



FRANCIS
KRAHE
& ASSOCIATES

The Bradbury Building
304 South Broadway, Suite 203
Los Angeles, CA 90013

+1 213 617 0477
fkaild.com

San Diego State University

**Evolve Student Housing, University Towers East
Component**

San Diego, California

EXTERIOR LIGHTING AND GLARE STUDY

Prepared for: Dudek

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1. INTRODUCTION

The San Diego State University (SDSU) University Towers East Component Exterior Lighting Study (Study) is prepared by Francis Krahe & Associates Inc. to analyze the potential lighting impacts to adjacent sensitive properties from proposed new exterior building and site lighting associated with the redevelopment of the San Diego State University University Towers East Component located at 5527-5573 Montezuma Road in San Diego, California (Project). San Diego State University, proposes to demolish the existing surface parking lot and site elements to allow for redevelopment with a new 9-story student housing apartment building with approximately 720 beds and associated site landscaping, pedestrian pathways, and seating area.

This Study reviews the parameters that affect Light Trespass and Glare (each as defined in section 4 below), reviews relevant lighting metrics and regulations pertaining to exterior artificial lighting, examines the existing lighting conditions within and surrounding the Project site, and evaluates the Project's artificial exterior lighting to identify the potential lighting environmental impacts.

The methods of analysis utilized for this Study are based upon the recommended practices established by the Illuminating Engineering Society of North America (IESNA) for the practice of illumination engineering design and application, and the actual measurements of light sources and illuminated surfaces. IESNA reference publications include: American National Standards Institute (ANSI)/Illuminating Engineering Society (IES) OL-IM-01 Lighting Science Standards; ANSI/IES OL-IM-02 Lighting Practice Standards; ANSI/IES OL-IM-03 Lighting Applications Standards; ANSI/IES OL-IM-04 Lighting Measurements and Testing Standards; and ANSI/IES OL-IM-05 Lighting Roadway and Parking Facilities Standards. The ANSI/IES Standards replace the IESNA 10th Edition Handbook and all various references published by IESNA prior to 2011.

2. PROJECT DESCRIPTION

The Proposed Project is the construction and development of new student housing, dining, and auxiliary uses on and adjacent to SDSU's main campus. The Proposed Project is comprised of two components - the Peninsula Component, which would be located adjacent to the main SDSU campus at the northern terminus of 55th Street; and the University Towers East Component, which would be located east and immediately adjacent to the existing University Towers on Montezuma Road.

The proposed University Towers East Component would be developed on an approximately 1.1-acre site located immediately east of the existing University Towers Building, south of Montezuma Road. The existing parking lot would be demolished to allow for redevelopment of the site to include a new 9-story student housing building that would accommodate approximately 720 students.

This Study examines lighting associated with the University Towers East Component.

The Project is located in a relatively topographically flat area. SDSU campus housing buildings exist to the west and north of the Project. Residential properties exist to the south and east of the Project site. Figure 1 below illustrates the Project site and surrounding context. The Project site is shaded in blue, while adjacent residential properties are shaded in red.

The Project site is currently used as a parking lot for the existing University Towers student housing. The existing conditions at the Project site include asphalt paved parking lot drive aisles and parking stalls, palm trees, area lights, and other site features.

The Project includes exterior site lighting to illuminate the perimeter of the property and hardscape throughout the Project site. The Conceptual Project Exterior Site Lighting (Appendix A) includes an example of a lighting fixture product specification for site lighting throughout the Project site.

The Project would include the following Project Design Features relating to exterior lighting to specifically control Light Trespass and Glare at adjacent sensitive residential properties:

PDF-1: Project site exterior lighting will be shielded and aimed away from the Project site property line, and installed in such manner to limit Light Trespass to 0.74 footcandles maximum at sensitive residential properties.

PDF-2: Site light fixtures at perimeter of the property will comply with CALGreen Backlight, Uplight, and Glare (BUG) requirements, including the use of backlight shields, and installed in such manner to limit maximum surface luminance visible from any residential use to 100 cd/m² to prevent glare.

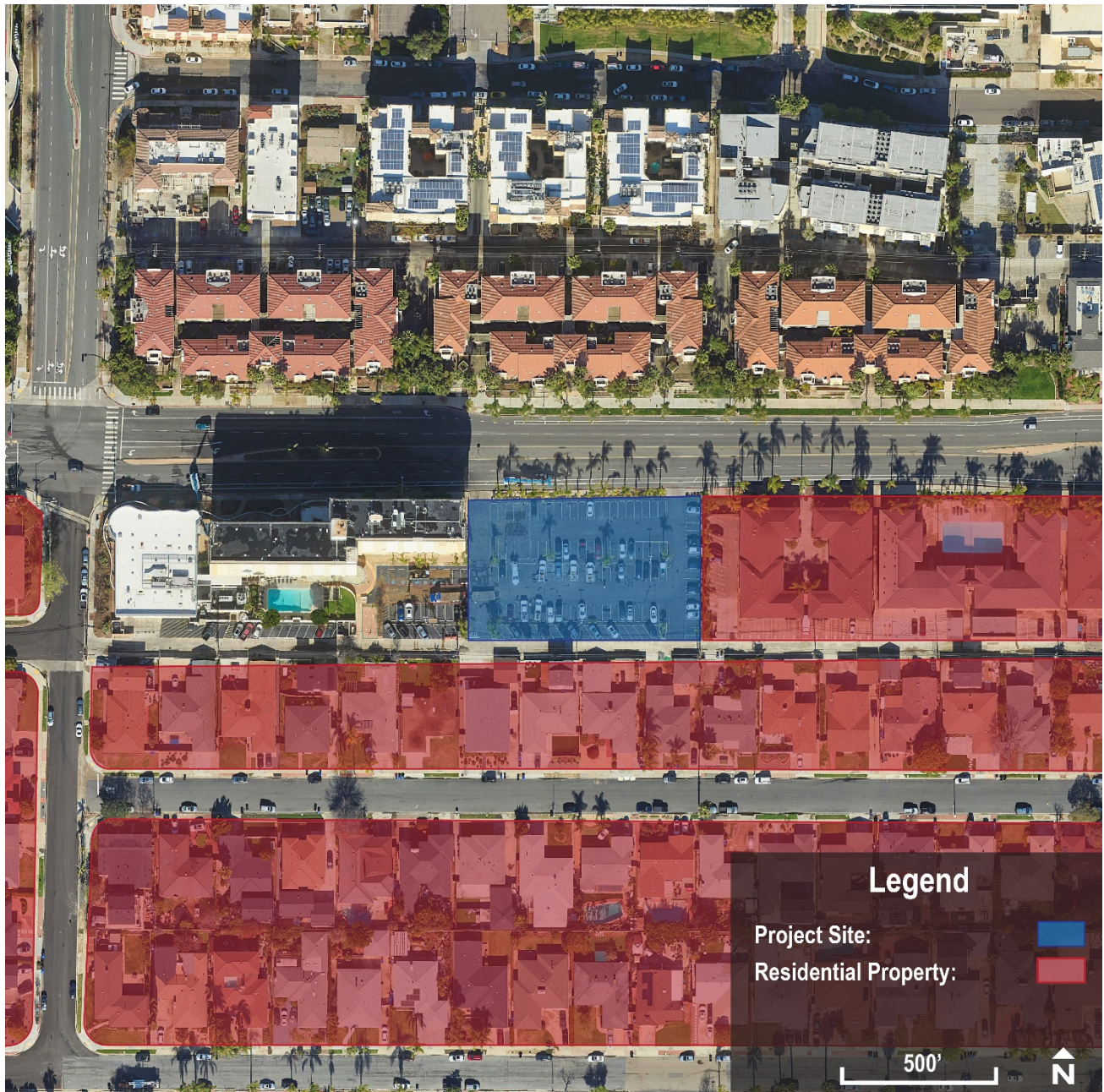


Figure 1: Project Site Diagram

3. SUMMARY OF LIGHT TRESPASS AND GLARE

This Study evaluates potential environmental impacts from the Project's exterior lighting that would be authorized by approval of the proposed Project. Light from the Project may affect the environmental conditions at surrounding properties with respect to Light Trespass or Glare. For this Study, light from the Project is analyzed at sensitive properties where additional light from the Project may substantially impact the use of these properties. Sensitive properties are defined in this study as residential use properties and or sensitive natural habitats. Other sensitive properties may include outdoor dining facilities, hotel properties, or hospitals, which are not present in the vicinity of the Project site. Commercial use properties, such as office buildings or retail stores are not considered sensitive properties because additional light at these property uses does not adversely affect the use of the property. Sensitive properties nearest to the Project are evaluated. Light

intensity decreases exponentially with distance¹ therefore more distant properties would receive much less light from the Project.

Environmental impacts from the Project at sensitive properties are evaluated with respect to Light Trespass and Glare; These two terms are defined and described in Section 4 Lighting Glossary, below. Light Trespass occurs when light from the Project leaves the Project site and reaches a sensitive property. Glare occurs where the Project lighting is visible and the Project light source luminance is substantially brighter than the background luminance when viewing the Project from a sensitive property. Glare describes the discomfort or reduced visibility from very bright surfaces. Glare may occur either during the day or night, while Light Trespass occurs only at night.

3.1 Light Trespass

This Study concludes the Project would not create high Light Trespass illuminance exceeding 0.74 fc at sensitive residential properties, as per Project Design Feature PDF-1. This Project Design Feature stipulates that exterior lighting will be shielded and aimed away from the Project site property line to limit Light Trespass to 0.74 fc maximum at sensitive residential properties. Therefore, the Project would not create a significant Light Trespass impact.

3.2 Glare

This Study demonstrates the Project will not create a significant source of Glare because the Project will not create new high contrast conditions visible at adjacent sensitive residential properties. This Study analyzes the proposed building and site improvements, and considers the visibility of the Project lighting fixtures from the adjacent residential properties. The Project lights will be visible from sensitive residential properties offsite. However, CALGreen and Project Design Feature PDF-2 limit site light source brightness to 100 cd/m² which will not present a high contrast condition with greater than 30:1 Contrast Ratio at any sensitive residential properties. The Contrast Ratio compares the maximum Project luminance to the existing average luminance measured at the Monitoring Sites which are adjacent to the sensitive residential properties, and are defined below in Section 7.1a and analyzed in Section 8. Therefore, the Project will not create a new Glare condition at adjacent sensitive residential properties.

Light intensity degrades exponentially with distance. Therefore, sensitive properties which are more distant than the locations analyzed in this Study will receive substantially less light from the Project. In addition, light sources within the Project will not be visible at these more distant locations. Therefore, the Project will not create Contrast Ratios exceeding 30:1 and there will be no Light Trespass or Glare impacts at locations more distant than the Monitoring Sites.

4. LIGHTING GLOSSARY

Discussions of lighting issues include precise definitions, descriptions or terminology of the specific lighting technical parameters. The following glossary summarizes explanations of the technical lighting terms utilized in this Study and the related practice standards. The following technical terms are used in this Study.

Brightness:	The magnitude of sensation that results from viewing surfaces from which light comes to the eye. This sensation is determined partly by the measurable luminance of the source and partly by the conditions of observation (Context), such as the state of adaptation of the eye. For example, very bright lamps at
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¹ Inverse Square Law

night appear dim during the day, because the eye adapts to the higher brightness of daylight.

BUG Rating:

A luminaire classification system established in *IES TM-15-11*, BUG Ratings Addendum that provides for uniform assessment of the directional characteristics of illumination for exterior area lighting. BUG is an acronym composed of Backlight, Up light, and Glare. BUG ratings are based on a zonal lumen calculation for secondary solid angles defined in *IES TM-15-11*.

Candela:

Measure of light energy from a source at a specific standard angle and distance. Candela (cd) is a convenient measure to evaluate output of light from a lamp or light fixture in terms of both the intensity of light and the direction of travel of the light energy away from the source.

Contrast:

Calculated evaluation of high, medium and low contrast of visible light sources or surfaces within the Property by a ratio of luminance. Contrast is the ratio of one surface luminance to a second surface luminance or to the field of view. Contrast exceeding 30 to 1 are usually deemed uncomfortable; 10 to 1 are clearly visible; and less than 3 to 1 appear to be equal.

Fully Shielded:

A lighting fixture constructed in such a manner that all light emitted by the fixture, either directly from the lamp or a diffusing element, or indirectly by reflection or refraction from any part of the Luminaire, is projected below the horizontal as determined by photometric test or certified by the manufacturer. Any structural part of the light fixture providing this shielding must be permanently affixed. In other words, no light shines above the horizontal from any part of the fixture.

Glare:

The sensation produced by luminances within the visual field that are sufficiently greater than the luminance to which the eyes are adapted to cause annoyance, discomfort, or loss in visual performance or visibility.

For exterior environments at night, Glare occurs when the range of luminance in a visual field is too large. The light energy incident at a point is measured by a scale of footcandles or lux and is described in the technical term Illuminance. This incident light is not visible to the eye until it is reflected from a surface, such as pavement, wall, dust in the atmosphere or the surface of a light bulb. The visible brightness of a surface is measured in footlamberts (or metric equivalent candelas per square meter) and is described by the term Luminance.

The human eye processes brightness variations across a very broad spectrum of intensities. The range of brightness generated by direct noon sun versus a moonlight evening is over 5000 to 1. Human eyes are capable of accommodating to this range of intensities given adequate time to adjust. However, the eye cannot process brightness ratios of more than 30 to 1 within a view without discomfort. See IESNA 10th Edition Handbook, Section 4.10.1, Discomfort Glare and Section 10.9.2 Calculating Glare.

Also see definitions for "Disability Glare", "Blinding Glare", "Discomfort Glare", "Discomfort Glare Rating", "Direct Glare", "Reflected Glare".

For the purpose of this analysis, brightness of light sources may be described subjectively by the following criteria:

High Contrast Conditions: View of light fixture emitting surface, such as a lens, reflector, or lamp, where brightness contrast ratio exceeds 30 to 1 (source Luminance to background Luminance ratio in footlamberts).

Medium Contrast Conditions: Brightly lighted surfaces where contrast ratio exceeds 10 to 1 but is less than 30 to 1 (source Luminance to background Luminance ratio in footlamberts).

Low Contrast Conditions: Illuminated surfaces where contrast ratio is less than 10 to 1 (source Luminance to background Luminance ratio in footlamberts).

Illuminance:

Illuminance is the means of evaluating the density of Luminous Flux. Illuminance indicates the amount of Luminous Flux from a light source falling on a given area. Illuminance is measured in footcandles (fc) which is the lumens per square foot, or Lux (lumens per square meter). Illuminance need not necessarily be related to a real surface since it may be measured at any point within a space. Illuminance is determined from the Luminous intensity of the light source. Illuminance of a point source decreases with the square of the distance from the light source (see Inverse Square Law definition).

For the purposes of this analysis, illuminance may be described subjectively by the following criteria:

High Illuminance: Illuminance greater than 0.74 footcandles.

Medium Illuminance: Illuminance less than 0.74 footcandles and greater than 0.09 footcandles.

Low Illuminance: Illuminance less than 0.09 footcandles.

Horizontal Illuminance:

Illuminance incident upon a horizontal plane. The orientation of the illuminance meter or calculation point will be 180° from Nadir.

Vertical Illuminance:

Illuminance incident upon a vertical plane. The orientation of the illuminance meter or calculation point will be 90° from Nadir.

Inverse Square Law:

In physics, an inverse-square law is any physical law stating that a specified physical quantity or intensity is inversely proportional to the square of the distance from the source of that physical quantity. The fundamental cause for this relationship can be understood as geometric dilution corresponding to point-source radiation into three-dimensional space (see Figure 2). The divergence of a vector field which is the resultant of radial inverse-square law fields with respect to one or more sources is everywhere proportional to the strength of the local sources, and hence zero outside sources. Newton's law of universal gravitation follows an inverse-square law, as do the effects of

electric, magnetic, light, sound, and radiation phenomena. Thus, Illuminance decreases with the square of the distance from the light source.

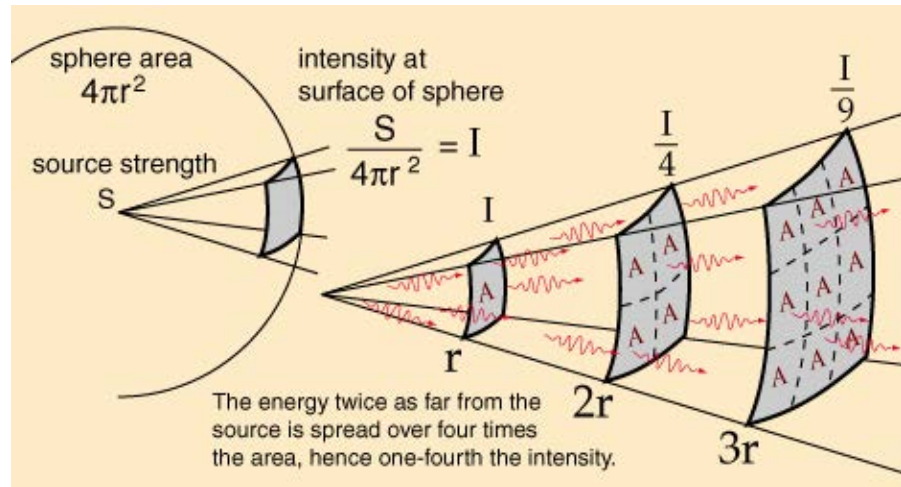


Figure 2: Inverse square law diagram (hyperphysics.phy-astr.gsu.edu)

Output Direction:

Luminaires for general lighting are classified in accordance with the percentages of total luminaire output emitted above and below horizontal. The light distribution curves may take many forms within the limits of upward and downward distribution, depending upon the type of light and the design of the luminaire.

Lighting Array:

An installation of multiple light sources or lamps where the distance between each lamp or light source within the Lighting Array is less than 5 feet on center in any direction from any other source.

Light Source:

Device which emits light energy from an electric power source.

Light Trespass:

The encroachment of light, typically across property boundaries, causing annoyance, loss of privacy, or other nuisance.

Lighting Zone (LZ):

Defined by IESNA and summarized on pages 10 and 11 in the LP-11-20 Environmental Considerations for Outdoor Lighting and adopted by CALGreen.

Lighting Zone LZ3:

Outdoor areas of human activity where the vision of human residents and users is adapted to moderately high light levels. Lighting is generally desired for safety, security and/or convenience.

Luminaire:

A complete lighting unit consisting of a light source together with the parts designed to distribute the light, to position and protect the light source, and to connect the light source to the power supply. Also referred to as a Light Fixture.

Luminance:

Luminance is a measure of emissive or reflected light from a specific surface in a specific direction over a standard area. Luminance is measured in

footlamberts (fL) ($1/\pi$ Candela per square foot) or cd/m^2 (Candela per square meter). $1\text{fL} = 3.43 \text{ cd}/\text{m}^2$.

Whereas Illuminance indicates the amount of Luminous Flux falling on a given surface, Luminance describes the brightness of an illuminated or luminous surface. Luminance is defined as the ratio of luminous intensity of a surface (Candela) to the projected area of this surface (m^2 or ft^2).

Luminous Flux:

Mean value of total Candelas produced by a light source. Luminous Flux describes the total amount of light emitted by a light source. The unit for measuring Luminous Flux is Lumen (lm).

This radiation could basically be measured or expressed in watts. This does not, however, describe the optical effect of a light source adequately, since the varying spectral sensitivity of the eye is not taken into account. To include the spectral sensitivity of the eye the Luminous Flux is measured in lumen. Radiant Flux or 1 W emitted at the peak of the spectral sensitivity (in the photopic range at 555 nanometers produces a Luminous Flux of 683 lumen). The unit of lumen does not define direction.

Monitoring Sites:

Monitoring Sites are locations selected for observation and field lighting measurements to evaluate the views to the Project site from adjacent sensitive properties and to determine the extent and intensity of existing light sources within and surrounding the Project site. The Monitoring Sites are within the public right of way, and may be adjacent to sensitive sites. These locations are representative of the view to the Project from the vicinity of the sensitive sites surrounding the Project site to the north, south, east and west. Figure 4 below illustrates the Monitoring Site locations.

5. REVIEW OF LIGHTING REGULATIONS AND REFERENCE STANDARDS

Exterior lighting regulations that apply to this Project are the California energy and building codes including the California Green Building Code (CALGreen) and the California Energy Code (CEC). Reference standards include model lighting ordinances provided by the Illuminating Engineering Society of North America (IESNA) and the International Dark Sky Organization. Various aspects of these reference standards are included in regulations to improve the outcomes of any approved project and avoid future disputes or legal challenges to proposed exterior building and site lighting. The lighting standards summarized below balance the requirements of property owners for sufficient brightness, with minimizing the off-site negative effects of Light Trespass and Glare.

5.1 California Code of Regulations, Title 24 (California Building Standards Code)

Title 24 of the California Code of Regulations (CCR), also known as the California Building Standards Code, consists of regulations to control building standards throughout the State. The following components of Title 24 include standards related to exterior building and site lighting:

2022 Building Energy Efficiency Standards (Title 24, Part 6)

The 2022 Building Energy Efficiency Standards, also referred to the California Energy Code (CEC), stipulates allowances for lighting power and provides lighting control requirements for various lighting systems, with the aim of reducing energy consumption through efficient and effective use of lighting equipment.

2022 California Green Building Standards Code (Title 24, Part 11)

The 2022 California Green Building Standards Code, which is Part 11 of Title 24, is commonly referred to as the CALGreen Code. Paragraph 5.106.8, Light Pollution Reduction (included herein as Appendix B), requires that all non-residential outdoor lighting must comply with the following requirements:

“The minimum requirements in the CEC for Lighting Zones 1 – 4 as defined in Chapter 10 of the California Administrative Code; and

“Comply with a local ordinance lawfully enacted pursuant to Section 101.7, whichever is more stringent.”

Further requirements and exceptions are defined in 2022 Building Energy Efficiency Standards, Title 24 Part 6, Section 140.7 PRESCRIPTIVE REQUIREMENTS FOR OUTDOOR LIGHTING. Section 140.7 (see Appendix C) includes the following exceptions which apply to the Project exterior lighting:

“**Exceptions to Section 140.7(a):** When more than 50 percent of the light from a luminaire falls within one or more of the following applications for the lighting power for that luminaire shall be exempt from Section 140.7:

....

“9. Landscape lighting.”

The 2022 Building Energy Efficiency Standards, Title 24 Part 6 includes the following requirements which apply to Glare in Section 130.2 Outdoor Lighting Controls and Equipment (Appendix D):

Section 130.2 OUTDOOR LIGHTING CONTROLS AND EQUIPMENT

“(b) Luminaire cutoff requirements. All outdoor luminaire of 6,200 initial luminaire lumens or greater, shall comply with backlight, uplight, and glare (collectively referred to as “BUG” in accordance with IES TM-15-11, Addendum A) requirements as follows:

1. Maximum zonal lumens for backlight, uplight, and glare shall be in accordance with Title 24, Part 11, Section 5.106.8.

Project light fixtures with less than 6,200 lumens are exempt from the requirements of Section 130.2.

5.2 California Energy Code Lighting Zone LZ3

The Project site and surrounding properties are within a suburban, institutional, and residential zone with extensive nighttime use, including the existing student housing apartment buildings, nearby residences to the west and north, and nearby SDSU facilities. Current best practices for lighting standards recognize the unique issues related to night time use adjacent to light sensitive locations. The California Administrative Code Table 10-114-A (Appendix E) includes designations for Lighting Zones (LZ) 1 through 4, which correspond to the Light Trespass Illuminance recommendations published by IESNA. The IESNA recommendations (Appendix F) for Light Trespass Illuminance vary based upon the extent of night time human activity and the extent of natural habitat.

All urban areas within California are designated Lighting Zone 3 as default under the CEC, which stipulates a maximum Light Trespass illuminance of 8 lux (0.74 footcandles). Per the California Administrative Code, Table 10-114-A, the designations for outdoor lighting zones in urban areas are as designated by the 2010 U.S. Census.

The Project site is within the geographic area corresponding to the definition of Lighting Zone 3. In addition, the IESNA defines Lighting Zone 3 as: "areas with moderately high lighting levels. These typically include commercial corridors, high intensity suburban commercial areas, town centers, mixed use areas, industrial uses and shipping and rail yards with high night time activity, high use recreational and playing fields, regional shopping malls, car dealerships, gas stations, and other nighttime active exterior retail areas".

IESNA Table 26.5, lists a Pre-curfew 8 Lux (0.74 footcandles) maximum at the location where trespass is under review for Lighting Zone 3. The California standard is well defined and supported by the IESNA and ASHRAE, and other independent lighting organizations such as the International Dark Sky Organization and U.S. Green Building Council.

5.3 IESNA Recommended Practices

The Illuminating Engineering Society of North America (IESNA) recommends illumination standards for a wide range of building and development types. These recommendations are widely recognized and accepted as best practices and are therefore a consistent predictor of the type and direction of illumination for any given building type. For all areas not governed by the regulatory building code, municipal code or specifically defined requirements, the IESNA standards are used as the basis for establishing the amount and direction of light recommended for the Project.

The IESNA Standards define Outdoor Lighting Zones relative to a range of human activity versus natural habitat. LP-11-20, Environmental Considerations for Outdoor Lighting pages 11 & 12, establishes the Zone designation for a range of existing lighting conditions, from low or no existing lighting to high light levels in urban areas. These lighting zone definitions are referenced by the California Administrative Code as noted above in relation to allowable energy use for outdoor lighting. In addition, the IESNA standards define recommended Light Trespass limits (Appendix F) relative to the Outdoor Lighting Zones. The recommended Light Trespass illuminance limits define the maximum Light Trespass values in Lux and footcandles at the location where Light Trespass is under review.

The existing conditions surrounding the Project site are best described as Lighting Zone 3. IESNA RP-8-18 Table 4-2, lists a Pre-curfew 8 Lux (0.74 footcandles) maximum at the location where trespass is under review for Zone 3.

The IESNA recommendations listed above are not a regulatory requirement and are overridden by the applicable California State University requirements for Light Trespass at sensitive properties.

6. SIGNIFICANCE THRESHOLD

Appendix G of the California Environmental Quality Act (CEQA) Guidelines (Title 14 California Code of Regulations, Sections 15000–15387) provides a set of sample questions to evaluate impacts with regard to aesthetics, including light and glare. The following question pertains to Light Trespass and Glare is as follows:

Would the project:

Create a new source of substantial light and glare which would adversely affect day or nighttime views in the area?

In the context of this question from the CEQA Guidelines, the determination of significance in this Study takes into account the following factors:

The change in ambient nighttime light levels as a result of Project exterior lighting sources; and

The extent to which exterior lighting from the Project would spill off the Project site and affect adjacent sensitive properties.

Specifically, the Project would create a significant impact with regard to artificial light or glare if:

Light Trespass illuminance from the Project exceeds 0.74 fc at a residential property line, and therefore adversely changes the ambient light level at adjacent residential properties.

Or, the Project creates Glare with new high contrast conditions with contrast ratio greater than 30:1, visible from a field of view from a residential property.

7. METHODOLOGY

7.1 Existing Conditions Procedures

Existing conditions lighting observations were conducted following recommended practice procedures defined by the IESNA in RP-33-00 Lighting for Outdoor Environments, TM-10-00 Addressing Obtrusive Light (Urban Sky Glow and Light Trespass) in Conjunction with Roadway Lighting, and TM-11-00 Light Trespass: Research, Results and Recommendations. Field illuminance and luminance measurements were conducted to accurately document all existing incident and visible light at each Monitoring Site location. Incident light can be understood as a vector of luminous flux moving through space. As the vector (light) is incident upon a surface, the intensity of the resulting illuminance will vary depending upon the relative orientation of the vector to the surface. The greatest illuminance will result when the surface and vector are perpendicular. The least illuminance will result when the surface and vector are parallel. In the field conditions, where there are multiple sources of light originating from varied positions, illuminance measurements are recorded horizontally with the photosensor facing up at 3 feet above grade, and vertically with the photosensor facing the Project as per IESNA standards. These measurements document the total horizontal illuminance received at a Monitoring Site as well as the direction and intensity of light converging on the Monitoring Site from the direction of the Project site. The recommendations from the IESNA for evaluating Light Trespass indicates the orientation of the trespass analysis to should be within a vertical plane at the property line. Therefore, this Study utilizes a vertical illuminance analysis. The existing Illuminance is measured with a Minolta T-10A Illuminance meter.



Figure 3: Minolta LS-100 luminance meter

The existing luminance is measured from a Monitoring Site to light sources and surfaces within the field of view toward the Project site from that Monitoring Site. This existing conditions luminance data is measured with a Minolta LS-100 Luminance meter with procedures consistent with best practices for field measurement of luminance as per IESNA standards. The LS-100 Luminance meter utilized by Francis Krahe & Associates, Inc. reports luminance data in either candelas per square meter (cd/m^2) or footlamberts (fL). All existing luminance data measured and reported in this Study are recorded as cd/m^2 .

a. Existing Conditions Monitoring Sites

Monitoring Sites are utilized to describe and evaluate the existing lighting conditions at and surrounding the Project site to determine the maximum potential impacts that may result from light or Glare onto adjacent sensitive properties surrounding the Project. All Monitoring Site locations are within proximity of the Project and have views of the Project. Monitoring Sites are located within the public right of way or Project site and immediately adjacent to existing residential properties.

The following criteria were used to select the Monitoring Site locations:

Project Light Visibility – Monitoring Sites were analyzed that provide direct view of the areas of greatest light intensity from the Project.

Proximity – Monitoring Sites at the least distance to the Project are analyzed. These locations are selected because light intensity decreases exponentially with distance. Locations at a greater distance will experience less light from the Project than those that are near.

Table 1. Existing Conditions Lighting Criteria

Criteria	Metric	Procedure
Light Trespass - Illuminance	Measured illuminance (footcandles) documented at each Monitoring Site.	Measured illuminance recorded each Monitoring Site with Minolta T-10A illuminance meter.
Glare - Contrast Ratio	Measured luminance (candelas per meter squared) documented at each Monitoring Site. Observed existing conditions.	Measured luminance recorded at each Monitoring Site with Minolta LS-100 luminance meter. Day and night photographs to record the view to the Project site from the Monitoring Site in terms of Project visibility, prominent light sources, and lighted surfaces.

This Study includes four Monitoring Sites to document and evaluate the existing conditions including the views from light sensitive properties surrounding the Project and the extent of existing lighting at these sensitive site locations. Figure 4 diagrams the Monitoring Site locations within and near to the Project site. The Project site is shaded blue, while residential properties are shaded red.



Figure 4: Monitoring Site Locations

Monitoring Site M-E1: Monitoring Site M-E1 is located at the east Project property line approximately midway between Montezuma Road and the public alley along the south side of the Project site, and immediate west of the residential property at 5667 Montezuma Road to evaluate the Project east elevation from adjacent residential properties to the east of the Project.

Monitoring Site M-S1: Monitoring Site M-S1 is within the public alley to the south of the Project site and immediately north of the residential property at 5578 Mary Lane Drive, to evaluate the Project south elevation from adjacent residential properties to the southwest.

Monitoring Site M-S2: Monitoring Site M-S2 is within the public alley to the south of the Project site and immediately north of the residential property at 5606 Mary Lane Drive, to evaluate the Project south elevation from adjacent residential properties directly south of the Project.

Monitoring Site M-S3: Monitoring Site M-S3 is within the public alley to the south of the Project site and immediately north of the residential property at 5634 Mary Lane Drive, to evaluate the Project south elevation from adjacent residential properties to the southeast.

7.2 Lighting Analysis Method

This analysis of the Project exterior lighting includes evaluation of the Light Trespass at the nearest residential properties adjacent to the Project, and an evaluation of light from the Project visible at residential properties to determine whether the Project would introduce a new source of Glare. This Study presents a conservative analysis with respect to Light Trespass and Glare as described below. This Study evaluates an example of an exterior site lighting scheme which meets Project design illumination criteria to evaluate the Projects potential to create Light Trespass and Glare. Description of the Project lighting analyzed is included in Section 9 below and the Conceptual Project Exterior Site Lighting (Appendix A) which defines the output, scale, and distribution of the light fixtures analyzed.

a. Light Trespass Analysis

Light Trespass is the artificial light produced from the Project that falls on an adjacent property. Light Trespass is measured in terms of illuminance (footcandles or metric units lux), and can be measured at any point and in any direction. Where Light Trespass is evaluated, the illuminance is measured perpendicular to the source of light, toward the source of light, at the property line.

Light Trespass illuminance is calculated at the location where lighting is under review through the illumination modeling software program AGI32. This software utilizes the 3-dimensional architectural computer model, which includes topography, massing of surrounding context buildings and the proposed Project, and lighting locations, orientation, and dimensions to generate an accurate prediction of future illuminance from the Project at adjacent sensitive properties. The calculations simulate light meters at a vertical surface extending from grade to the height of the tallest adjacent sensitive property or the maximum Project height, whichever is greater. Figure 5 illustrates the vertical plane locations where Light Trespass is calculated and analyzed.

The Project exterior lighting analyzed is described in Section 9 and specified in the Conceptual Project Exterior Site Lighting (Appendix A). Project Design Feature PDF-1 is included as part of the Project exterior lighting to reduce Light Trespass at adjacent sensitive residential properties. The analysis assumes all lighting operating at full brightness, simultaneously. This analysis with all lighting operating at maximum output presents a conservative evaluation of the Project's potential for off-site Light Trespass illuminance.

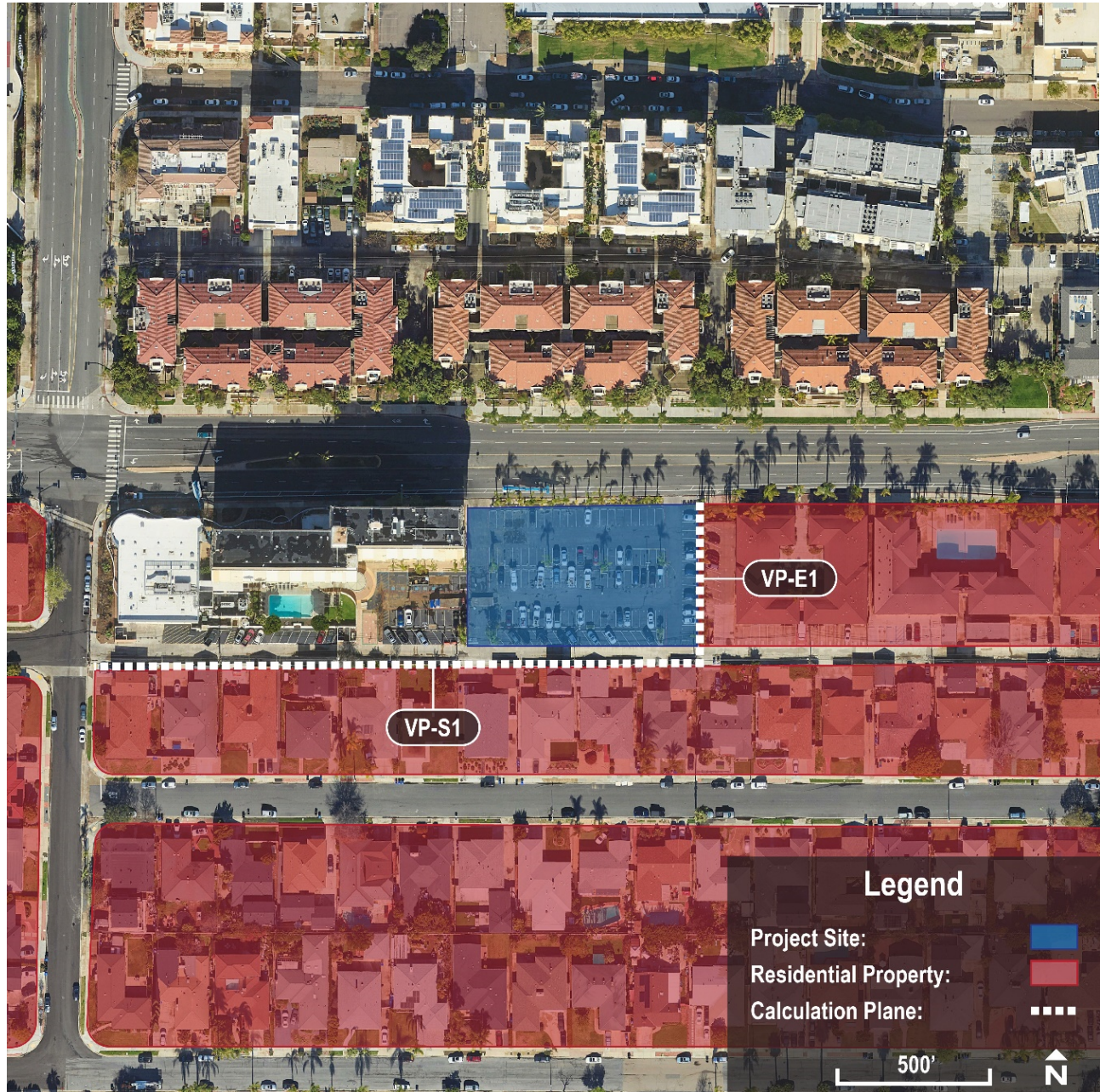


Figure 5: Calculation Plane Locations

The calculated Light Trespass illuminance from Project exterior lighting is evaluated relative to the thresholds identified in Section 6 Significance Threshold, which defines a maximum Light Trespass illuminance of 0.74 fc at the nearest residential property line. Project Light Trespass results exceeding this threshold will create an impact with respect to Light Trespass. Light Trespass from the Project which do not exceed the threshold will not create a Light Trespass impact. See Section 9 for analysis of the Project exterior lighting Light Trespass.

b. Glare Analysis Methodology

Glare from the Project² may occur where the Project light sources are visible at night from nearby sensitive properties. At locations where the Project lighting is visible, the Glare from the Project is determined by the contrast ratio, which equals the maximum Project exterior lighting luminance divided by the measured average existing luminance within the visual field from the Monitoring Sites toward the Project. The measured average existing luminance is identified in the field survey of existing conditions (see Section 8 below).

The Project exterior lighting is required to comply with the backlight, uplight, and glare (BUG) ratings included in CALGreen. The BUG ratings limit light fixture maximum zonal lumens of any light fixture based upon the location of the light source and the distance from the Project property line and elevation above grade. In addition, Project Design Feature PDF-2 limits the Project light source brightness to no greater than 100 cd/m² as viewed from adjacent sensitive residential properties. This Study assumes a worst case scenario with regard to light source brightness to determine the maximum potential Project exterior lighting luminance. Calculation of the maximum Project exterior lighting luminance used is provided in Section 9 for visible site lighting fixtures. The calculated maximum Project exterior lighting luminance is compared to measured average existing luminance from the Monitoring Sites in Table 3 within Section 8 below. Contrast ratios greater than 30:1 are considered "High" and potential Glare conditions.

8. PROJECT EXISTING CONDITIONS

The existing lighting conditions within the Project site and at surrounding properties are defined by the observed and measured existing conditions summarized below. The Existing Conditions Analysis includes the evaluation of the the visibility of the Project exterior lighting from each Monitoring Site, with photographs of the view from the Monitoring Sites to the Project during the day and at night. Existing illuminance at each Monitoring Site is measured with the illuminance meter aimed toward the Project site. Existing luminance is measured within the field of view from the Monitoring Site toward the Project.

Monitoring Site locations were selected for observation and field lighting measurements to evaluate the views to the Project from adjacent residential properties and to determine the extent and intensity of existing light sources within and surrounding the Project. The Monitoring Sites are within the public right of way, adjacent to residences or at the Project site boundary. The Monitoring Site locations are representative of the view to the Project from the vicinity of the sensitive properties surrounding the Project to the east and south.

8.1 Monitoring Site Night Survey Data

The existing lighting conditions at night surrounding the the Project site include existing streetlights, parking pole lighting and area lights, and building lighting for adjacent residential properties. The observations and measurement at each Monitoring Site of the existing lighting conditions within and surrounding the Project Site are summarized below.

a. Visibility Analysis

The visibility of the Project at each Monitoring Site is evaluated during field surveys during the day and at night. Visibility of the Project from the each Monitoring Site is analyzed in Table 2 below.

The distance from the Project site to adjacent sensitive properties varies from a minimum of 0 feet at Monitoring Site M-E1 directly east of the Project site, to a maximum distance at 20 feet at Monitoring Sites M-S1, M-S2, and M-S3 to the south of the Project site.

² Luminance and or Glare is not cumulative. Therefore, this Study evaluates the potential Glare impact from the proposed Project Building Lighting and not existing light sources.

All Monitoring Sites visibility toward the Project. Further analysis is presented below to evaluate the Project exterior lighting potential for Light Trespass and or Glare at these Monitoring Sites, which are used to predict the view of the Project from nearby sensitive properties.

Table 2. Project Visibility From Monitoring Sites

Monitoring Site	M-Site Location	Distance to Project Site	Visibility from Monitoring Site
M-E1	Within Project site, adjacent to the west property line of 5667 Montezuma Road	0 ft	Project site is fully visible from the Monitoring Site. Existing fencing and trees partially shield views from locations further east.
M-S1	Within alley, adjacent to the north property line of 5578 Mary Lane Drive	20 ft	Project site is fully visible from the Monitoring Site. Buildings from the south have an expansive view of the Project looking north.
M-S2	Within alley, adjacent to the north property line of 5606 Mary Lane Drive	20 ft	Project site is fully visible from the Monitoring Site. Buildings from the south have an expansive view of the Project looking north.
M-S3	Within alley, adjacent to the north property line of 5634 Mary Lane Drive	20 ft	Project site is fully visible from the Monitoring Site. Buildings from the south have an expansive view of the Project looking north.

b. Measured Existing Illuminance

The illuminance data listed in Table 3, summarize the measured illuminance at each Monitoring Site. For this Study the measured illuminance greater than 0.74 fc is evaluated as high illuminance, from 0.09 fc to 0.74 fc is evaluated as medium illuminance, and less than 0.09 fc is evaluated as low illuminance.

The Project site currently includes lighting for the existing parking lot. Streets and buildings nearby the Project site contain lighting for streets, pathways, and exterior residential lighting. The areas surrounding the Project site characterized as a well lighted environment with existing illuminance ranging from medium to high. The measured illuminance is consistent with an urban lighting condition.

The highest existing horizontal illuminance level was recorded at Monitoring Site at M-S1 with 1.00 fc, while the lowest horizontal illuminance was recorded at Monitoring Sites M-S3 at 0.13 fc. The highest existing vertical illuminance was recorded at Monitoring Site M-E1 at 2.27 fc, while the lowest vertical illuminance was recorded at Monitoring Site M-S3 at 0.77 fc.

Table 3. Measured Illuminance (fc) at Monitoring Sites

Monitoring Site	Illuminance (fc)		Evaluation
	Horizontal	Vertical	
M-E1	0.67	2.72	Medium horizontal illuminance, High vertical illuminance
M-S1	1.00	1.58	High horizontal illuminance, High vertical illuminance
M-S2	0.64	1.40	Medium horizontal illuminance, High vertical illuminance
M-S3	0.13	0.77	Medium horizontal illuminance, High vertical illuminance

c. Measured Existing Luminance

The visual evaluation of High, Medium, and Low Contrast describes the perception of how bright a visible object appears to the surrounding objects within any given field of view and context. High Contrast indicates a potential Glare condition for residential properties nearby. Contrast is the ratio of one surface luminance to

the average luminance in the field of view. Contrast exceeding 30 to 1 are usually deemed uncomfortable and evaluated as high; contrast less than 30 to 1 but greater than 10 to 1 is evaluated as medium; contrast less than 10 to 1 is evaluated as low.

For this Study, the following luminance criteria are applied to measured and calculated luminance: luminance below 10 cd/m² is evaluated as low luminance; luminance greater than 10 cd/m² and less than 100 cd/m² is evaluated as medium luminance; luminance greater than 100 cd/m² is evaluated as high luminance. The measured luminance recorded at the Monitoring Sites within the view to the Project includes prominent, high brightness sources, such as streetlights, and flood lighted areas, as well as lower brightness surfaces such as shaded or unilluminated walls and asphalt paved areas.

The existing Project site is used as a surface parking lot which contains pole mounted flood lights to illuminate the parking lot. Ambient brightness withing and adjacent to the Project site and nearby residential properties is generally bright, as evidenced by the measured luminance data. The range of recorded luminance is summarized in Table 4. The highest average luminance was recorded at Monitoring Site M-S2 at 589.2 cd/m² which is evaluated as High, while the lowest average luminance was measured at Monitoring Site M-S3 at 260.0 cd/m², which is also evaluated as High luminance. Therefore, all average measured luminances at all four Monitoring Sites is evaluated as High luminance (greater than 100 cd/m²).

The highest maximum luminance was recorded at Monitoring Site M-S2 with 6,508.0 cd/m², while the lowest maximum luminance was measured at Monitoring Site M-S3 at 2485.0 cd/m². The measured maximum luminance at all four Monitoring Sites is evaluated as High luminance (greater than 100 cd/m²).

The calculated Contrast Ratio (maximum luminance / average luminance) varies from a minimum of 8.5 to 1 at Monitoring Site M-S1 to a maximum of 11.1 to 1 at Monitoring Site M-E1. The calculated existing Contrast Ratio at M-S1 and M-S3 is evaluated as Low Contrast (Less than 10 to 1), while the existing Contrast Ratio at M-E1 and M-S2 is evaluated as Medium Contrast (less than 30 to 1, and greater than 10 to 1).

Table 4. Measured Luminance, (cd/m²) at Monitoring Sites

Monitoring Site	Luminance (cd/m ²)		Contrast Ratio (Max / Avg)	Evaluation
	Average	Maximum		
M-E1	387.8	4286.0	11.1 : 1	High Average luminance, High Maximum luminance, Medium Contrast
M-S1	354.2	3026.0	8.5 : 1	High Average luminance, High Maximum luminance, Low Contrast
M-S2	589.2	6508.0	11.0 : 1	High Average luminance, High Maximum luminance, Medium Contrast
M-S3	260.0	2485.0	9.6 : 1	High Average luminance, High Maximum luminance, Low Contrast

8.2 Monitoring Site Data

a. Monitoring Site M-E1

The existing lighting conditions at M-E1 are high horizontal / high vertical illumination from the existing parking lot flood lights within the Project site. Prominent light sources visible in the field of view from M-E1 toward the Project site include parking lot pole lights and exterior building lighting, of the SDSU residential tower immediately west of the Project site. The lighting environment is uniformly illuminated to a high intensity.



Figure 6: M-E1 – 08/20/2024, 3:56 pm



Figure 7: M-E1 – 08/20/2024, 8:44 pm

b. Monitoring Site M-S1

The existing lighting conditions at M-S1 are high horizontal / high vertical illumination from from the existing parking lot flood lights within the Project site. Prominent light sources visible in the field of view from M-S1 toward the Project site include parking lot pole lights and exterior building mounted lighting on surrounding residential properties. The lighting enviroment is uniformly illuminated to a high intensity.



Figure 8: M-S1 – 08/20/2024, 4:00 pm



Figure 9: M-S1 – 08/24/2024, 10:05 pm

c. Monitoring Site M-S2

The existing lighting conditions at M-S2 are high horizontal / high vertical illumination from the existing parking lot flood lights within the Project site. Prominent light sources visible in the field of view from M-S2 toward the Project site include existing parking lot pole lights located within the Project site and interior and exterior building lighting of the SDSU residential development north of Montezuma Road. The lighting environment is uniformly illuminated to a high intensity.



Figure 10: M-S2 – 08/20/2024, 3:59 pm



Figure 11: M-S2 – 08/24/2024, 10:07 pm

d. Monitoring Site M-S3

The existing lighting conditions at M-S3 are high horizontal / high vertical illumination from the existing parking lot flood lights within the Project site. Prominent light sources visible in the field of view from M-S3 toward the Project site include parking lot lighting fixtures and exterior building lighting, of the SDSU residential tower immediately west of the Project site and SDSU residential development to the north of Montezuma Road. The lighting environment is uniformly illuminated to a high intensity.



Figure 12: M-S3 – 08/20/2024, 3:58 pm



Figure 13: M-S3 – 08/24/2024, 10:08 pm

9. PROJECT LIGHTING ANALYSIS

The Project would introduce new exterior lighting as part of the site improvements. This Study analyzes an example of lighting scheme which provides illumination of the site and building to allow for safety, security, and use of the Project. The implemented Project lighting design would satisfy similar criteria as the scheme analyzed in this study and include the Project Design Features listed in Section 2 above.

The lighting design analyzed in this Study consists of bollards located at 10 feet on center along the north, east, and south of the Project site and along pathways to illuminate all hardscape areas to a minimum of 1.0 fc. Fixtures are aimed inward towards the Project site and away from adjacent sensitive residential properties. Bollards are 42 inches tall and have asymmetric light output as indicated in Appendix A. As stated in the Project Design Feature PDF-1, Project lighting will be designed such that light fixtures are shielded and aimed away from the Project site perimeter to limit light trespass at sensitive residential properties to 0.74 fc maximum.

To analyze the Project's exterior lighting impacts, the Project lighting is compared to the applicable thresholds identified within Section 6 Significance Threshold above with respect to Light Trespass and Glare:

- Project exterior lighting trespass illuminance must not exceed 0.74 fc at the property line of adjacent sensitive properties.
- Project exterior lighting luminance visible from residential properties must be less than high contrast conditions, i.e., less than 30 to 1 contrast ratio.

9.1 Light Trespass Analysis

Project Light Trespass illuminance from Project exterior lighting is evaluated by way of the calculated illuminance (fc) as per the methodology defined in Section 7, at the vertical calculation plane locations where lighting is under review. As noted above, this Study evaluates the Light Trespass illuminance from Project with respect to the regulations defined by CALGreen at the adjacent residential property lines. This Study analyzes the exterior lighting scheme as described in Section 9 above and the Conceptual Project Exterior Site Lighting (Appendix A), which defines the lighting fixtures, locations, dimensions, and orientation.

The vertical calculation planes for the Project Light Trespass analysis are located at the property line of nearby residential properties to the east and south, as illustrated in Figure 5. There are no sensitive properties nearby the Project site to the west and north. Light Trespass illuminance is evaluated within vertical planes extending from grade to the maximum Project building elevation above grade. The vertical planes are located to capture light traveling from the Project site toward surrounding properties, which may fall onto, and illuminate, adjacent sensitive properties.

Project exterior lighting is analyzed in this Study with all Project exterior lighting operating simultaneously at the maximum output as noted above. This configuration would produce the maximum possible amount of Light Trespass and therefore represents a conservative analysis. The information in the Conceptual Project Exterior Site Lighting (Appendix A) and as described in Section 9 above was utilized to calculate the Project's Light Trespass illuminance in this Study.

The evaluation of illuminance as High, Medium, and Low describes the relative amount of Light Trespass received at location at night where Light Trespass is under review. Light Trespass illuminance greater than 0.74 fc (the maximum permitted by CALGreen) is evaluated as "High". Illuminance greater than 0.09 fc but less than 0.74 fc is evaluated as "Medium". Illuminance less than 0.09 fc is evaluated as "Low".

Table 5: Calculated Light Trespass Illuminance (fc)

Vertical Plane	Illuminance (fc)			CALGreen Analysis (0.74 fc threshold)
	Max	Min	Avg	
VP-E1	0.70	0.00	0.13	Below threshold
VP-S1	0.30	0.00	0.05	Below threshold

This Study Analyzes the Light Trespass illuminance (fc) with respect to CALGreen against the Threshold of 0.74 fc at the Project property line or centerline of adjacent roadway. The calculated Light Trespass from the Project at the vertical planes is presented in Table 5. Complete Light Trespass illuminance calculated data is presented in Appendix G.

The maximum calculated Light Trespass illuminance in Table 5 varies from a maximum of 0.70 fc at vertical plane VP-E1 to a minimum of 0.30 fc at vertical plane VP-S1. The calculated Light Trespass illuminance from the Project Exterior Lighting is less than the 0.74 fc threshold established by CALGreen at all locations where Light Trespass is under review. Therefore, the Project's Exterior Lighting will not create a Light Trespass impact at residential properties to the east and south of the Project site.

There are no sensitive residential properties nearby to the north and west with potential to receive Light Trespass from the Project. All properties more distant from the Project site than the locations studied will receive substantially less Light Trespass due to the increased distance (See "Inverse Square Law").

9.2 Glare Analysis

The evaluation of High, Medium, and Low Contrast describes the perception of how bright a visible object appears in comparison to the surrounding objects within any given field of view. The "luminance ratio" is the ratio of the maximum Project luminance as compared to the Average Luminance within the field of view visible at an observer position. This ratio is referred to as "contrast", and is determined by the variation of luminance. "High," "Medium," and "Low" contrast are terms used to describe effect of the contrast ratios (the ratio of maximum luminance to the average within a field of view) of greater than 30:1, between 10:1 and 30:1, and below 10:1, respectively. Luminance contrast ratios above 30:1 are generally uncomfortable for the human eye to perceive. High Contrast, greater than a 30:1 Contrast Ratio, indicate a potential Glare condition.

The existing lighting conditions at night within and surrounding the Project site and visible within the field of view from the Monitoring Sites were evaluated on August 20th, and August 24th of 2024. Measurements of the existing luminance at night within the field of view from the Monitoring Sites are summarized in Section 8.2 and Table 4 above.

Potential Glare from the Project exterior lighting is evaluated by calculating the Contrast Ratio, which is the ratio of the maximum Project exterior lighting luminance to the existing measured average luminance. Table 6 summarizes the measured average luminance at each Monitoring Site (from Table 4) along with a calculation of the comparison of the proposed Project exterior lighting maximum luminance to the existing measured average luminance to determine the Contrast Ratio.

Table 6: Project Exterior Lighting Contrast Ratio

Monitoring Site	Existing Measured Luminance		Project Luminance		Evaluation
	Average	Maximum	Maximum	Contrast Ratio	
M-E1	387.8	4286.0	100.0	0.3 : 1	Low Contrast, No Glare
M-S1	354.2	3026.0	100.0	0.3 : 1	Low Contrast, No Glare
M-S2	589.2	6508.0	100.0	0.2 : 1	Low Contrast, No Glare
M-S3	260.0	2485.0	100.0	0.4 : 1	Low Contrast, No Glare

The Project Exterior Lighting includes site lighting that is shielded and directed away from the adjacent properties. The calculated Contrast Ratio from the Project at all Monitoring sites viewing toward the project varies from a maximum of 0.4 to 1 at M-S3 to a minimum of 0.2 to 1 at M-S2; All Contrast Ratios are evaluated as Low Contrast. All of the maximum Contrast Ratios from the Project Exterior Lighting are less than 30:1. Therefore, the proposed Project exterior lighting maximum luminance of 100 cd/m² will not create a new source of Glare at the Monitoring Sites or surrounding sensitive properties adjacent to the Project site.

This Study analyzed the proposed building and site improvements, and the visibility of the Project lighting fixtures from the adjacent residential properties to the east and south of the Project site, and concludes the Project Exterior Lighting will be visible, but will not present a high contrast condition with greater than 30:1 Contrast Ratio. Light degrades rapidly with distance as described above by the Inverse Square Law. Therefore, properties more distant from the Project site than the Monitoring Sites will receive substantially less light than the Monitoring Sites. Therefore, the Project will not create a new Glare condition at any sensitive residential properties.

10. CONCLUSIONS

This Study reviews the parameters that affect Light Trespass and Glare, reviews relevant lighting metrics and regulations pertaining to exterior artificial lighting, examines the existing lighting conditions within and surrounding the Project site, and evaluates the Project's exterior lighting to identify the potential lighting environmental impacts.

The Study concludes that Light Trespass from the proposed Project exterior lighting will not exceed the threshold of 0.74 fc defined by CALGreen and stipulated by Project Design Feature PDF-1 at sensitive residential properties to the east and south of the Project site. There are no sensitive residential properties near to the Project site to the north and west. Therefore, the Project will not create a Light Trespass impact at any surrounding sensitive residential properties.

This Study demonstrates the Project will not create a significant source of Glare because the Project will not create a new high contrast condition visible at adjacent sensitive residential properties. The Project exterior lighting will include lighting fixtures compliant with CALGreen requirements regarding off-site Glare and Project Design Feature PDF-2 which limits light source brightness to no greater than 100 cd/m². Therefore, the Project will not create a significant source of Glare at sensitive properties.

Light intensity degrades exponentially with distance. Therefore, sensitive properties which are more distant than the locations analyzed in this Study will receive substantially less light from the Project. Therefore the Project will not create Light Trespass or Glare impacts at locations more distant than the locations studied.

APPENDIX A: CONCEPTUAL PROJECT EXTERIOR SITE LIGHTING

LINEA 950 Illuminating Bollard

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DESCRIPTION

The simple linear form of LINEA combined with LED illumination provides a synergy of form and function. High-power LEDs provide a wide asymmetric distribution while generating no light above ninety degrees horizontal. Bollard housing and shaft are single-piece and finished in finely textured paint. All hardware is stainless steel.

PROTECTED BY
PRIMAR®



Date: _____ Type: _____ Catalog Number: _____

Project Name: _____

ORDERING INFORMATION

LUMINAIRE							
MODEL	CONFIGURATION	OUTPUT	CCT	CONTROL	VOLTAGE	FINISH	OPTION
LN950-IF Linea 950 with Internal Flange Mount	S Single Head	SO Standard Output	30K 3000K	DIM 0-10v Dimming	UNV 120-277v	BL Black	GFCI GFCI Receptacle
LN950-EF Linea 950 with External Flange Mount	D Dual Head	HO High Output	40K 4000K			DB Dark Bronze	OCC Occupancy Sensor
			A True Amber ¹ (590-595nm)			DG Dark Grey	TVSS20 20KV Surge Suppressor
			¹ Amber available in Standard Output only.			GG Graphite Grey	BSS Beach-Side Shield ²
						SG Silver Grey	² Available with Single Head Amber Bollard Only
						CC Custom RAL Color	

MOUNTING KIT (Required, Ordered Separately)

MODEL

LN950-IF-MK

Mounting Kit for Linea 950 with Internal Flange Mount (Includes (4x) ø0.5" x 15" x 3" Anchor Bolts and Hot-dip Galvanized Steel Mounting Plate)

LN950-EF-MK

Mounting Kit for Linea 950 with External Flange Mount (Includes (4x) ø0.375" x 8" x 1.5" Anchor Bolts and Hot-dip Galvanized Steel Mounting Plate)

Consult factory for availability of custom options. Factory assistance is available via phone at (864) 487-3535 ext. 258 or via email at DesignServices@EXP-Brands.com.

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In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials. Technical specification sheets that appear online are the most recent ones available. ¹Consult the factory to verify current status of BAA/TAA/BABAA compliance.

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LINEA 950

Illuminating Bollard

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SPECIFICATIONS

HOUSING

Single piece bollard consists of one or two integral luminaire heads and shaft fabricated from rectangular 6061 aluminum alloy with radiussed corners. Nominal wall thickness is 0.187" with cross-section of 7.5" x 3.5". LED light engine and driver are housed in self contained weather-proof powerpack enclosure within the bollard and removable with a single fastener. Lens is clear impact-resistant acrylic. LED array is thermally managed using convection and transmission of heat through the use of an aluminum heat sink and the luminaire housing. All hardware is stainless steel.

OPTICS

Each LED light engine consists of five high output multi-chip LED arrays fitted with prismatic lens optics to produce a uniform asymmetric light distribution pattern suitable for pathways and sidewalks. Luminaire emits zero uplight at or above 90 degrees horizontal and qualifies for use in LEED zones LZ1, LZ2, LZ3, and LZ4. Color temperature may be 3000K or 4000K at CRI>80.

ELECTRICAL

Standard Output: Integral dimmable LED driver is housed in luminaire head. Each luminaire head consumes 16 watts at 350 mA. Twin mount bollard with two heads consumes 32 watts. Input voltage range is 120v - 277v AC, 50-60 Hz. LED driver shall be UL recognized.

High Output: Integral dimmable LED driver is housed in luminaire head. Each luminaire head consumes 33 watts at 700 mA. Twin mount bollard with two heads consumes 66 watts. Input voltage range is 120v - 277v AC, 50-60 Hz. LED driver shall be UL recognized.

LED DELIVERED LUMENS / BUG RATING PER LUMINAIRE HEAD

Standard Output: 17 Watts

3000K: 568 Lumens / B0-U0-G1

4000K: 659 Lumens / B0-U0-G1

High Output: 34 Watts

3000K: 1061 Lumens / B0-U0-G2

4000K: 1239 Lumens / B0-U0-G2

NOTE:

Due to rapid and continuous advances in LED technology, LED luminaire data is subject to change without notice and at the discretion of HessAmerica. Consult factory for current technical data.

MOUNTING

Flangeless mounting is standard. Optional external flange mounting available on request.

WEIGHT

20 Pounds

FINISH

Standard finishes are finely textured matte silver grey metallic, dark grey, graphite grey, matte black, or dark bronze. Special colors available on request.

CERTIFICATION

NRTL Certified for Wet Locations

WARRANTY

Limited product warranty period including LEDs is five years. Driver shall carry the manufacturer's limited warranty.

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In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials. Technical specification sheets that appear online are the most recent ones available. *Consult the factory to verify current status of BAA/TA/BABAA compliance.

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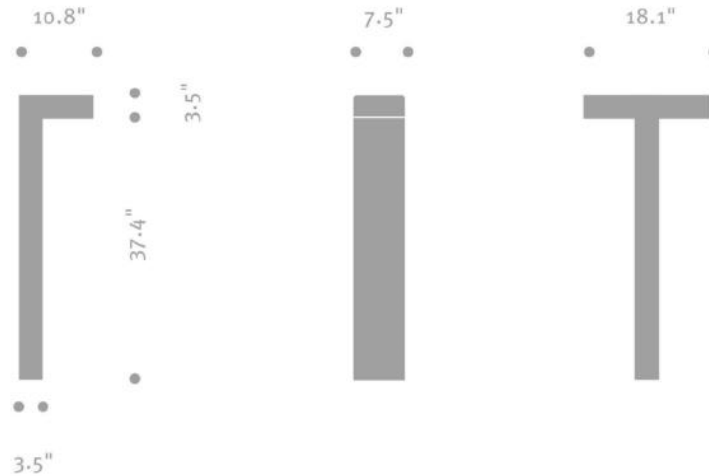
LINEA 950

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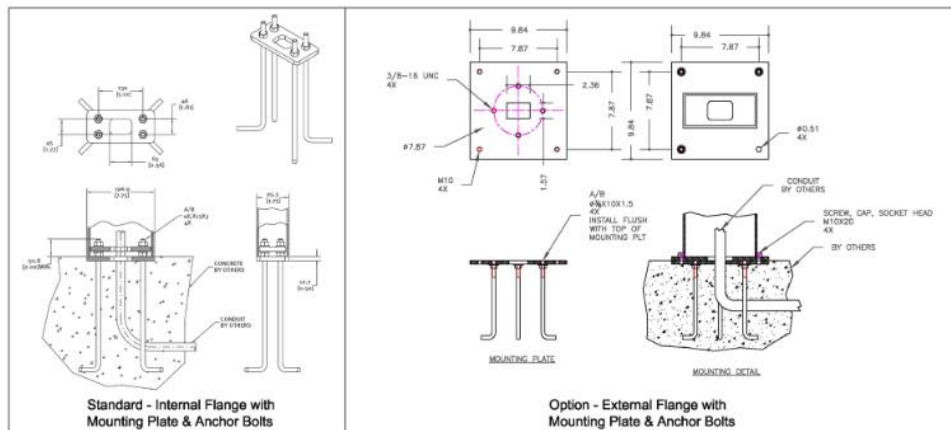
DIMENSIONS

All dimensions are shown in inches unless otherwise noted.



MOUNTING DETAILS

All dimensions are shown in inches unless otherwise noted.



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CUSTOMIZE YOUR **EX**PERIENCE.

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APPENDIX B: TITLE 24, PART 11, SECTION 5.106.8

Chapter 5 Nonresidential Mandatory Measures

5.106.8 Light pollution reduction.

[N] Outdoor lighting systems shall be designed and installed to comply with the following:

1. The minimum requirements in the *California Energy Code* for Lighting Zones 0-4 as defined in Chapter 10, Section 10-114 of the *California Administrative Code*; and
2. Backlight (B) ratings as defined in IES TM-15-11 (shown in Table A-1 in Chapter 8);
3. Uplight and Glare ratings as defined in *California Energy Code* (shown in Tables 130.2-A and 130.2-B in Chapter 8) and
4. Allowable BUG ratings not exceeding those shown in Table 5.106.8 [N], or

Comply with a local ordinance lawfully enacted pursuant to Section 101.7, whichever is more stringent.

Exceptions:

1. Luminaires that qualify as exceptions in Sections 130.2(b) and 140.7 of the *California Energy Code*.
2. Emergency lighting.
3. Building facade meeting the requirements in Table 140.7-B of the *California Energy Code*, Part 6.
4. Custom lighting features as allowed by the local enforcing agency, as permitted by Section 101.8 Alternate materials, designs and methods of construction.
5. Luminaires with less than 6,200 initial luminaire lumens.

TABLE 5.106.8 [N] MAXIMUM ALLOWABLE BACKLIGHT, UPLIGHT AND GLARE (BUG) RATINGS^{1,2}

ALLOWABLE RATING	LIGHTING ZONE LZ0	LIGHTING ZONE LZ1	LIGHTING ZONE LZ2	LIGHTING ZONE LZ3	LIGHTING ZONE LZ4
Maximum Allowable Backlight Rating (B)					
Luminaire greater than 2 mounting heights (MH) from property line	N/A	No Limit	No Limit	No Limit	No Limit
Luminaire back hemisphere is 1 – 2 MH from property line	N/A	B2	B3	B4	B4
Luminaire back hemisphere is 0.5 – 1 MH from property line	N/A	B1	B2	B3	B3
Luminaire back hemisphere is less than 0.5 MH from property line	N/A	B0	B0	B1	B2
Maximum Allowable Uplight Rating (U)					
For area lighting ³	N/A	U0	U0	U0	U0
For all other outdoor lighting, including decorative luminaires	N/A	U1	U2	U3	U4
Maximum Allowable Glare Rating (G)					
Luminaire greater than 2 MH from property line	N/A	G1	G2	G3	G4
Luminaire front hemisphere is 1 – 2 MH from property line	N/A	G0	G1	G1	G2
Luminaire front hemisphere is 0.5 – 1 MH from property line	N/A	G0	G0	G1	G1
Luminaire front hemisphere is less than 0.5 MH from property line	N/A	G0	G0	G0	G1

1. IESNA Lighting Zones 0 are not applicable; refer to Lighting Zones as defined in the *California Energy Code* and Chapter 10 of the *California Administrative Code*.

2. For property lines that abut public walkways, bikeways, plazas and parking lots, the property line may be considered to be 5 feet beyond the actual property line for purpose of determining compliance with this section. For property lines that abut public roadways and public transit corridors, the property line may be considered to be the centerline of the public roadway or public transit corridor for the purpose of determining compliance with this section.

3. General lighting luminaires in areas such as outdoor parking, sales or storage lots shall meet these reduced ratings. Decorative luminaires located in these areas shall meet U-value limits for "all other outdoor lighting."

APPENDIX C: TITLE 24, PART 6, SECTION 140.7

SECTION 140.7 – PRESCRIPTIVE REQUIREMENTS FOR OUTDOOR LIGHTING

- (a) An outdoor lighting installation complies with this section if it meets the requirements in Subsections (b) and (c), and the actual outdoor lighting power installed is no greater than the allowed outdoor lighting power calculated under Subsection (d). The allowed outdoor lighting shall be calculated according to outdoor lighting zone in Title 24, Part 1, Section 10-114.

Exceptions to Section 140.7(a): When more than 50 percent of the light from a luminaire falls within one or more of the following applications, the lighting power for that luminaire shall be exempt from Section 140.7:

1. Temporary outdoor lighting.
2. Lighting required and regulated by the Federal Aviation Administration, and the Coast Guard.
3. Lighting for public streets, roadways, highways and traffic signage lighting, including lighting for driveway entrances occurring in the public right-of-way.
4. Lighting for sports and athletic fields, and children's playgrounds.
5. Lighting for industrial sites, including but not limited to, rail yards, maritime shipyards and docks, piers and marinas, chemical and petroleum processing plants, and aviation facilities.
6. Lighting of public monuments.
7. Lighting of signs complying with the requirements of Sections 130.3 and 140.8.
8. Lighting of tunnels, bridges, stairs, wheelchair elevator lifts for American with Disabilities Act (ADA) compliance, and ramps that are other than parking garage ramps.
9. Landscape lighting.
10. In theme parks: outdoor lighting only for themes and special effects.
11. Lighting for outdoor theatrical and other outdoor live performances, provided that these lighting systems are additions to area lighting systems and are controlled by a multiscene or theatrical cross-fade control station accessible only to authorized operators.
12. Outdoor lighting systems for qualified historic buildings, as defined in the California Historic Building Code (Title 24, Part 8), if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems for qualified historic buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic replica components are exempt. All other outdoor lighting systems for qualified historic buildings shall comply with Section 140.7.

- (b) **Outdoor lighting power trade-offs.** Outdoor lighting power trade-offs shall be determined as follows:

1. Allowed lighting power determined according to Section 140.7(d)1 for general hardscape lighting allowance may be traded to specific applications in Section 140.7(d)2, provided the hardscape area from which the lighting power is traded continues to be illuminated in accordance with Section 140.7(d)1A.
2. Allowed lighting power determined according to Section 140.7(d)2 for additional lighting power allowances for specific applications shall not be traded between specific applications, or to hardscape lighting in Section 140.7(d)1.
3. Trading of lighting power allowances between outdoor and indoor areas shall not be permitted.

- (c) **Calculation of actual lighting power.** The wattage of outdoor luminaires shall be determined in accordance with Section 130.0(c).

- (d) **Calculation of allowed lighting power.** The allowed lighting power shall be the combined total of the sum of the general hardscape lighting allowance determined in accordance with Section 140.7(d)1, and the sum of the additional lighting power allowance for specific applications determined in accordance with Section 140.7(d)2.

SECTION 140.7 – PRESCRIPTIVE REQUIREMENTS FOR OUTDOOR LIGHTING

1. **General hardscape lighting allowance.** Determine the general hardscape lighting power allowances as follows:
 - A. The general hardscape area of a site shall include parking lot(s), roadway(s), driveway(s), sidewalk(s), walkway(s), bikeway(s), plaza(s), bridge(s), tunnel(s), and other improved area(s) that are illuminated. In plan view of the site, determine the illuminated hardscape area, which is defined as any hardscape area that is within a square pattern around each luminaire or pole that is ten times the luminaire mounting height with the luminaire in the middle of the pattern, less any areas that are within a building, beyond the hardscape area, beyond property lines or obstructed by a structure. The illuminated hardscape area shall include portions of planters and landscaped areas that are within the lighting application and are less than or equal to 10 feet wide in the short dimensions and are enclosed by hardscape or other improvement on at least three sides. Multiply the illuminated hardscape area by the area wattage allowance (AWA) from Table 140.7-A for the appropriate lighting zone.
 - B. Determine the perimeter length of the general hardscape area. The total perimeter shall not include portions of hardscape that are not illuminated according to Section 140.7(d)1A. Multiply the hardscape perimeter by the linear wattage allowance (LWA) for hardscape from Table 140.7-A for the appropriate lighting zone. The perimeter length for hardscape around landscaped areas and permanent planters shall be determined as follows:
 - i. Landscaped areas completely enclosed within the hardscape area, and which have a width or length less than 10 feet wide, shall not be added to the hardscape perimeter length.
 - ii. Landscaped areas completely enclosed within the hardscape area, and which width or length is a minimum of 10 feet wide, the perimeter of the landscaped areas or permanent planter shall be added to the hardscape perimeter length.
 - iii. Landscaped edges that are not abutting the hardscape shall not be added to the hardscape perimeter length.
 - C. Determine the Initial Wattage Allowance (IWA) for general hardscape lighting from Table 140.7-A for the appropriate lighting zone. The hardscape area shall be permitted one IWA per site.
 - D. The general hardscape lighting allowance shall be the sum of the allowed watts determined from (A), (B) and (C) above.
2. **Additional lighting power allowance for specific applications.** Additional lighting power for specific applications shall be the smaller of the additional lighting allowances for specific applications determined in accordance with Table 140.7-B for the appropriate lighting zone, or the actual installed lighting power meeting the requirements for the allowance.

SECTION 140.7 – PRESCRIPTIVE REQUIREMENTS FOR OUTDOOR LIGHTING

APPENDIX D: TITLE 24, PART 6, SECTION 130.2

SECTION 130.2 – OUTDOOR LIGHTING CONTROLS AND EQUIPMENT

Nonresidential and hotel/motel buildings shall comply with the applicable requirements of Sections 130.2(a) through 130.2(c).

(a) **Reserved.**

(b) **Luminaire shielding requirements.** All outdoor luminaires of 6,200 initial luminaire lumens or greater shall comply with backlight, uplight and glare (BUG) in accordance with ANSI/IES TM-15-20, Annex A requirements in accordance with Title 24, Part 11, Section 5.106.8.

Exception 1 to Section 130.2(b): Signs.

Exception 2 to Section 130.2(b): Lighting for building facades, public monuments, public art, statues and vertical surfaces of bridges.

Exception 3 to Section 130.2(b): Lighting not permitted by a health or life safety statute, ordinance or regulation to be a cutoff luminaire.

Exception 4 to Section 130.2(b): Temporary outdoor lighting.

Exception 5 to Section 130.2(b): Replacement of existing pole mounted luminaires in hardscape areas meeting all of the following conditions:

- A. Where the existing luminaire does not meet the luminaire BUG requirements in Section 130.2(b); and
- B. Spacing between existing poles is greater than six times the mounting height of the existing luminaires; and
- C. Where no additional poles are being added to the site; and
- D. Where new wiring to the luminaires is not being installed; and
- E. Provided that the connected lighting power wattage is not increased.

Exception 6 to Section 130.2(b): Luminaires that illuminate the public right of way including publicly-maintained or utility-maintained roadways, sidewalks and bikeways.

Exception 7 to Section 130.2(b): Outdoor lighting attached to a hotel/motel building and separately controlled from the inside of a guest room.

(c) **Controls for outdoor lighting.** Outdoor lighting shall be independently controlled from other electrical loads, and the controls for outdoor lighting shall meet the following functional requirements:

Exception 1 to Section 130.2(c): Outdoor lighting not permitted by a health or life safety statute, ordinance or regulation to be turned OFF or reduced.

Exception 2 to Section 130.2(c): Lighting in tunnels required to be illuminated 24 hours per day and 365 days per year.

1. **Daylight availability.** All installed outdoor lighting shall be controlled by a photo control, astronomical time-switch control, or other control capable of automatically shutting OFF the outdoor lighting when daylight is available.
2. **Automatic scheduling controls.**
 - A. Automatic scheduling controls shall be installed for all outdoor lighting. Automatic scheduling controls may be installed in combination with motion sensing controls or other outdoor lighting controls.
 - B. Automatic scheduling controls shall be capable of reducing the outdoor lighting power by at least 50 percent and no more than 90 percent, and separately capable of turning the lighting OFF, during scheduled unoccupied periods.

- C. Automatic scheduling controls shall allow scheduling of a minimum of two nighttime periods with independent lighting levels, and may include an override function that turns lighting ON during its scheduled dim or OFF state for no more than two hours when an override is initiated.
- 3. **Motion sensing controls.**
 - A. Motion sensing controls shall be installed for the following luminaires. Motion sensing controls may be installed for other outdoor lighting and in combination with other outdoor lighting controls.
 - i. Outdoor luminaires other than those providing building façade, ornamental hardscape, outdoor dining or outdoor sales frontage lighting, where the bottom of luminaire is mounted 24 feet above grade or lower; and
 - ii. Bilaterally symmetric outdoor wall-mounted luminaires (typically referred to as “wall packs”) providing building façade, ornamental hardscape or outdoor dining lighting that are mounted 24 feet above grade or lower.
 - B. Motion sensing controls shall be capable of reducing the outdoor lighting power of each controlled luminaire by at least 50 percent and no more than 90 percent, and separately capable of turning the luminaire OFF, during unoccupied periods.
 - C. Motion sensing controls shall be capable of reducing the lighting to its dim or OFF state no longer than 15 minutes after the area has been vacated, and of returning the lighting to its ON state when the area becomes occupied.
 - D. No more than 1,500 watts of lighting power shall be controlled by a single sensor or as a single zone.

Exception 1 to Section 130.2(c)3: Luminaires with a maximum rated wattage of 40 watts each are not required to have motion sensing controls.

Exception 2 to Section 130.2(c)3: Applications listed as Exceptions to Section 140.7(a) are not required to have motion sensing controls.

Exception 3 to Section 130.2(c)3: Lighting subject to a health or life safety statute, ordinance, or regulation may have a minimum time-out period longer than 15 minutes or a minimum dimming level above 50 percent when necessary to comply with the applicable law.

Note: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 130.2 – OUTDOOR LIGHTING CONTROLS AND EQUIPMENT

APPENDIX E: TITLE 24, PART 1, TABLE 10-114-A

10-114 – DETERMINATION OF OUTDOOR LIGHTING ZONES AND ADMINISTRATIVE RULES FOR USE

This section establishes rules for implementing outdoor lighting zones to show compliance with Section 140.7 of Title 24, California Code of Regulations, Part 6.

- (a) **Lighting Zones.** Exterior lighting allowances in California vary by Lighting Zones (LZ).
- (b) **Lighting Zone Characteristics.** TABLE 10-114-A specifies the relative ambient illumination level and the statewide default location for each lighting zone.
- (c) **Amending the Lighting Zone Designation.** A local jurisdiction may officially adopt changes to the lighting zone designation of an area by following a public process that allows for formal public notification, review, and comment about the proposed change. The local jurisdiction may determine areas where Lighting Zone 4 is applicable and may increase or decrease the lighting zones for areas that are in State Default Lighting Zones 1, 2 and 3, as specified in TABLE 10-114-A.
- ~~(d) **Commission Notification, Amended Outdoor Lighting Zone Designation.** Local jurisdictions who adopt changes to the State Default Lighting Zones shall notify the Commission by providing the following materials to the Executive Director:~~
 - ~~1. A detailed specification of the boundaries of the adopted Lighting Zones, consisting of the county name, the city name if any, the zip code(s) of the redesignated areas, and a description of the physical boundaries within each zip code;~~
 - ~~2. A description of the public process that was conducted in adopting the Lighting Zone changes; and~~
 - ~~3. An explanation of how the adopted Lighting Zone changes are consistent with the specifications of Section 10-114.~~
- ~~(e) The Commission shall have the authority to not allow Lighting Zone changes which the Commission finds to be inconsistent with the specifications of Section 10-114.~~

TABLE 10-114-A LIGHTING ZONE CHARACTERISTICS AND RULES FOR AMENDMENTS BY LOCAL JURISDICTIONS

Zone	Ambient Illumination	State wide Default Location	Moving Up to Higher Zones	Moving Down to Lower Zones
LZ0	Very Low	Undeveloped areas of government designated parks, recreation areas, and wildlife preserves.	Undeveloped areas of government designated parks, recreation areas, and wildlife preserves can be designated as LZ1 or LZ2 if they are contained within such a zone.	Not applicable
LZ1	Low	<u>Rural areas, as defined by the 2010 U.S. Census. These areas include: single or dual family residential areas, parks, and agricultural zone districts.</u> Developed Developed portion of government designated parks, recreation areas, and wildlife preserves. Those that are wholly contained within a higher lighting zone may be considered by the local government as part of that lighting zone.	Developed portion of a government designated park, recreation area, or wildlife preserve, can be designated as LZ2 or LZ3 if they are contained within such a zone. <u>Retail stores, located in a residential neighborhood, and rural town centers, as defined by the 2010 U.S. Census, can be designated as LZ2 if the business operates during hours of darkness.</u>	Not applicable.
LZ2	Moderate	Rural areas Urban clusters, as defined by the 2010 U.S. Census. <u>The following building types may occur here: multifamily housing, mixed use residential neighborhoods, religious facilities, schools, and light commercial business districts or industrial zoning districts.</u>	Special districts within a default LZ2 zone may be designated as LZ3 or LZ4 by a local jurisdiction. Examples include special commercial districts or areas with special security considerations located within a <u>rural mixed-use residential area or city center.</u>	Special districts and government designated parks within a default LZ2 zone may be designated as LZ1 by the local jurisdiction, for lower illumination standards, without any size limits.
LZ3	Moderately High	Urban areas, as defined by the 2010 U.S. Census. <u>The following building types may occur here: high intensity commercial corridors, entertainment centers, and heavy industrial or manufacturing zone districts.</u>	Special districts within a default LZ3 may be designated as a LZ4 by local jurisdiction for high intensity nighttime use, such as entertainment or commercial districts or areas with special security considerations requiring very high light levels.	Special districts and government designated parks within a default LZ3 zone may be designated as LZ1 or LZ2 by the local jurisdiction, without any size limits.
LZ4	High	None.	Not applicable.	Not applicable.

NOTE: Authority: Sections 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

APPENDIX F: IESNA TABLE 26.5, LIGHT TRESPASS

Table 26.5 | Recommended Light Trespass Illuminance Limits

Lighting Zone	Limit in lux ^a	
	Pre-curfew	Post-curfew
LZ4	15	6
LZ3	8	3
LZ2	3	1
LZ1	1	0
LZ0	0.1	0

- a. Maximum initial illuminance on a plane perpendicular to the line of sight to the luminaire(s). Plane located at observer position where light trespass is under review. [7]

APPENDIX G: LIGHT TRESPASS ILLUMINANCE CALCULATION DATA

Project exterior lighting illuminance data presented below is derived from the lighting illuminance calculations prepared as described in Section 9 above. Illuminance data is presented in the following tables with location coordinates defined relative to the elevation and horizontal distance from lower left, viewing from the Project to the vertical plane where Light Trespass illuminance is under review. Grid data is displayed at ten feet on center, vertical and horizontal.

VP-E1

Horizontal (ft)		5	15	25	35	45	55	65	75	85	95	105
Vertical (ft)	115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	75	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	65	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	55	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	45	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	35	0.10	0.20	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	25	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	15	0.20	0.40	0.40	0.40	0.40	0.30	0.30	0.30	0.30	0.30	0.30
	5	0.30	0.60	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

VP-E1

Horizontal (ft)		115	125	135	145
Vertical (ft)	115	0.00	0.00	0.00	0.00
	105	0.00	0.00	0.00	0.00
	95	0.00	0.00	0.00	0.00
	85	0.00	0.00	0.10	0.10
	75	0.00	0.00	0.10	0.10
	65	0.00	0.00	0.10	0.10
	55	0.10	0.10	0.10	0.10
	45	0.10	0.10	0.10	0.10
	35	0.10	0.10	0.20	0.20
	25	0.20	0.20	0.20	0.20
	15	0.30	0.30	0.40	0.30
	5	0.70	0.70	0.70	0.60



VP-S1

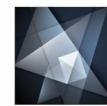
Horizontal (ft)		5	15	25	35	45	55	65	75	85	95	105
Vertical (ft)	115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.10
	95	0.10	0.10	0.10	0.00	0.00	0.00	0.10	0.10	0.10	0.10	0.10
	85	0.10	0.10	0.10	0.00	0.00	0.10	0.10	0.10	0.10	0.10	0.10
	75	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	65	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	55	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.20	0.20
	45	0.10	0.10	0.10	0.10	0.10	0.10	0.20	0.20	0.20	0.20	0.20
	35	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.30
	25	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30
	15	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
	5	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

VP-S1

Horizontal (ft)		115	125	135	145	155	165	175	185	195	205	215
Vertical (ft)	115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	105	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	95	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.10	0.10
	85	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.10	0.10
	75	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	65	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	55	0.20	0.20	0.20	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	45	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.10	0.10	0.10	0.10
	35	0.30	0.30	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	25	0.30	0.30	0.30	0.30	0.30	0.30	0.20	0.20	0.20	0.20	0.20
	15	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.20	0.20
	5	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.00	0.10

VP-S1

Horizontal (ft)		225	235	245	255	265	275	285	295	305	315	325
Vertical (ft)	115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	85	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	75	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	65	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	55	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	45	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	35	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	25	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	15	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



VP-S1

Horizontal (ft)		335	345	355	365	375	385	395	405	415	425	435
Vertical (ft)	115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

VP-S1

Horizontal (ft)		445	455	465	475	485	495	505	515	525	535	545
Vertical (ft)	115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

VP-S1

Horizontal (ft)		555	565	575	585	595	605	615	625	635
Vertical (ft)	115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00