

Lighting around Peyton Hall



General Lighting Levels – Introduction

2015 Master Lighting Plan: **recommended values are 0.3 – 0.5 FC**

Table 2: Recommended Pedestrian Walkway Illuminance Levels

| Pedestrian Walkway Classification | Average Target Horizontal Illuminance (FC) | Average Target Vertical Illuminance (FC) (6 feet above grade) | Uniformity (avg to min) | |
|---|--|---|-------------------------|------|
| | | | (H) | (V) |
| Pedestrian Path - Adjacent to Road (Intermediate / Collector) | 0.5 | 1 | 10:1 | 10:1 |
| Pedestrian Path - Adjacent to Road (Local / Interior) | 0.5 | 0.04 | 10:1 | 10:1 |
| Pedestrian Path - Distant from Road | 0.5 | 0.04 | 10:1 | 10:1 |
| Pedestrian Path - Stairs / Abrupt Change in Elevation | 0.5 | 1 | 10:1 | 10:1 |

Recommended illumination levels adapted from Table 6 of RP-33-99 Lighting for Exterior Environments. Some values have been modified to preserve Princeton's prevailing park-like lighting conditions.

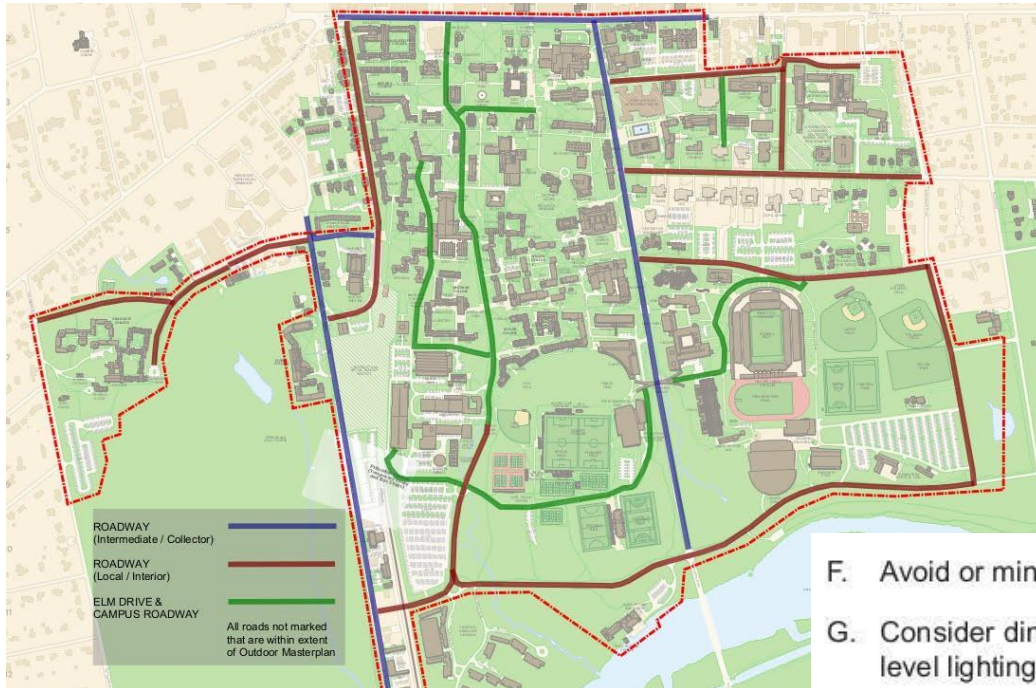
Table 4: Recommended Roadway Illuminance Levels

| Roadway Classification | Average Target Horizontal Illuminance (FC) | Minimum Target Vertical Illuminance (FC) (4.9 feet above grade) | Uniformity (avg to min) | |
|---|---|---|-------------------------|-----|
| | | | (H) | (V) |
| Roadway (Intermediate / Collector) | 0.6 - 1.2 | - | 4:1 | - |
| Roadway (Local / Interior) | 0.4 - 0.9 | - | 6:1 | - |
| Crosswalks (Intermediate / Collector Roads) | 0.4 | 0.1 | 4:1 | 4:1 |
| Crosswalks (Local / Interior Roads) | 0.3 | 0.08 | 6:1 | 6:1 |
| Campus Roadway | Refer to Pedestrian Path - Distant from Roadways Recommended Illumination Values. Same values apply to crosswalks traversing alleyways. | | | |

Recommended illumination levels adapted from Tables 2, 6 and 7 of RP-8-00 (Reaffirmed 2005) Roadway Lighting. Some values have been modified to preserve Princeton's prevailing park-like lighting conditions.

General Lighting Levels – Introduction

2015 Master Lighting Plan: map of roadways. Ivy lane is a “Local/Interior” roadway.



Some important principles from 2015:

- B. Avoid or minimize nuisance glare by providing low-glare or cutoff-type luminaires.
- F. Avoid or minimize spill light into the night sky.
- G. Consider dimmable luminaires wired to motion sensors to allow for multi-level lighting operation.

2025 Master Lighting Plan* – Introduction

Recommended values are: 0.2 - 0.9 FC

03 LIGHTING GUIDELINES

Table 1: Recommended Pavement Illuminance Criteria for Roadway Lighting

| ROADWAY CLASSIFICATION | AVERAGE TARGET HORIZONTAL ILLUMINANCE (FC) | MINIMUM TARGET VERTICAL ILLUMINANCE (FC) (4.9 FEET ABOVE GRADE) | UNIFORMITY (AVG TO MIN) |
|---|--|---|-------------------------|
| | L21 & L22 | L21 & L22 | (H) |
| ROADWAY (INTERMEDIATE / COLLECTOR) | 0.4 - 0.8 | - | 3:1 - 4:1 |
| ROADWAY (LOCAL / INTERIOR) | 0.3 - 0.6 | - | 6:1 |
| CROSSWALKS (INTERMEDIATE / COLLECTOR ROADS) | 11 - 22 | ≥ 11 - 22 | 4:1 |
| CROSSWALKS (LOCAL / INTERIOR ROADS) | 0.7 - 1.7 | ≥ 0.7 - 1.7 | 6:1 |
| CAMPUS ROADWAY | REFER TO PEDESTRIAN PATH - DISTANT FROM ROADWAYS RECOMMENDED ILLUMINATION VALUES. SAME VALUES APPLY TO CROSSWALKS TRAVERSING ALLEYWAYS | | |

Recommended illumination levels adapted from Table 12-2 RP-8-22 Part 2 Lighting Roadway and Parking Facilities

Table 2: Recommended Pedestrian Pathway Illuminance Levels

| PEDESTRIAN WALKWAY CLASSIFICATION | AVERAGE TARGET HORIZONTAL ILLUMINANCE (FC) | | AVERAGE TARGET VERTICAL ILLUMINANCE (FC) (6 FEET ABOVE GRADE) | | UNIFORMITY (AVG TO MIN) |
|---|--|---|---|-----|-------------------------|
| | L21 | L22 | L21 | L22 | (H) |
| PEDESTRIAN PATH - ADJACENT TO ROAD (INTERMEDIATE / COLLECTOR) | 0.2 - 0.9 | 0.2 - 0.9 | 1 | - | 5:1 |
| PEDESTRIAN PATH - ADJACENT TO ROAD (LOCAL / INTERIOR) | 0.2 - 0.9 | 0.2 - 0.9 | 0.04 | - | 5:1 - 10:1 |
| PEDESTRIAN PATH - DISTANT FROM ROAD | 0.4 - 0.8 (landscape) 1 - 2 (bldgs.) | 0.2 - 0.4 (landscape) 0.5 - 1 (bldgs.) | 0.04 | - | 10:1 |
| PEDESTRIAN PATH - STAIRS / ABRUPT CHANGE IN ELEVATION | 2 - 3 | 1 - 2 | 1 | - | 5:1 |

Recommended illumination levels adapted from Table A-3 of RP-43-22 Lighting for Exterior Applications.

Five Lighting Principles for Responsible Outdoor Lighting



Responsible outdoor lighting is

1 Useful

Use light only if it is needed

All light should have a clear purpose. Consider how the use of light will impact the area, including wildlife and their habitats.



2 Targeted

Direct light so it falls only where it is needed

Use shielding and careful aiming to target the direction of the light beam so that it points downward and does not spill beyond where it is needed.



3 Low Level

Light should be no brighter than necessary

Use the lowest light level required. Be mindful of surface conditions, as some surfaces may reflect more light into the night sky than intended.



4 Controlled

Use light only when it is needed

Use controls such as timers or motion detectors to ensure that light is available when it is needed, dimmed when possible, and turned off when not needed.



Warm-colored

Use warmer color lights where possible

Limit the amount of shorter wavelength (blue-violet) light to the least amount needed.



1,400 × 904

The master plan is under development

Princeton and Sustainability – Introduction

Princeton has a broad and thorough sustainability plan:

<https://www.calameo.com/read/0008049750f1d739b8d74?page=103>



04

A Sustainability Framework

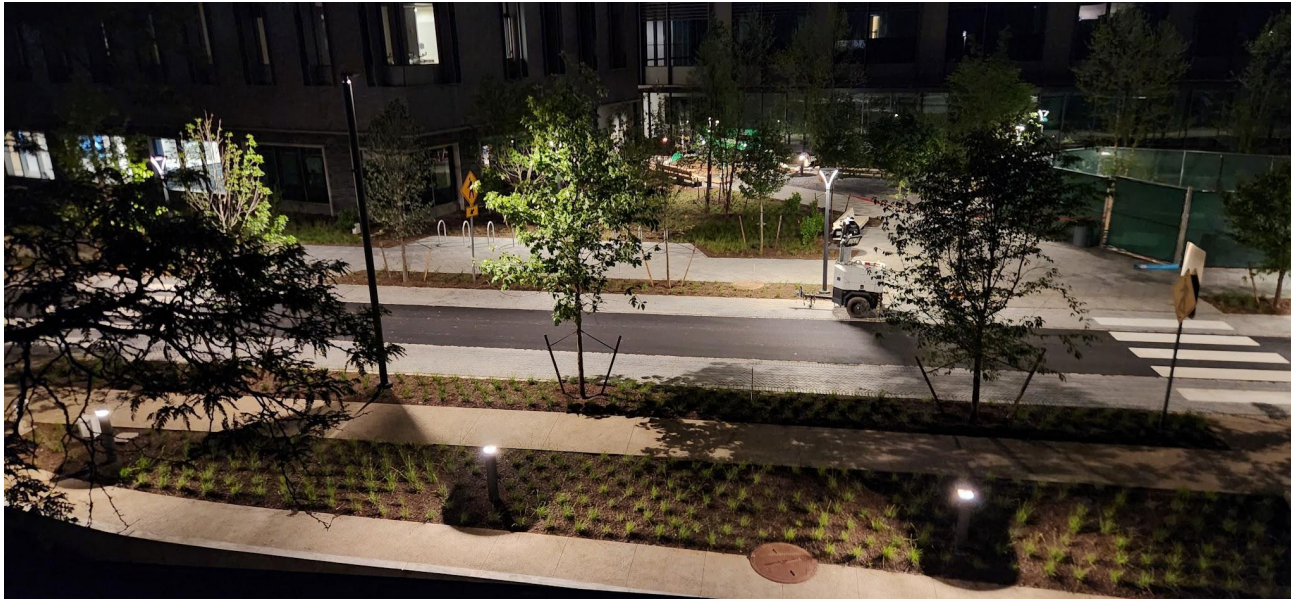
A defining characteristic of Princeton's planning process has been thorough integration of campus planning and infrastructure planning with sustainability planning. The campus planning framework includes a sustainability framework that identifies priorities, proposes performance targets, and suggests planning and design strategies that can be incorporated into the campus's physical development to advance Princeton's sustainability objectives. Another component of the campus planning framework is an integrated infrastructure master plan that coordinates Princeton's utility infrastructure needs with its anticipated development and sustainability objectives. This section provides an overview of the sustainability framework that incorporates sustainability objectives and strategies into campus planning.

Lights around Peyton Hall – Ivy Lane

Light levels, pedestrian walkway: 0.75 - 3 FC (lighting plan: 0.2 – 0.9). Overlighting by 3x.

Light levels: roadway: 0.9 - 2.1 FC (lighting plan: 0.3 - 0.6). Overlighting by 3x.

Lighting appears to be ~3000 K. No dimming, no motion sensing.



Bollards with direct glare



Photos taken from Peyton's roof.

Northeast Side of Peyton



Note the direct light/glare from the bollards

North Side, Office Lights

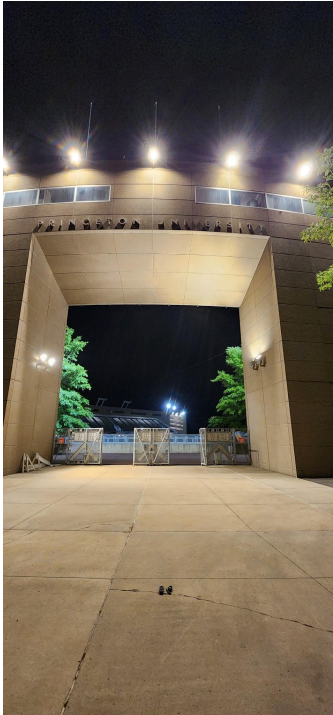


Suggested solutions:

- i) ask ES+SEAS occupants to use their shades (will be a hit or miss)
- ii) development of automatic shades for the night
- iii) development of a wall extension/shade on Peyton's North wall

South side of Peyton

Light levels due to archway lighting: up to 5.7 FC illuminance!



South Side of Peyton

Archway lights directly illuminate the roof, and cause overlighting



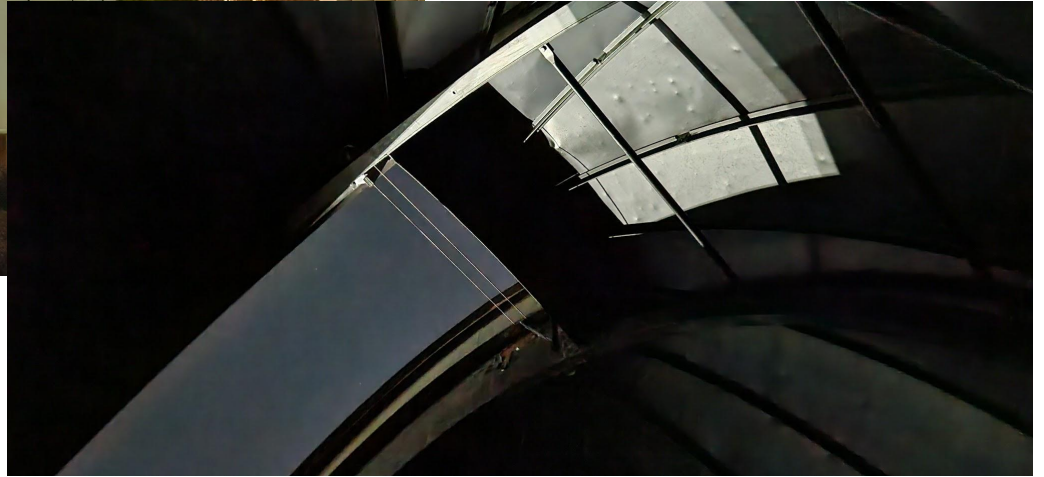
South Side of Peyton

Archway lights directly illuminate the roof, and cause overlighting



Unnamed AST205 student was trying to get Orion's belt in her telescope. No undergraduate was harmed in the experiment.

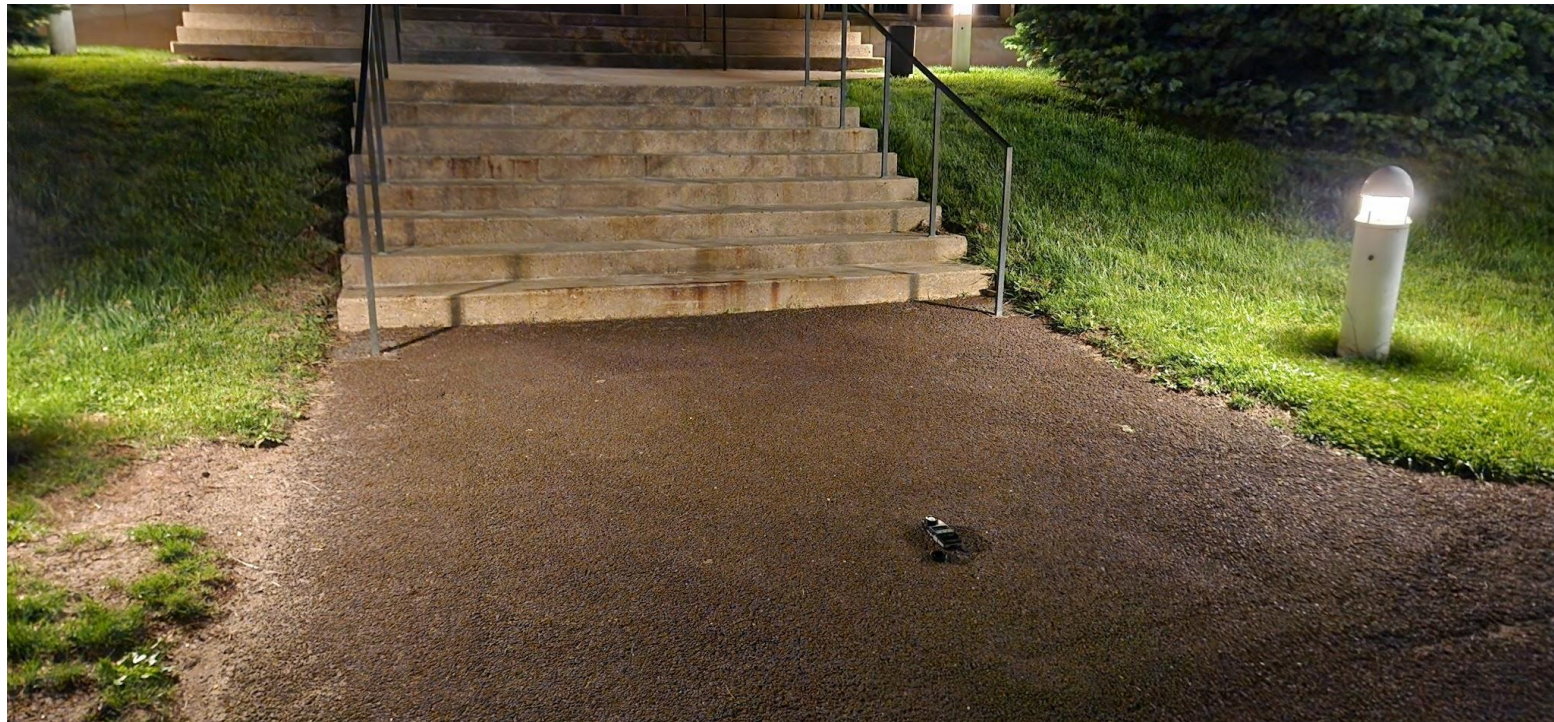
Peyton Dome



West Side of Peyton



South Side, Old-Style shielded bollards



NorthWest, Greenhouse



Solutions

Simple solutions exist. They are all fully consistent with our 2015 and 2025 master lighting plans, and with general principles of sustainability.

- **Decrease lighting levels to 1/3rd.** Further dimming by motion sensing and timer-based dimming (e.g. > 10pm). Both the roadway and walkway lights are dimmable (see next slides).
- Permanently turn off/disable, or fully shield bollards.
- Remove or fully shield any lights directly shining on Peyton's roof
- Automatic evening shades for ES+SEAS building offices and/or strong policies on pulling their shades in the evening.
- Full light blackout shading for the greenhouse.
- Eliminate archway lights. They are polluting, overly bright, and redundant.

Bega 99556

This roadway fixture is dimmable, has “DALI” dimming, and also has AMBER LED versions.

DALI (Digital Addressable Lighting Interface) dimming is a digital lighting control protocol that allows for precise and flexible control of lighting fixtures. It enables individual or group control of lights, offering advanced features like scene setting, grouping, and feedback. Sources:

https://bega-censhare.s3.us-east-2.amazonaws.com/userfiles/files/99556_BEGA_Spec.pdf

<https://www.bega-us.com/categories/exterior/pole-top/single-and-twin-160001/99556>

Electrical

| | |
|---------------------------|--------------------------|
| Operating voltage | 120-277V AC |
| Minimum start temperature | -30° C |
| LED module wattage | 31.4W |
| System wattage | 40.0W |
| Controllability | 0-10V dimming down to 1% |
| Color rendering index | Ra > 80 |
| Luminaire lumens | 4555 lm |
| LED service life (L70) | 60000 hrs |

LED color temperature

- 4000K (K4)
- 3500K (K35)
- 3000K (K3)
- 2700K (K27)

BEGA can supply you with suitable LED replacement modules for up to 20 years after the purchase of LED luminaires - see website for details

Finish

All BEGA standard finishes are matte, textured powder coat with minimum 3 mil thickness. BEGA Unidure® finish provides superior fade protection in Black, Bronze, and Silver. BEGA standard White is a super durable polyester powder. Optionally available RAL, custom, and premium colors provided in polyester powder and/or liquid paint.

Available options

| | |
|--------|--------------------------|
| 347V | 347V input |
| AMB | Amber LED |
| CUS | Custom finish |
| DALI-2 | DALI dimming |
| FSC | Fusing |
| MGU | Marine grade undercoat |
| PCR | Photocell receptacle |
| RAL | RAL finish |
| STP | Step dimming (120V only) |

BEGA

Lighting Furniture Projects Resources Purchase Search

BEGA > Products > Exterior > Pole-top > Area/Roadway luminaire > 99 556



Area/Roadway luminaire

Bega 84121

This walkway fixture is dimmable, has “DALI” dimming. The dimming was confirmed by BEGA lighting engineers.

Sources:

<https://www.bega-us.com/categories/exterior/pole-top/symmetric-and-asymmetric-160025/84121>

https://bega-censhare.s3.us-east-2.amazonaws.com/userfiles/files/84121_BEGA_Spec.pdf

EPA (Effective projection area): 0.7 sq. ft.

Electrical

| | |
|---------------------------|------------|
| Operating voltage | 120-277VAC |
| Minimum start temperature | -30° C |
| LED module wattage | 23.6W |
| System wattage | 28.0W |

Controllability 0-10V dimming down to 1%

| | |
|------------------------|-----------|
| Color rendering index | Ra > 80 |
| Luminaire lumens | 2297 lm |
| LED service life (L70) | 60000 hrs |

LED color temperature

- 4000K (K4)
- 3500K (K35)
- 3000K (K3)
- 2700K (K27)



Longer Term Solutions

- Longer term: replace roadway lighting around Peyton with amber LEDs. Readily available and would also help educate the community.
- Committee on Light Pollution @ Princeton. Any project with lighting would be reviewed by the committee.
- Educating Princetonians on light pollution and the choices we make.
- Explore Andlinger Center roof for star-viewing.
- Dedicating dark-sky eco-friendly areas on campus (such as Broadmead, Butler tracts, Poe Field, Golf Course).
- Finding land North of Princeton for an off-campus observatory. (This is a major project, I am just raising it here).

Log of Measurements



Light meter halfway between roadway lights at the local minimum illuminance. Values are 0.9 FC.

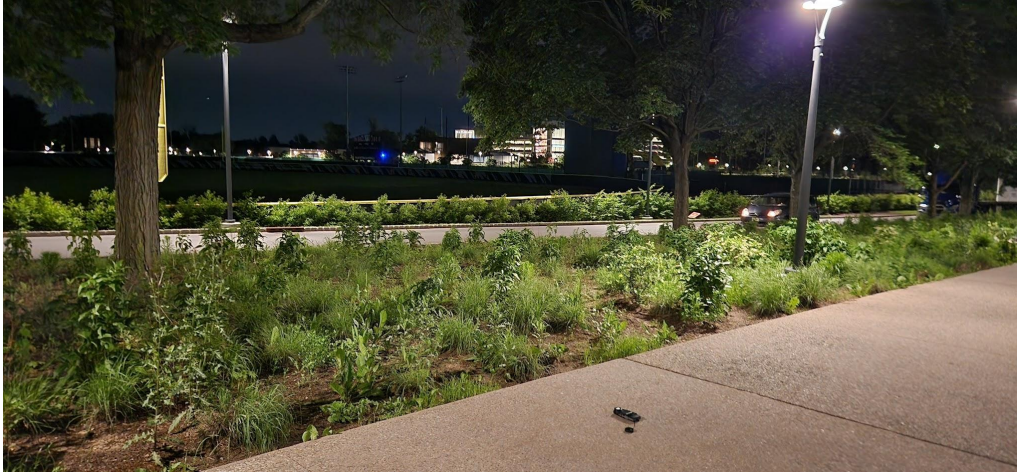


Log of Measurements

Light meter under roadway lights at the local maximum illuminance. Values are 2.4 FC.



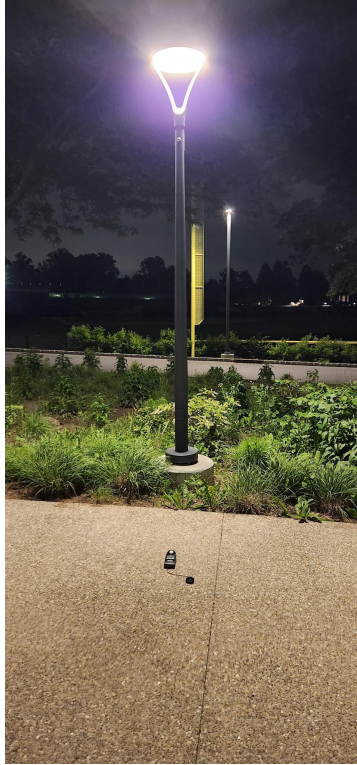
Log of Measurements



Light meter halfway between walkway lights at the local minimum illuminance. Values are 0.75 FC.



Log of Measurements



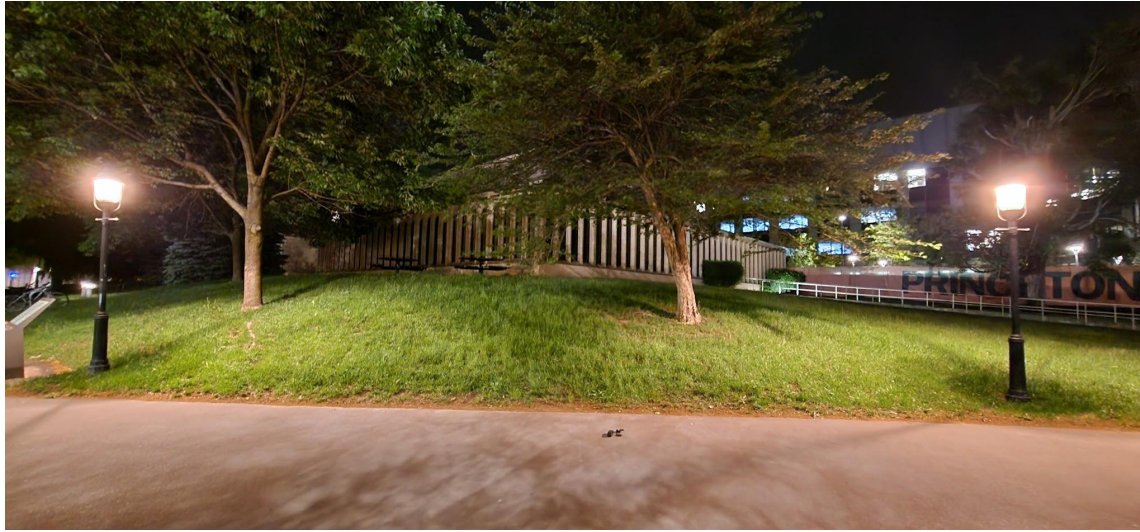
Light meter under walkway lights at the local maximum illuminance. Values are 3.3 FC.

Log of Measurements



Light meter under walkway lights at the local maximum illuminance. Values are 3.9 FC.

Log of Measurements



Light meter halfway between walkway lights at the local minimum illuminance. Values are 0.9 FC.

