walkways and luminaire supports.

11.5 Existing Highway Lighting System

When an existing lighting system is being affected by construction and the light source is other than high pressure sodium, it shall be converted to high pressure sodium.

11.6 Temporary Lighting

During various stages of construction, temporary lighting shall be provided for a section of highway that is opened to traffic and has any of the following conditions:

- The existing lighting system, either utility pole lighting system or State lighting system, is being interrupted.
- An acute change in the highway geometry and/or traveled lane(s).
- Designer shall indicate on either the Traffic Control Plan, Stage Construction sheets or with separate plan sheets, the areas where temporary highway lighting is required.

11.6.1 Designing the Temporary Lighting

Temporary lighting design is concerned with the duration and location of the lighting units, so as to provide the illuminance values as outlined in section 11.3 with a uniformity of 3:1 to 4:1. Provide a safe temporary lighting system that

conforms to the publications listed in Section 11.2 with considerations to the following:

- Investigate the possibility of installing certain proposed lighting systems, including underground facilities in the early stage of construction and utilize them as the temporary lighting.
- The use of galvanized steel, helix screw type foundations.
- The use of wood poles.

Regardless of what type of temporary lighting facilities, the contractor shall maintain the installations, until they are no longer required and then remove the portions that are not part of the permanent lighting system.

11.7 Highway Lighting Plans

A sample lighting plan, sheet E-1, is available as part of the NJDOT Sample Plans.

Provide a Highway Lighting Key Sheet which includes the placement of the lighting system equipment.

11.8 Lighting at Intersections

All signalized intersections are to be illuminated.

Non-signalized Major intersections must meet one of the criteria as outlined below:

- Four lane highway.
- Warrants (dusk to dawn):
  1. Any right turn movement on to the highway greater than 75 VPH.
  2. Any left turn movement on to the highway greater than 25 VPH/Leg.
  3. Through movement for the intersecting roadway greater than 50 VPH in either leg.

  The VPH warrants for lighting depicted on these figures are based on the highest VPH count in a given nighttime hour.
- If lighting is warranted based on the above warrants, then the need for lighting at a particular intersection must be considered utilizing evaluation Form 7 (Lighting Form 7) or Form 8 (Lighting Form 8) appropriately.
- Design Criteria for Intersection Lighting:

  Lighting levels shall be 0.6 footcandle to 1.2 footcandle.

  1. Design for a uniformity of illuminance on the highway that shall produce a uniformity ratio of 3:1 to 4:1 or better with a 0.2 footcandle minimum level. The ratio is defined as the average to minimum illuminance.
  2. Typical area of illumination shall be as shown in Figures 11-B and 11-C.
  3. At signalized intersections lighting shall be installed on traffic signal standards wherever possible if minimum utility clearances allow. Refer to Section 11.3.2.
  4. 150 watt luminaires shall be used.

11.9 Non-Functional Historic Replica Lighting

In special historical areas where it is desirable to construct "Streetscape" type projects. The luminaries shall have a lens without prisms and a low wattage HPS

SON lamp mounted at a height not to exceed 12 feet. The level of illuminance on the highway shall not exceed 0.2 footcandle.

A plan, with isolux lines, of the project area shall be submitted to the Bureau of Traffic Signal and Safety Engineering for approval.

11.10 Functional Historic Lighting

In special State Historic Preservation Office (SHPO) designated areas, it may be desirable to utilize luminaries/standards other than those described elsewhere in this Section. The following guidelines shall apply:

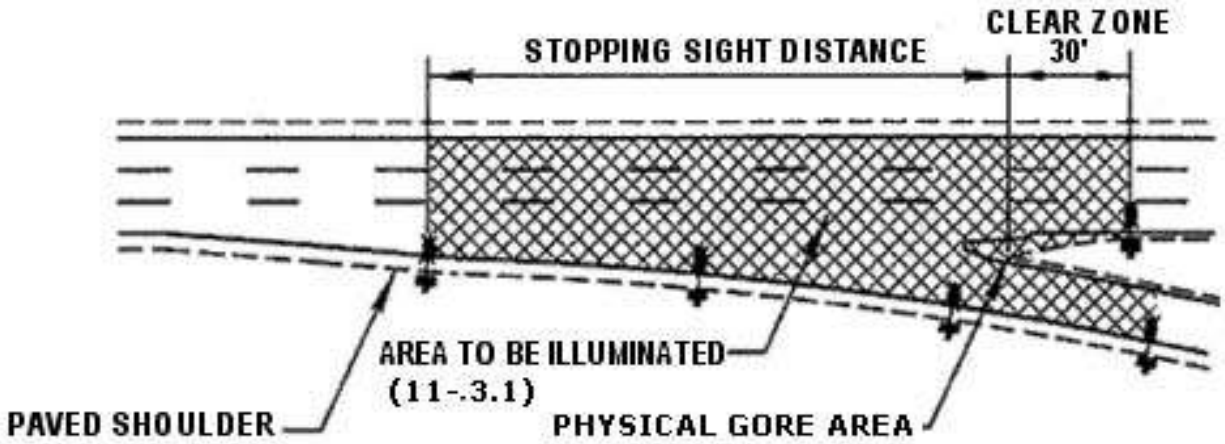
- The designer shall submit the proposed design as per 11.3.6 to the Bureau of Traffic Signal and Safety Engineering.
- The design shall conform to all other requirements of this section.
- Lighting standards, arms and luminaires mounted on top of parapets may be special nonstandard types.
- Lighting standards are mounted at grade. The standard may be anodized a color compatible with the area design scheme.
- The arm may be a special type, but must be capable of mounting on a Department lighting standard.
- The designer shall meet with the in the Bureau of Traffic Signal and Safety Engineering prior to beginning the design.

11.11 Mid-Block Pedestrian Crossings

Special considerations must be given to provide proper lighting within the designated crosswalk areas. Since these crossings are not at intersections, higher illuminance values than the standard roadway levels are required. Minimum average maintained illuminance within the crosswalk area shall be between 1.2 footcandles and 2.0 footcandles. Luminaires shall be placed approximately 10 ft. prior to the edge of the crosswalk in the direction of travel.

Higher values may be required depending upon the level of night time pedestrian activity and design circumstances, but must be approved in writing by NJDOT.

FREEWAYS MINIMUM LIGHTING STANDARDS	FIGURE 11-A BDC09MR-02



EXIT RAMP

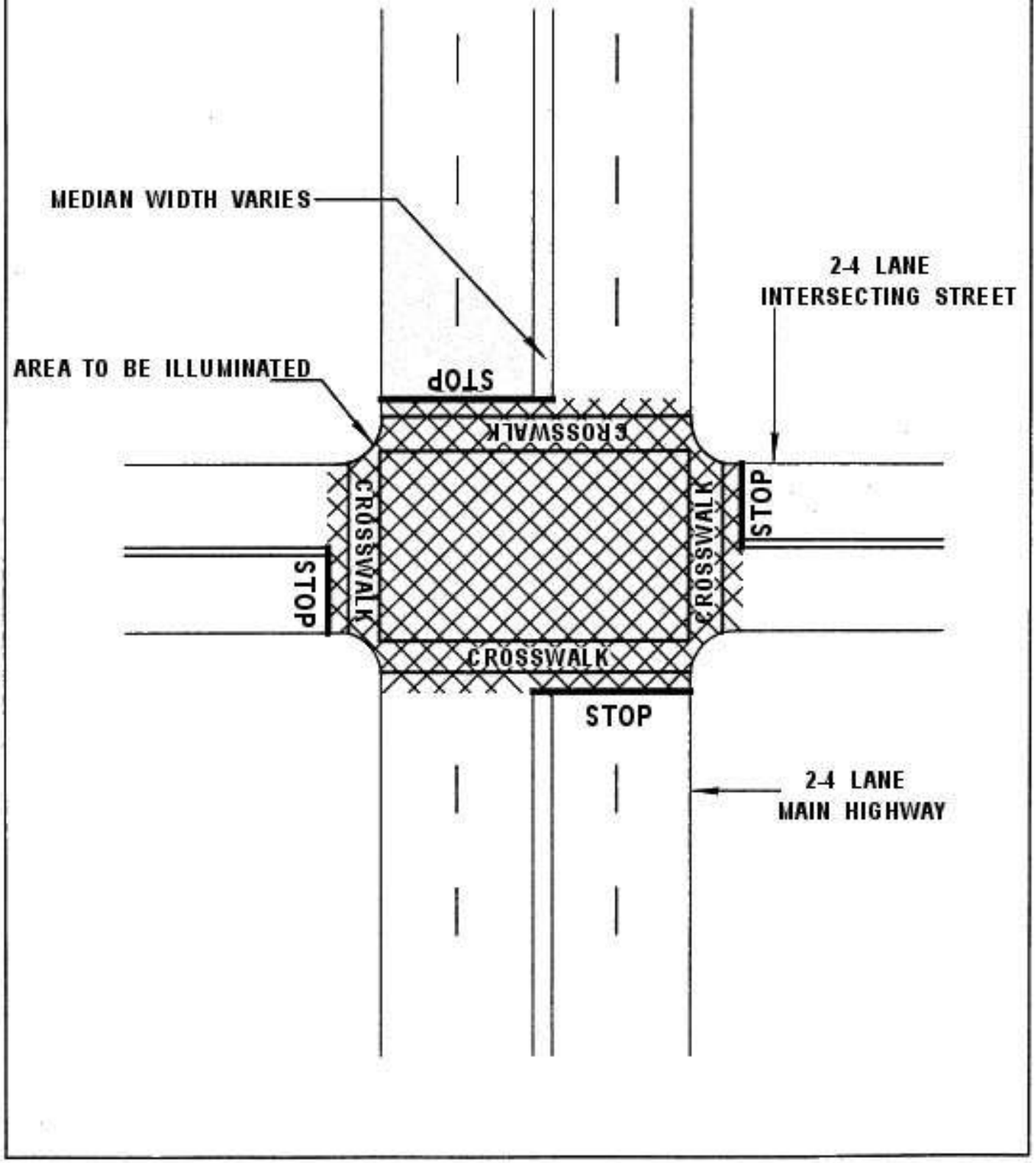
STOPPING SIGHT DISTANCES

65 MPH = 735 FT	45 MPH = 400 FT
55 MPH = 550 FT	40 MPH = 325 FT
50 MPH = 475 FT	35 MPH = 250 FT

NON-CONTROLLED ACCESS (LAND SERVICE) HIGHWAYS
SIGNALIZED OR NON-SIGNALIZED INTERSECTION
MINIMUM LIGHTING STANDARDS

FIGURE 11-B

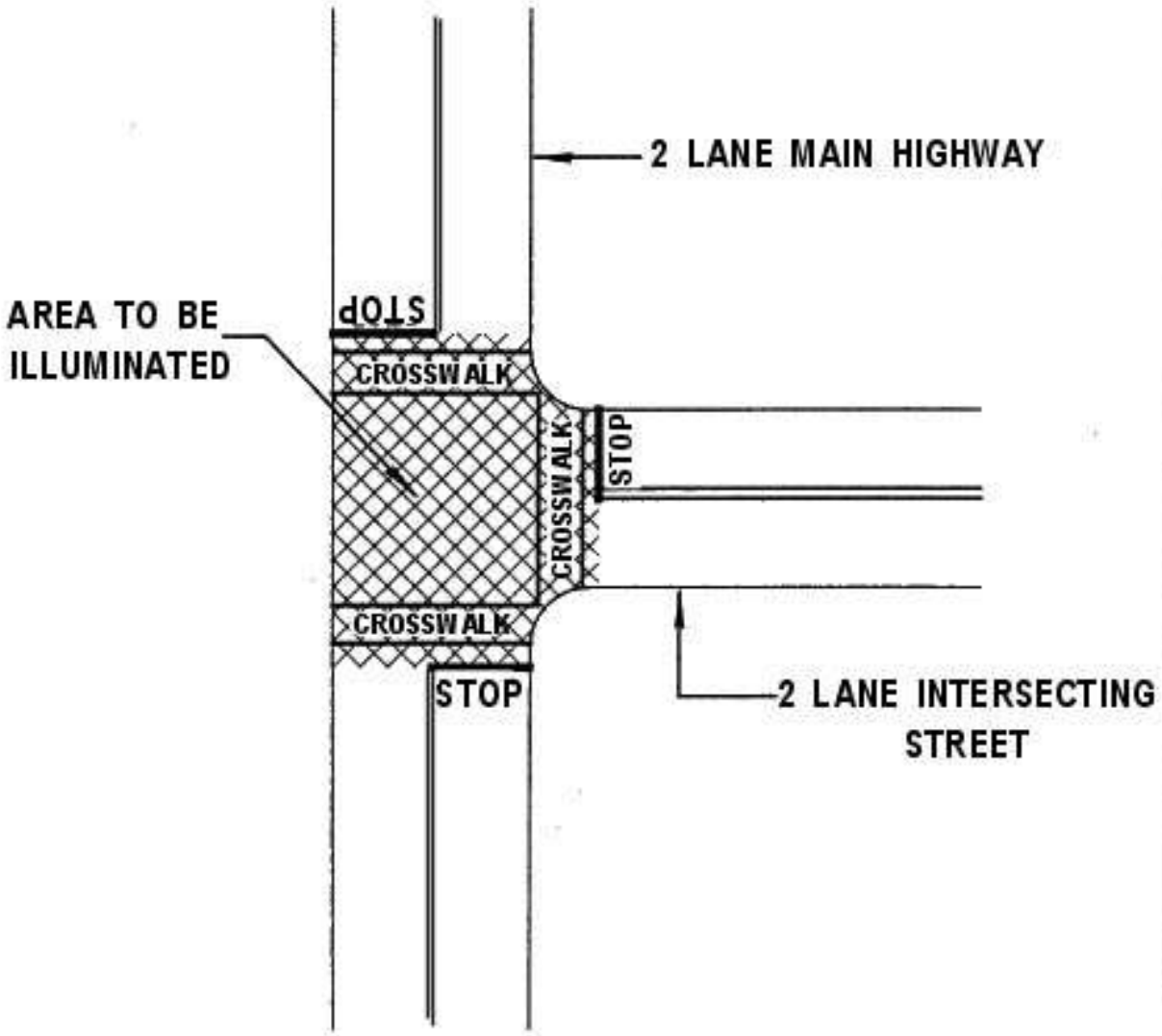
BDC09MR-02



NON- CONTROLLED ACCESS (LAND SERVICE) HIGHWAYS
MINIMUM LIGHTING STANDARDS
SIGNALIZED OR NON-SIGNALIZED "T" INTERSECTION

FIGURE 11-C

BDC09MR-02



EVALUATION FORM FOR CONTROLLED ACCESS FACILITY (CONTINUOUS FREEWAY LIGHTING)	**LIGHTING FORM 1**

CLASSIFICATION FACTOR	***RATING***					**UNLIT WEIGHT (A)**	**LIGHTED WEIGHT (B)**	**DIFF (A-B)**	**RATING X(A-B)**
	1	**2**	**3**	**4**	**5**				
GEOMETRIC FACTORS									
NUMBER OF LANES	4		6		≥8	1.0	0.8	0.2	
LANE WIDTH	>12'	12'	11'	10'	≤9'	3.0	2.5	0.5	
MEDIAN WIDTH	>40'	24'-39'	12'-23'	4'-11'	0-3'	1.0	0.5	0.5	
SHOULDERS	10'	8'	6'	4'	0	1.0	0.5	0.5	
SLOPES	≥8:1	6:1	4:1	3:1	2:1	1.0	0.5	0.5	
CURVES	0-½°	½-1°	1-2°	2-3°	3-4°	13.0	5.0	8.0	
GRADES	<3%	3.0-3.9%	4.0-4.9%	5.0-6.9%	>7%	3.2	2.8	0.4	
INTERCHANGE FREQUENCY	21,000'	16,000'	10,500'	5000'	<5,000'	4.0	1.0	3.0	
						GEOMETRIC TOTAL			
OPERATIONAL FACTORS									
LEVEL OF SERVICE (ANY DARK HOUR)	A	B	C	D	E	6.0	1.0	5.0	
						OPERATIONAL TOTAL			
ENVIRONMENTAL									
% DEVELOPMENT	0%	25%	50%	75%	100%	3.5	0.5	3.0	
OFFSET TO DEVELOPMENT	200'	150'	100'	50'	<50'	3.5	0.5	3.0	
						ENVIRONMENTAL TOTAL			
ACCIDENTS									
RATIO OF NIGHT-TO-DAY ACCIDENTS	1.0	1.0-1.2	1.2-1.5	1.5-2.0	2.0*	10.0	2.0	8.0	
						ACCIDENT TOTAL			

* CONTINUOUS LIGHTING WARRANTED

GEOMETRIC TOTAL =_____
OPERATIONAL TOTAL =_____
ENVIRONMENTAL TOTAL =_____
ACCIDENT TOTAL =_____

SUM = **POINTS**

WARRANTING CONDITION = **95 POINTS**

EVALUATION FORM FOR INTERCHANGE LIGHTING

LIGHTING FORM 2

CLASSIFICATION FACTOR	RATING 1	2	3	4	5	UNLIT WEIGHT (A)	LIGHTED WEIGHT (B)	DIFF (A-B)	RATING X(A-B)
GEOMETRIC FACTORS									
RAMP TYPES	DIRECT	DIAMOND	BUTTON HOOK CLOVERLEAF	TRUMPET	SCISSOR & LEFTSIDE	2.0	1.0	1.0	
CROSS ROAD CHANNELIZATION	NONE	-----	CONTINUOUS	-----	AT INTERCHANGE INTERSECTION	2.0	1.0	1.0	
FRONTAGE ROADS	NONE	-----	ONE WAY	-----	TWO WAY	1.5	1.0	0.5	
FREEWAY LANE WIDTH	>12'	12'	11'	10'	<10'	3.0	2.5	0.5	
FREEWAY MEDIAN WIDTH	>40'	34'-40'	12'-23'	4'-11'	<4'	1.0	0.5	0.5	
NUMBER OF FREEWAY LANES	≤4	-----	6	-----	≥8	1.0	0.8	0.2	
MAIN LANE CURVES	<½°	1-2°	2-3°	3-4°	>4°	13.0	5.0	8.0	
GRADES	<3%	3.0-3.9%	4.0-4.9%	5.0-6.9%	≥7%	3.2	2.8	0.4	
SIGHT DISTANCE CROSS ROAD INTERSECTION	>1,000'	700'-1,000'	500'-700'	400'-500'	<400'	2.0	1.8	0.2	
						GEOMETRIC TOTAL			
OPERATIONAL FACTORS									
LEVEL OF SERVICE (ANY DARK HOUR)	A	B	C	D	E	6.0	1.0	5.0	
						OPERATIONAL TOTAL			
ENVIRONMENTAL									
% DEVELOPMENT	NONE	1 QUAD	2 QUAD	3 QUAD	4 QUAD	2.0	0.5	1.5	
SET BACK DISTANCE	>200'	150'-200'	100'-150'	50'-100'	<50'	0.5	0.3	0.2	
CROSS ROAD APPROACH LIGHTING	NONE	-----	PARTIAL	-----	COMPLETE	3.0	2.0	1.0	
FREEWAY LIGHTING	NONE	-----	INTERCHANGE ONLY	-----	CONTINUOUS*	5.0	3.0	2.0	
						ENVIRONMENTAL TOTAL			
ACCIDENTS									
RATIO OF NIGHT-TO-DAY ACCIDENTS	<1.0	1.0-1.2	1.2-1.5	1.5-2.0	>2.0*	10.0	2.0	8.0	
						ACCIDENT TOTAL			

* COMPLETE LIGHTING WARRANTED

GEOMETRIC TOTAL =_____
OPERATIONAL TOTAL =_____
ENVIRONMENTAL TOTAL =_____
ACCIDENT TOTAL =_____
SUM =_____ POINTS
COMPLETE LIGHTING WARRANTING CONDITION = 90 POINTS
PARTIAL LIGHTING WARRANTING CONDITION = 60 POINTS

EVALUATION FORM FOR CONTROLLED ACCESS FACILITY (NEW ROADWAY/ALIGNMENT)	LIGHTING FORM 3

CLASSIFICATION FACTOR	RATING 1	2	3	4	5	UNLIT WEIGHT (A)	LIGHTED WEIGHT (B)	DIFF (A-B)	RATING X(A-B)
GEOMETRIC FACTORS									
NUMBER OF LANES	4		6		≥8	1.0	0.8	0.2	
LANE WIDTH	>12'	12'	11'	10'	≤9'	3.0	2.5	0.5	
MEDIAN WIDTH	>40'	24'-39'	12'-23'	4'-11'	0-3'	1.0	0.5	0.5	
SHOULDERS	10'	8'	6'	4'	0	1.0	0.5	0.5	
SLOPES	≥8:1	6:1	4:1	3:1	2:1	1.0	0.5	0.5	
CURVES	0-½°	½-1°	1-2°	2-3°	3-4°	13.0	5.0	8.0	
GRADES	<3%	3.0-3.9%	4.0-4.9%	5.0-6.9%	>7%	3.2	2.8	0.4	
INTERCHANGE FREQUENCY	21,000'	16,000'	10,500'	5,000'	<5,000'	4.0	1.0	3.0	
						GEOMETRIC TOTAL			
OPERATIONAL FACTORS									
LEVEL OF SERVICE (ANY DARK HOUR)	A	B	C	D	E	6.0	1.0	5.0	
						OPERATIONAL TOTAL			
ENVIRONMENTAL									
% DEVELOPMENT	0%	25%	50%	75%	100%	3.5	0.5	3.0	
OFFSET TO DEVELOPMENT	200'	150'	100'	50'	<50'	3.5	0.5	3.0	
						ENVIRONMENTAL TOTAL			

GEOMETRIC TOTAL =_____
OPERATIONAL TOTAL =_____
ENVIRONMENTAL TOTAL =_____

= POINTS

SUM

= 70 POINTS

WARRANTING CONDITION

EVALUATION FORM FOR INTERCHANGE LIGHTING (NEW ALIGNMENT)

LIGHTING FORM 4

CLASSIFICATION FACTOR	RATING 1	2	3	4	5	UNLIT WEIGHT (A)	LIGHTED WEIGHT (B)	DIFF (A-B)	RATING X(A-B)
GEOMETRIC FACTORS									
RAMP TYPES	DIRECT	DIAMOND	BUTTON HOOK CLOVERLEAF	TRUMPET	SCISSOR & LEFTSIDE	2.0	1.0	1.0	
CROSS ROAD CHANNELIZATION	NONE	-----	CONTINUOUS	-----	AT INTERCHANGE INTERSECTION	2.0	1.0	1.0	
FRONTAGE ROADS	NONE	-----	ONE WAY	-----	TWO WAY	1.5	1.0	0.5	
FREEWAY LANE WIDTH	>12'	12'	11'	10'	<10'	3.0	2.5	0.5	
FREEWAY MEDIAN WIDTH	>40'	34'-40'	12'-23'	4'-11'	<4'	1.0	0.5	0.5	
NUMBER OF FREEWAY LANES	≤4	-----	6	-----	≥8	1.0	0.8	0.2	
MAIN LANE CURVES	<½°	1-2°	2-3°	3-4°	>4°	13.0	5.0	8.0	
GRADES	<3%	3.0-3.9%	4.0-4.9%	5.0-6.9%	≥7%	3.2	2.8	0.4	
SIGHT DISTANCE CROSS ROAD INTERSECTION	>1,000'	700'-1,000'	500'-700'	400'-500'	<400'	2.0	1.8	0.2	
						GEOMETRIC TOTAL			
OPERATIONAL FACTORS									
LEVEL OF SERVICE (ANY DARK HOUR)	A	B	C	D	E	6.0	1.0	5.0	
						OPERATIONAL TOTAL			
ENVIRONMENTAL									
% DEVELOPMENT	NONE	1 QUAD	2 QUAD	3 QUAD	4 QUAD	2.0	0.5	1.5	
SET BACK DISTANCE	>200'	150'-200'	100'-150'	50'-100'	<50'	0.5	0.3	0.2	
CROSS ROAD APPROACH LIGHTING	NONE	-----	PARTIAL	-----	COMPLETE	3.0	2.0	1.0	
FREEWAY LIGHTING	NONE	-----	INTERCHANGE ONLY	-----	CONTINUOUS*	5.0	3.0	2.0	
						ENVIRONMENTAL TOTAL			

* COMPLETE LIGHTING WARRANTED

GEOMETRIC TOTAL =_____
OPERATIONAL TOTAL =_____
ENVIRONMENTAL TOTAL =_____

SUM =_____ POINTS
COMPLETE LIGHTING WARRANTING CONDITION = 65 POINTS
PARTIAL LIGHTING WARRANTING CONDITION = 35 POINTS

EVALUATION FORM FOR NON-CONTROLLED ACCESS FACILITY LIGHTING

LIGHTING FORM 5

CLASSIFICATION FACTOR	RATING 1	2	3	4	5	UNLIT WEIGHT (A)	LIGHTED WEIGHT (B)	DIFF (A-B)	RATING X(A-B)
GEOMETRIC									
NUMBER OF LANES	≤4	-----	6	-----	≥8	1.0	0.8	0.2	
LANE WIDTH	>12'	12'	11'	10'	<10'	3.0	2.5	0.5	
MEDIAN OPENING PER MILE	<4 OR ONE WAY	4.0-8.0	8.1-12.0	12.1-15.0	>15 OR NO ACCESS	5.0	3.0	2.0	
CURB CUTS	<10%	10-20%	20-30%	30-40%	>40%	5.0	3.0	2.0	
CURVES	<3.0°	3.1-6.0°	6.1-8.0°	8.1-10.0°	>10°	13.0	5.0	8.0	
GRADES	<3%	3.0-3.9%	4.0-4.9%	5.0-6.9%	>7.0%	3.2	2.8	0.4	
SIGHT DISTANCE	>700'	500'-700'	300'-500'	200'-300'	<200'	2.0	1.8	0.2	
PARKING	PROHIBITED BOTH SIDES	LOADING ZONE ONLY	OFF PEAK ONLY	PERMITTED ONE SIDE	PERMITTED BOTH SIDES	0.2	0.1	0.1	
						GEOMETRIC TOTAL			
OPERATIONAL									
SIGNALS	ALL MAJOR INTERSECTIONS	MAJORITY OF INTERSECTIONS	MOST MAJOR INTERSECTIONS	½ THE INTERSECTIONS	FREQUENT NON-SIGNALIZED INTERSECTIONS	3.0	2.8	0.2	
LEFT TURN LANE	ALL MAJOR INTERSECTIONS OR ONE WAY	MAJORITY OF INTERSECTIONS	MOST MAJOR INTERSECTIONS	½ MAJOR INTERSECTIONS	INFREQUENT OR UNDIVIDED STREET	5.0	4.0	1.0	
MEDIAN WIDTH	30'	20'-30'	10'-20'	4'-10'	0-4'	1.0	0.5	0.5	
SPEED LIMIT	≤25	30	35	40	≥45	1.0	0.2	0.8	
NIGHT PEDESTRIAN TRAFFIC (PEDS/KM)	FEW OR NONE	0-50	50-100	100-200	>200	1.5	0.5	1.0	
						OPERATIONAL TOTAL			
ENVIRONMENTAL									
% DEVELOPMENT	0%	0-30%	30-60%	60-90%	100%	0.5	0.3	0.2	
TYPE OF DEVELOPMENT	UNDEVELOPED	RESIDENTIAL	½ RESIDENTIAL AND/OR COMMERCIAL	INDUSTRIAL OR COMMERCIAL	STRIP INDUSTRY OR COMMERCIAL	0.5	0.3	0.2	
SET BACK DISTANCE	>200'	150'-200'	100'-150'	50'-100'	<50'	0.5	0.3	0.2	
ADVERTISING/AREA LIGHTING	NONE	0-40%	41-60%	61-80%	CONTINUOUS	3.0	1.0	2.0	
RAISED CURB MEDIAN	NONE	CONTINUOUS	AT ALL INTERSECTIONS	ALL SIGNALIZED INTERSECTIONS	FEW LOCATIONS	1.0	0.5	0.5	
CRIME RATE	EXTREMELY LOW	LOWER THAN CITY AVERAGE	CITY AVERAGE	HIGHER THAN CITY AVERAGE	EXTREMELY HIGH	1.0	0.5	0.5	
						ENVIRONMENTAL TOTAL			
ACCIDENTS									
RATIO OF NIGHT-TO-DAY ACCIDENTS	<1.0	1.0-1.2	1.2-1.5	1.5-2.0	>2.0*	10.0	2.0	8.0	
						ACCIDENT TOTAL			

* CONTINUOUS LIGHTING WARRANTED

GEOMETRIC TOTAL =_____
OPERATIONAL TOTAL =_____
ENVIRONMENTAL TOTAL =_____
ACCIDENT TOTAL =_____

SUM = **POINTS**
WARRANTING CONDITION = **85 POINTS**

EVALUATION FORM FOR NON-CONTROLLED ACCESS FACILITY LIGHTING (NEW ALIGNMENT)

LIGHTING FORM 6

CLASSIFICATION FACTOR	RATING 1	2	3	4	5	UNLIT WEIGHT (A)	LIGHTED WEIGHT (B)	DIFF (A-B)	RATING X(A-B)
GEOMETRIC									
NUMBER OF LANES	≤4	-----	6	-----	≥8	1.0	0.8	0.2	
LANE WIDTH	>12'	12'	11'	10'	<10'	3.0	2.5	0.5	
MEDIAN OPENING PER MILE	<4 OR ONE WAY	4.0-8.0	8.1-12.0	12.1-15.0	>15 OR NO ACCESS	5.0	3.0	2.0	
CURB CUTS	<10%	10-20%	20-30%	30-40%	>40%	5.0	3.0	2.0	
CURVES	<3.0°	3.1-6.0°	6.1-8.0°	8.1-10.0°	>10°	13.0	5.0	8.0	
GRADES	<3%	3.0-3.9%	4.0-4.9%	5.0-6.9%	>7.0%	3.2	2.8	0.4	
SIGHT DISTANCE	>700'	500'-700'	300'-500'	200'-300'	<200'	2.0	1.8	0.2	
PARKING	PROHIBITED BOTH SIDES	LOADING ZONE ONLY	OFF PEAK ONLY	PERMITTED ONE SIDE	PERMITTED BOTH SIDES	0.2	0.1	0.1	
						GEOMETRIC TOTAL			
OPERATIONAL									
SIGNALS	ALL MAJOR INTERSECTIONS	MAJORITY OF INTERSECTIONS	MOST MAJOR INTERSECTIONS	½ THE INTERSECTIONS	FREQUENT NON-SIGNALIZED INTERSECTIONS	3.0	2.8	0.2	
LEFT TURN LANE	ALL MAJOR INTERSECTIONS OR ONE WAY	MAJORITY OF INTERSECTIONS	MOST MAJOR INTERSECTIONS	½ MAJOR INTERSECTIONS	INFREQUENT OR UNDIVIDED STREET	5.0	4.0	1.0	
MEDIAN WIDTH	30'	20'-30'	10'-20'	4'-10'	0-4'	1.0	0.5	0.5	
SPEED LIMIT	≤25	30	35	40	≥45	1.0	0.2	0.8	
NIGHT PEDESTRIAN TRAFFIC (PEDS/KM)	FEW OR NONE	0-50	50-100	100-200	>200	1.5	0.5	1.0	
						OPERATIONAL TOTAL			
ENVIRONMENTAL									
% DEVELOPMENT	0%	0-30%	30-60%	60-90%	100%	0.5	0.3	0.2	
TYPE OF DEVELOPMENT	UNDEVELOPED	RESIDENTIAL	½ RESIDENTIAL AND/OR COMMERCIAL	INDUSTRIAL OR COMMERCIAL	STRIP INDUSTRY OR COMMERCIAL	0.5	0.3	0.2	
SET BACK DISTANCE	>200'	150'-200'	100'-150'	50'-100'	<50'	0.5	0.3	0.2	
ADVERTISING/AREA LIGHTING	NONE	0-40%	41-60%	61-80%	CONTINUOUS	3.0	1.0	2.0	
RAISED CURB MEDIAN	NONE	CONTINUOUS	AT ALL INTERSECTIONS	ALL SIGNALIZED INTERSECTIONS	FEW LOCATIONS	1.0	0.5	0.5	
CRIME RATE	EXTREMELY LOW	LOWER THAN CITY AVERAGE	CITY AVERAGE	HIGHER THAN CITY AVERAGE	EXTREMELY HIGH	1.0	0.5	0.5	
						ENVIRONMENTAL TOTAL			

GEOMETRIC TOTAL =_____
OPERATIONAL TOTAL =_____
ENVIRONMENTAL TOTAL =_____

SUM = **POINTS**
WARRANTING CONDITION = **60 POINTS**

EVALUATION FORM FOR INTERSECTION LIGHTING

LIGHTING FORM 7

CLASSIFICATION FACTOR	RATING 1	2	3	4	5	UNLIT WEIGHT (A)	LIGHTED WEIGHT (B)	DIFF (A-B)	RATING X(A-B)
GEOMETRIC									
NUMBER OF LEGS	-----	3	4	5	≥6 INCL TRAFFIC CIRCLE	3.0	2.5	0.5	
APPROACH LANE WIDTH	>12'	12'	11'	10'	<10'	3.0	2.5	0.5	
CHANNELIZATION	NO TURN LANES	LEFT TURN ON MAJOR LEG	LEFT TURN ALL LEGS-RIGHT TURN ON MAJOR LEGS	LEFT AND RIGHT TURN ON MAJOR LEGS	LEFT AND RIGHT TURN ON ALL LEGS	2.0	1.0	1.0	
CURVATURE ON APPROACH LEGS	<3.0°	3.1-6.0°	6.1-8.0°	8.1-10.0°	>10°	13.0	5.0	8.0	
GRADES ON APPROACH	<3%	3.0-3.9%	4.0-4.9%	5.0-6.9%	>7.0%	3.2	2.8	0.4	
APPROACH SIGHT DISTANCE	>700'	500'-700'	300'-500'	200'-300'	<200'	2.0	1.8	0.2	
PARKING	PROHIBITED BOTH SIDES	LOADING ZONE ONLY	OFF PEAK ONLY	PERMITTED ONE SIDE	PERMITTED BOTH SIDES	0.2	0.1	0.1	
						GEOMETRIC TOTAL			
OPERATIONAL									
TYPE OF CONTROL	ALL PHASES SIGNALIZED (INCL TURN LANE)	LEFT TURN LANE SIGNAL CONTROL	THRU TRAFFIC SIGNAL CONTROL ONLY	4-WAY STOP CONTROL	STOP CONTROL TO MINOR LEG OR NO CONTROL	3.0	2.7	0.3	
CHANNELIZATION	LEFT AND RIGHT SIGNAL CONTROL	LEFT AND RIGHT TURN LANE SIGNAL CONTROL MAJOR LEG	LEFT TURN LANE SIGNAL CONTROL ALL LEGS	LEFT TURN LANE SIGNAL CONTROL MAJOR LEG	NO TURN LANE CONTROL	3.0	2.0	1.0	
LEVEL OF SERVICE (LOAD FACTOR)	A 0	B 0-0.1	C 0.1-0.3	D 0.3-0.7	E 0.7-1.0	1.0	0.2	0.8	
SPEED LIMIT ON APPROACH LEGS	≤25	30	35	40	≥45	1.0	0.2	0.8	
NIGHT PEDESTRIAN TRAFFIC (PEDS/KM)	FEW OR NONE	0-50	50-100	100-200	>200	1.5	0.5	1.0	
						OPERATIONAL TOTAL			
ENVIRONMENTAL									
% DEVELOPMENT	0%	0-30%	30-60%	60-90%	100%	0.5	0.3	0.2	
TYPE OF DEVELOPMENT NEAR INTERSECTION	UNDEVELOPED	RESIDENTIAL	½ RESIDENTIAL AND/OR COMMERCIAL	INDUSTRIAL OR COMMERCIAL	STRIP INDUSTRY OR COMMERCIAL	0.5	0.3	0.2	
LIGHTING IN IMMEDIATE VICINITY	NONE	0-40%	41-60%	61-80%	CONTINUOUS	3.0	1.5	1.5	
CRIME RATE	EXTREMELY LOW	LOWER THAN CITY AVERAGE	CITY AVERAGE	HIGHER THAN CITY AVERAGE	EXTREMELY HIGH	1.0	0.5	0.5	
						ENVIRONMENTAL TOTAL			
ACCIDENTS									
RATIO OF NIGHT-TO-DAY ACCIDENTS	<1.0	1.0-1.2	1.2-1.5	1.5-2.0	>2.0*	10.0	2.0	8.0	
						ACCIDENT TOTAL			

* CONTINUOUS LIGHTING WARRANTED

GEOMETRIC TOTAL =_____
OPERATIONAL TOTAL =_____
ENVIRONMENTAL TOTAL =_____
ACCIDENT TOTAL =_____

SUM =_____ **POINTS**
WARRANTING CONDITION = **75 POINTS**

EVALUATION FORM FOR INTERSECTION LIGHTING (NEW ROADWAY/ALIGNMENT)

LIGHTING FORM 8

CLASSIFICATION FACTOR	RATING 1	2	3	4	5	UNLIT WEIGHT (A)	LIGHTED WEIGHT (B)	DIFF (A-B)	RATING X(A-B)
GEOMETRIC									
NUMBER OF LEGS	-----	3	4	5	≥6 INCL TRAFFIC CIRCLE	3.0	2.5	0.5	
APPROACH LANE WIDTH	>12'	12'	11'	10'	<10'	3.0	2.5	0.5	
CHANNELIZATION	NO TURN LANES	LEFT TURN ON MAJOR LEG	LEFT TURN ALL LEGS-RIGHT TURN ON MAJOR LEGS	LEFT AND RIGHT TURN ON MAJOR LEGS	LEFT AND RIGHT TURN ON ALL LEGS	2.0	1.0	1.0	
CURVATURE ON APPROACH LEGS	<3.0°	3.1-6.0°	6.1-8.0°	8.1-10.0°	>10°	13.0	5.0	8.0	
GRADES ON APPROACH	<3%	3.0-3.9%	4.0-4.9%	5.0-6.9%	>7.0%	3.2	2.8	0.4	
APPROACH SIGHT DISTANCE	>700'	500'-700'	300'-500'	200'-300'	<200'	2.0	1.8	0.2	
PARKING	PROHIBITED BOTH SIDES	LOADING ZONE ONLY	OFF PEAK ONLY	PERMITTED ONE SIDE	PERMITTED BOTH SIDES	0.2	0.1	0.1	
						GEOMETRIC TOTAL			
OPERATIONAL									
TYPE OF CONTROL	ALL PHASES SIGNALIZED (INCL TURN LANE)	LEFT TURN LANE SIGNAL CONTROL	THRU TRAFFIC SIGNAL CONTROL ONLY	4-WAY STOP CONTROL	STOP CONTROL TO MINOR LEG OR NO CONTROL	3.0	2.7	0.3	
CHANNELIZATION	LEFT AND RIGHT SIGNAL CONTROL	LEFT AND RIGHT TURN LANE SIGNAL CONTROL MAJOR LEG	LEFT TURN LANE SIGNAL CONTROL ALL LEGS	LEFT TURN LANE SIGNAL CONTROL MAJOR LEG	NO TURN LANE CONTROL	3.0	2.0	1.0	
LEVEL OF SERVICE (LOAD FACTOR)	A 0	B 0-0.1	C 0.1-0.3	D 0.3-0.7	E 0.7-1.0	1.0	0.2	0.8	
SPEED LIMIT ON APPROACH LEGS	≤25	30	35	40	≥45	1.0	0.2	0.8	
NIGHT PEDESTRIAN TRAFFIC (PEDS/KM)	FEW OR NONE	0-50	50-100	100-200	>200	1.5	0.5	1.0	
						OPERATIONAL TOTAL			
ENVIRONMENTAL									
% DEVELOPMENT	0%	0-30%	30-60%	60-90%	100%	0.5	0.3	0.2	
TYPE OF DEVELOPMENT NEAR INTERSECTION	UNDEVELOPED	RESIDENTIAL	½ RESIDENTIAL AND/OR COMMERCIAL	INDUSTRIAL OR COMMERCIAL	STRIP INDUSTRY OR COMMERCIAL	0.5	0.3	0.2	
LIGHTING IN IMMEDIATE VICINITY	NONE	0-40%	41-60%	61-80%	CONTINUOUS	3.0	1.5	1.5	
CRIME RATE	EXTREMELY LOW	LOWER THAN CITY AVERAGE	CITY AVERAGE	HIGHER THAN CITY AVERAGE	EXTREMELY HIGH	1.0	0.5	0.5	
						ENVIRONMENTAL TOTAL			

GEOMETRIC TOTAL =_____
OPERATIONAL TOTAL =_____
ENVIRONMENTAL TOTAL =_____

SUM =_____ **POINTS**
WARRANTING CONDITION = **50 POINTS**

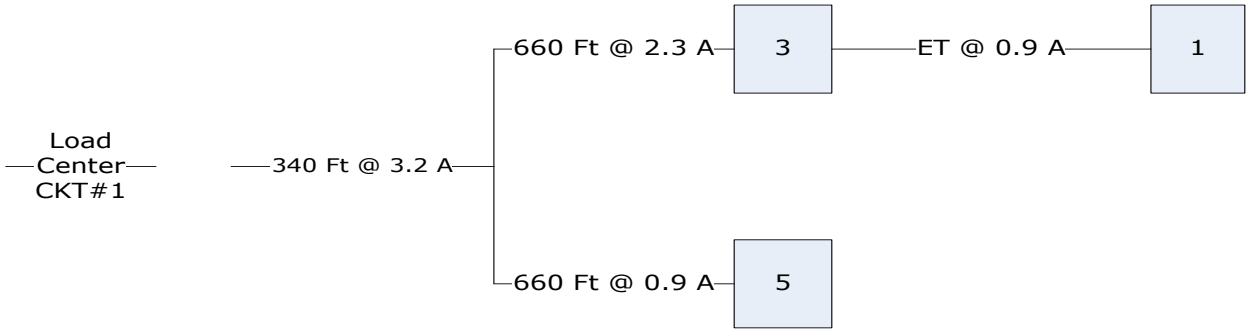
Voltage Drop Calculation Method

The total voltage drop in a highway lighting circuit is calculated by solving for the voltage drop in each branch of the circuit. In a simple circuit, the voltage drop in each section of a circuit is equal to the total current flowing in the section multiplied by the total impedance of the wire used in the section. The total voltage drop in each branch my not exceed 3%. Expressing this in equation form yields:

(V)		(I)		(Z)
VOLTAGE DROP IN EACH SECTION	**=**	**CURRENT IN EACH SECTION**	*****	**IMPEDANCE OF EACH SECTION**

The current (I) flowing in each section is equal to the sum of the currents drawn by the luminaires in the circuit behind the section.
The total impedance (Z) of a section is equal to the impedance of the cable in that section (including the neutral wire).

SAMPLE VOLTAGE DROP CALCULATION



Circuit voltage is 240 volts.

Luminaires #1 and #5 are 150 watt HPS (0.9 A each).

Luminaire #3 is 250 watt HPS (1.4 A each).

Wire size is # 2 AWG (0.20 ohms/1,000 feet).

SECTION NO.	FROM	TO	(I) CURRENT (amps)	LENGTH OF WIRE (feet)	(Z) IMPEDANCE (ohms)	(V) VOLTAGE DROP (volts)
BRANCH “A”						
1	L.C.	# 3	2.3	(1,000’) 2	(2,000’)(.001)(.20)	0.92
2	# 3	# 1	0.9	(500’) 2	(1,000’)(.001)(.20)	0.18
BRANCH “B”						
1	L.C.	# 5	0.9	(1,000’) 2	(2,000’)(.001)(.20)	0.36

Total Voltage Drop of Branch “A” = (0.92 v) + (0.18 v) = 1.10 volts
Percent Voltage Drop of Branch “A” = (1.10 v) / (240 v) * 100 % = 0.46 %
Percent Voltage Drop of Branch “B” = (0.36 v) / (240 v) * 100 % = 0.15 %

VOLTAGE DROP FORM 1

VOLTAGE DROP CALCULATION WORKSHEET

PROJECT:_____

LOAD CENTER:_____CIRCUIT DESIGNATION:_____

NUMBER OF LAMPS (TOTAL):_____TOTAL LOAD:_____Amps

LAMP TYPES & QUANTITY:_____

LAMP NUMBERS:_____

WIRE SIZE (AWG)	RESISTANCE PER 1,000 FEET
# 8	0.78 ohms
# 6	0.49 ohms
# 4	0.31 ohms
# 2	0.20 ohms
# 1/0	0.12 ohms

LAMP TYPE	LAMP CURRENT INCLUDING BALLAST AT 240 VOLTS
150 W HPS	0.9 / 1.5 amps
250 W HPS	1.3 amps
400 W HPS	2.0 amps
250 W MV	1.3 amps

WIRE SIZE USED:_____

NUMBER OF BRANCHES:_____

SECTION NO.	FROM	TO	(I) CURRENT (amps)	LENGTH OF WIRE (feet)	(Z) IMPEDANCE (ohms)	(V) VOLTAGE DROP (volts)

TOTAL VOLTAGE DROP OF BRANCH "A" =_____Volts

PERCENT VOLTAGE DROP OF BRANCH "A" =_____

TOTAL VOLTAGE DROP OF BRANCH "B" =_____Volts

PERCENT VOLTAGE DROP OF BRANCH "B" =_____

SKETCH:

VOLTAGE DROP FORM 2