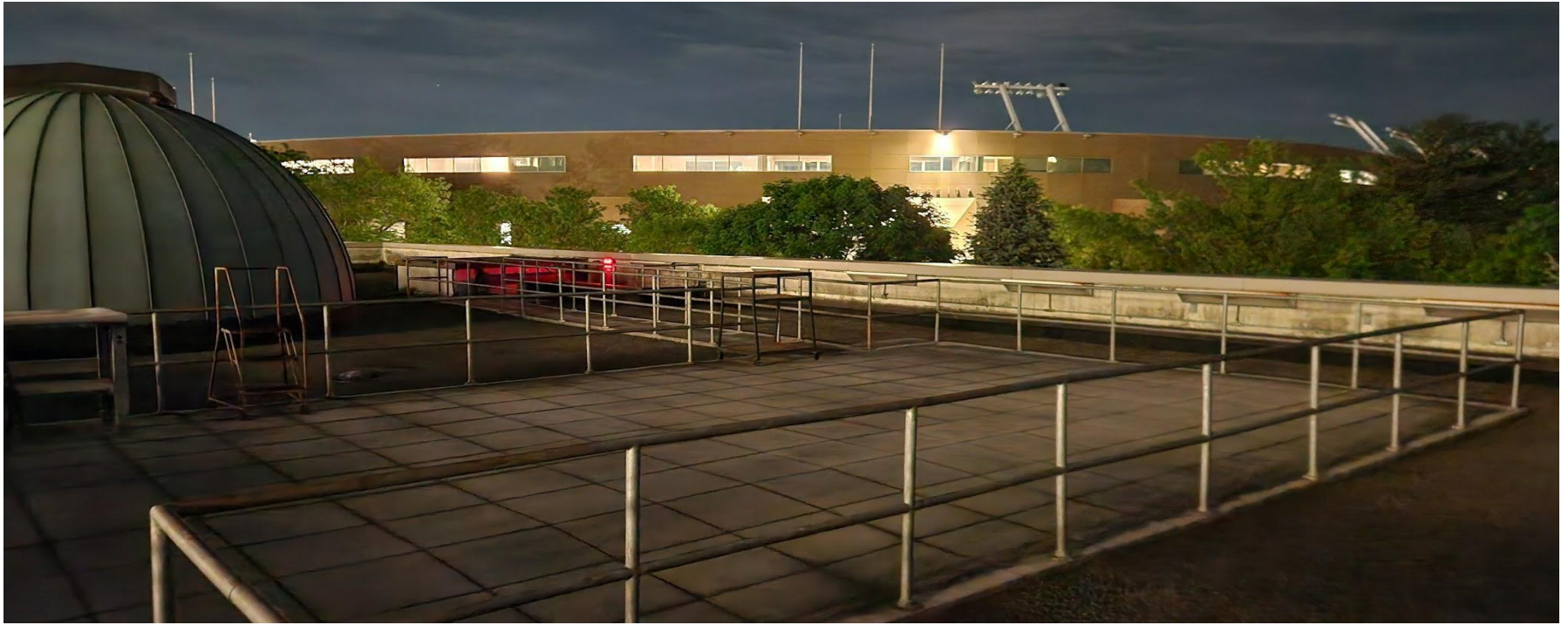
Lighting around Peyton Hall



Gaspar Bakos, Department of Astrophysics, 2025 June 2

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.

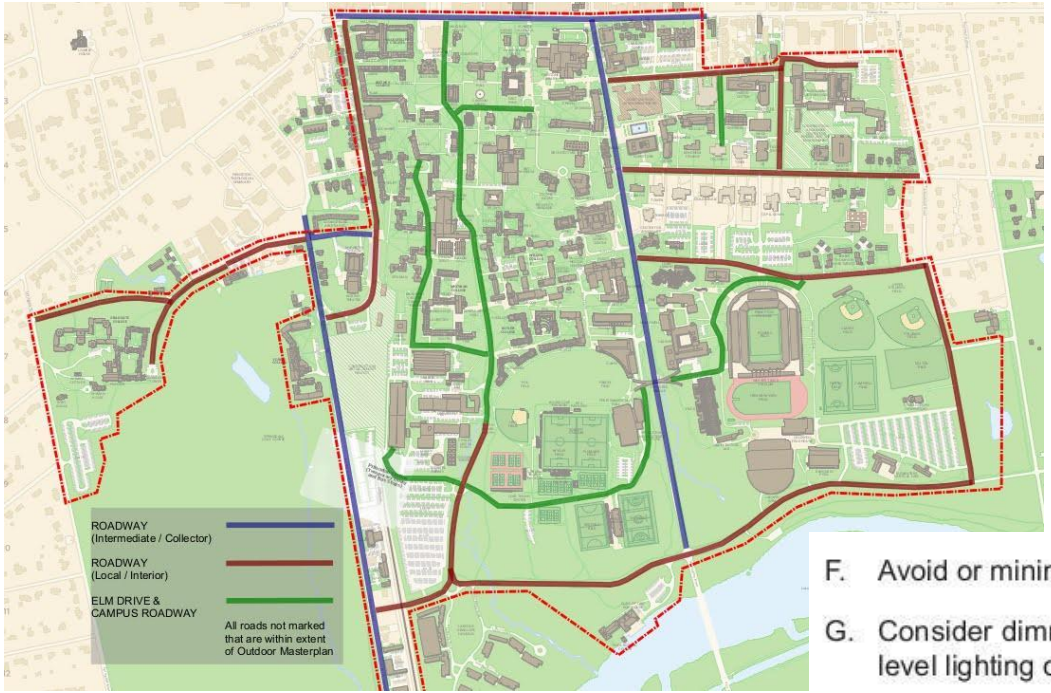
Table 4: Recommended Roadway Illuminance Levels

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

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)
	LZ1 & LZ2	LZ1 & LZ2	(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)	1.1 – 2.2	>= 1.1 – 2.2	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)
	LZ1	LZ2	LZ1	LZ2	(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.

The master plan is under development

Princeton and Sustainability – Introduction

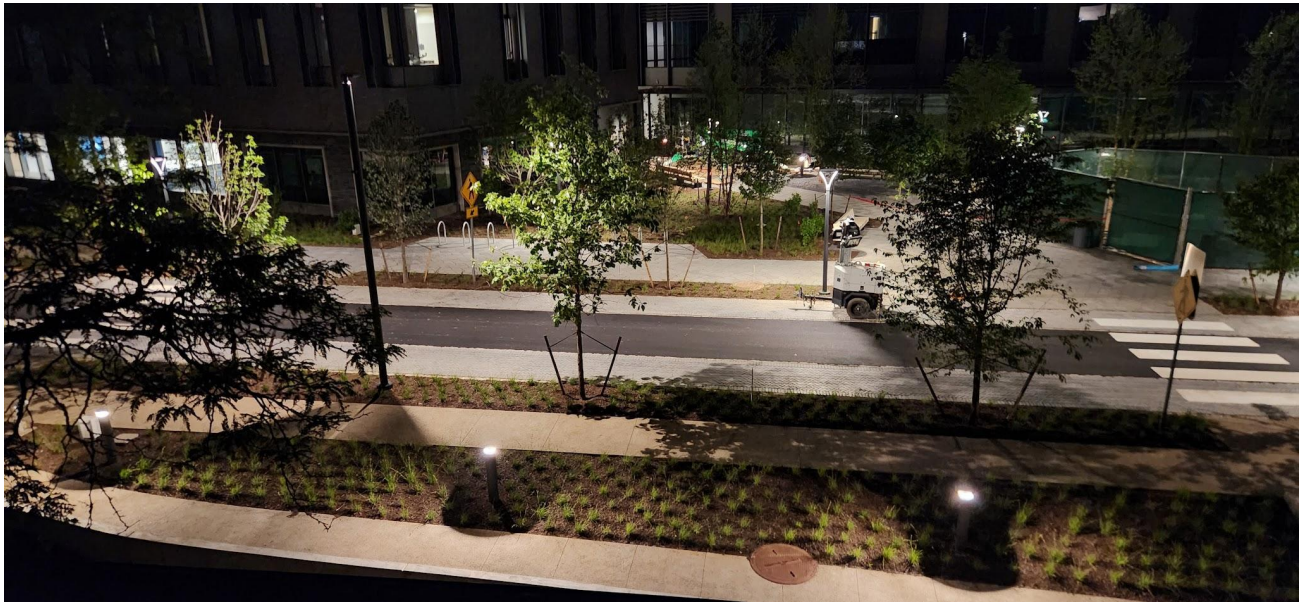
Princeton has a broad and thorough sustainability plan:
https://www.calameo.com/read/0008049750f1d739b8d74?page=103

Lights around Peyton Hall – Ivy Lane

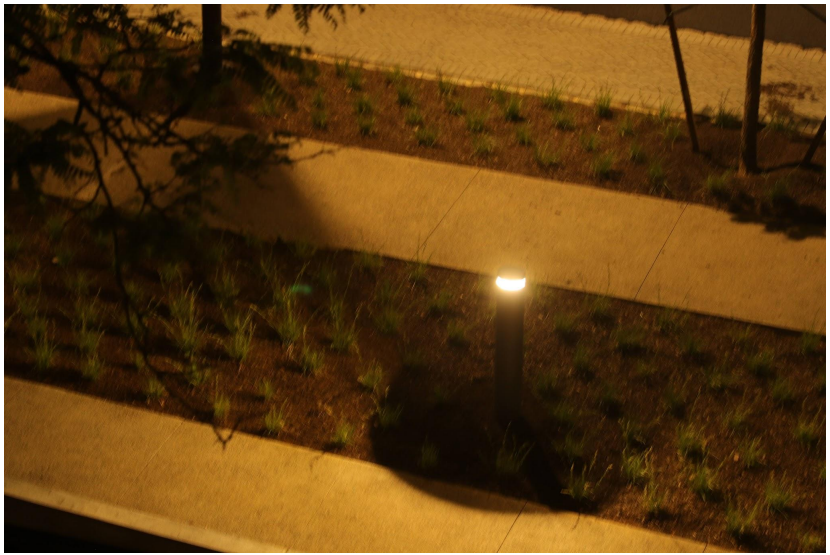
Light levels, pedestrian walkway: 0.75 - 3 FC (lighting plan: 0.2 – 0.9). Overlighting by 3x.

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

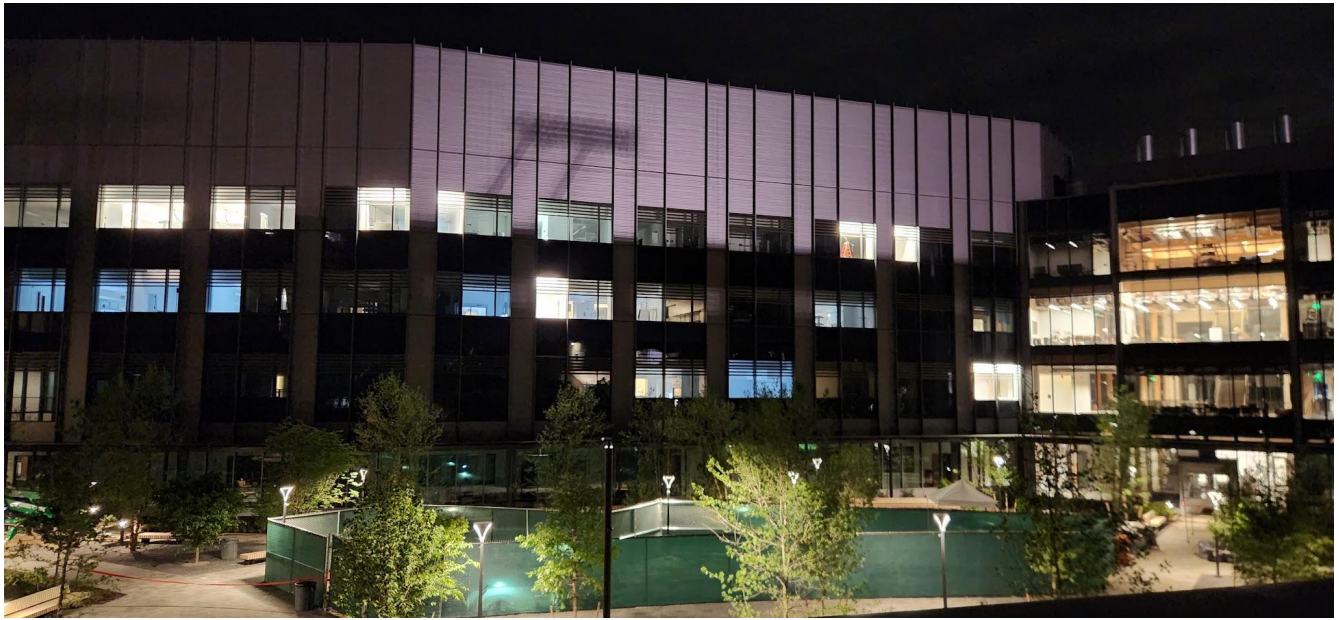


Photos taken from Peyton’s roof.

Northeast Side of Peyton

Note the direct light/glare from the bollards

North Side, Office Lights

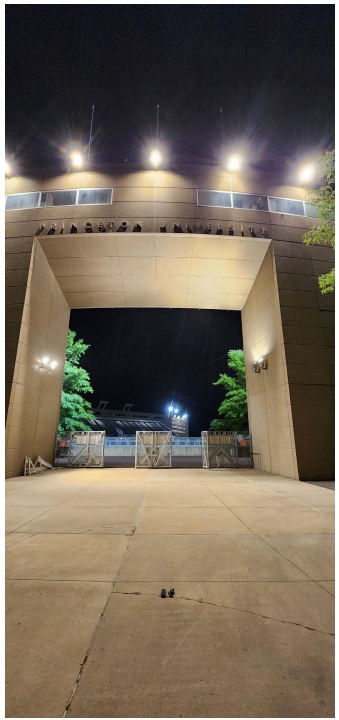


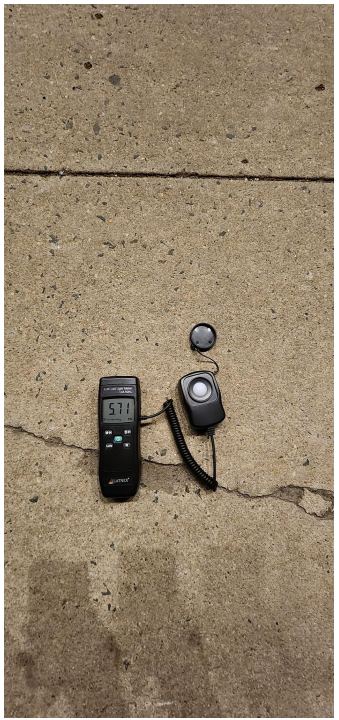
Suggested solutions:

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

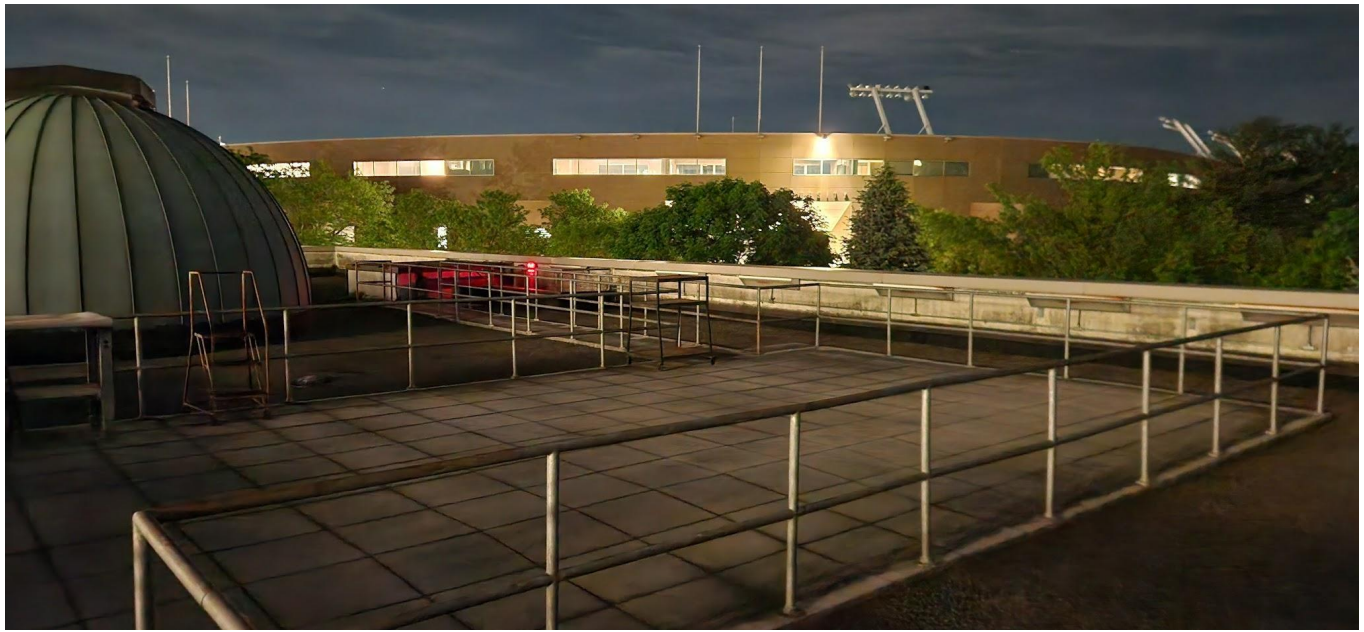
Light levels due to archway lighting: up to 5.7 FC illuminance!





South Side of Peyton

Archway lights directly illuminate the roof, and cause overlighting

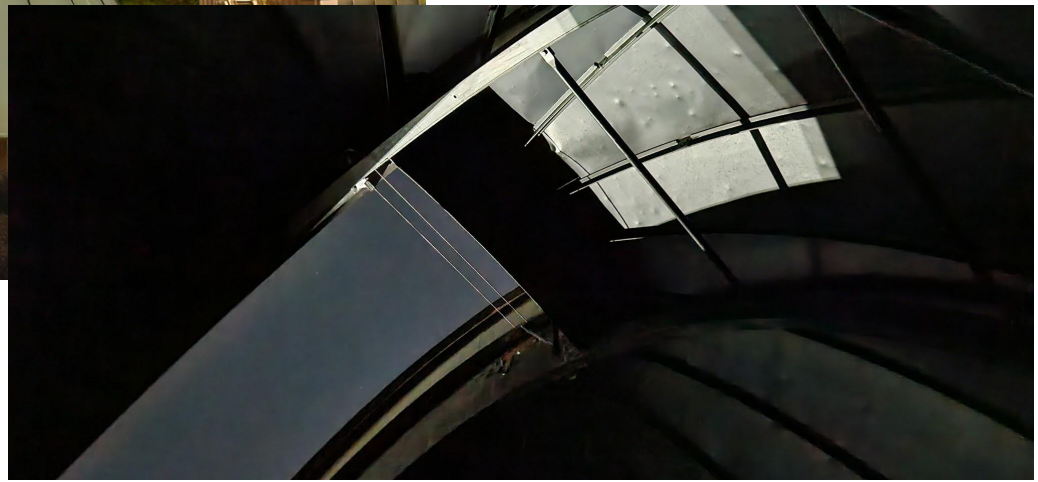


South Side of Peyton

Archway lights directly illuminate the roof, and cause overlighting

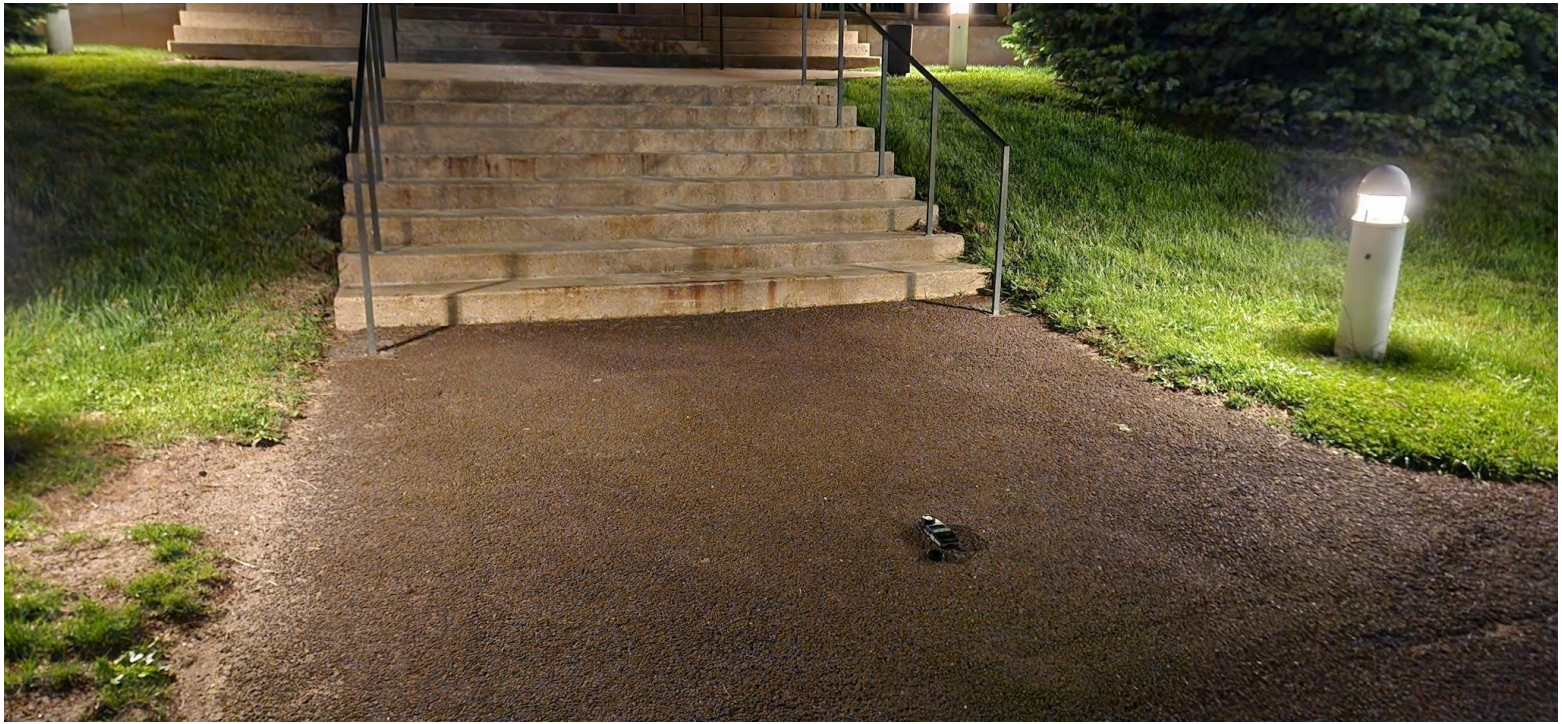
Unnamed AST205 student was trying to get Orion’s belt in her telescope. No undergraduate was harmed in the experiment.

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 blockout 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	31.4 W
System wattage	40.0 W
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)

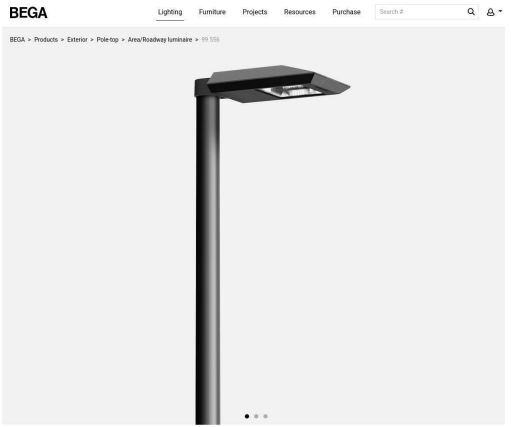
BEGA can supply you with suitable LED replacement modules for up to 20 years after the purchase of LED luminaires - see website for details

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 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

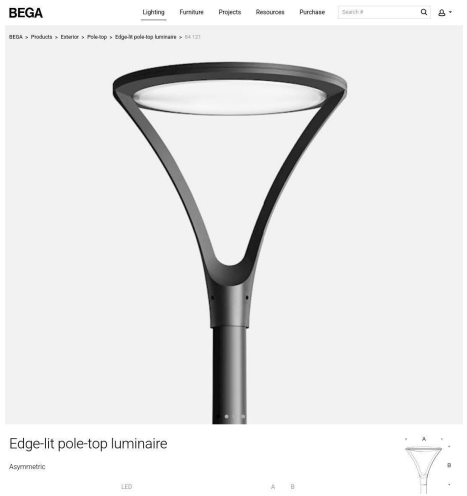
EPA (Effective projection area): 0.7 sq. ft.

Electrical

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

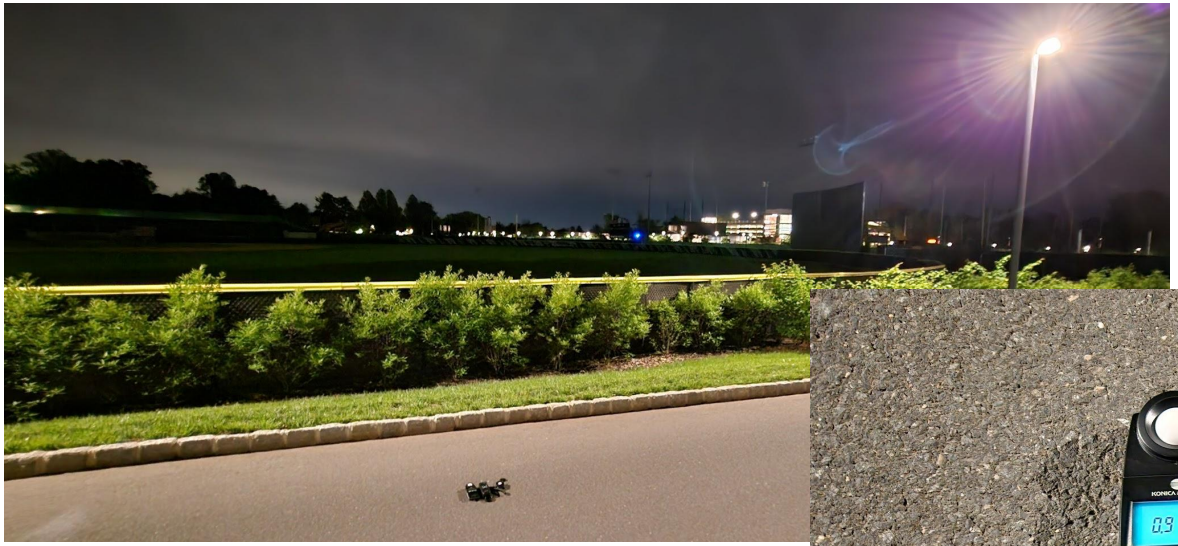
- 4000K (K4)
- 3500K (K35)
- 3000K (K3)
- 2700K (K27)



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).

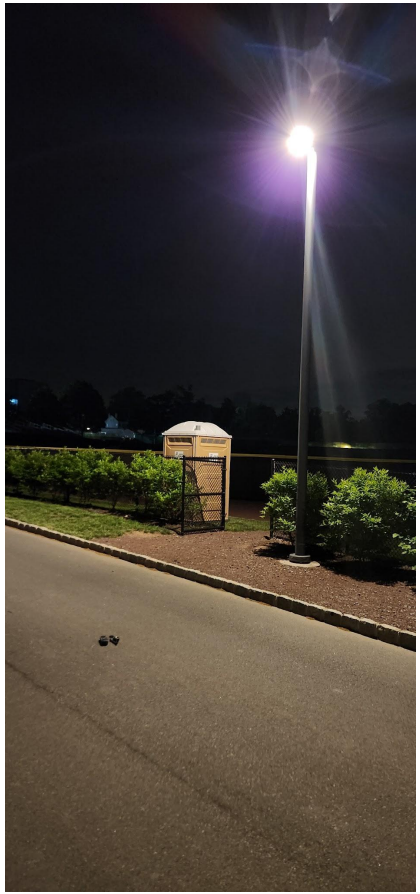
Log of Measurements



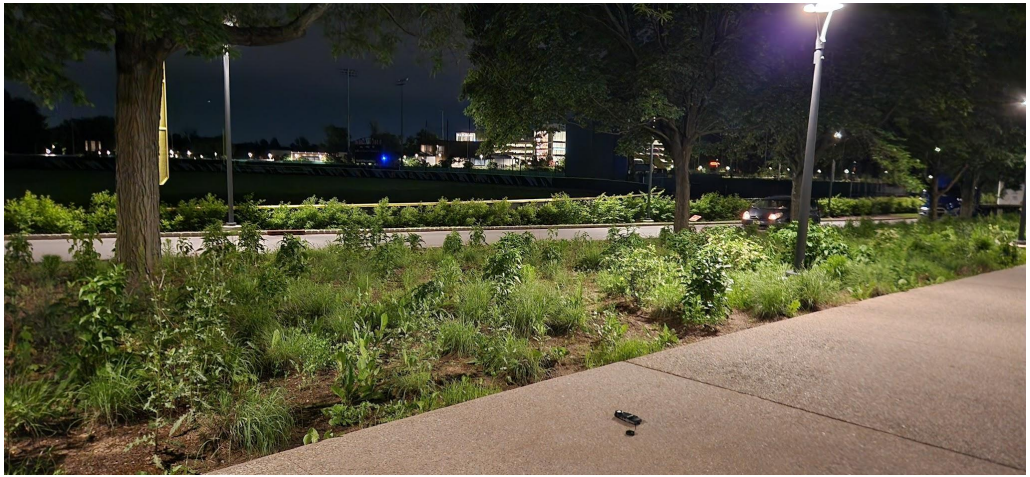
Light meter halfway between roadway lights at the local minimum illuminance. Values are 0.9 FC.

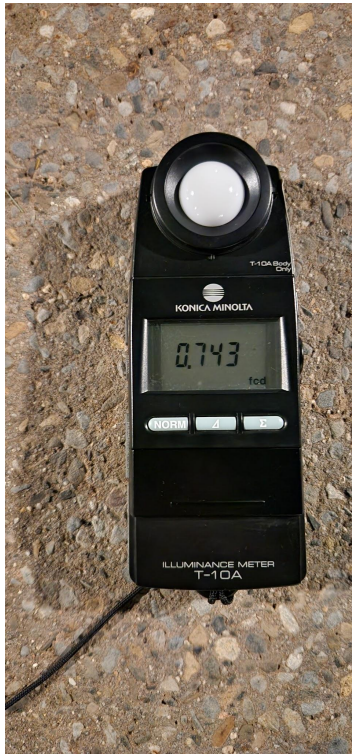
Log of Measurements

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



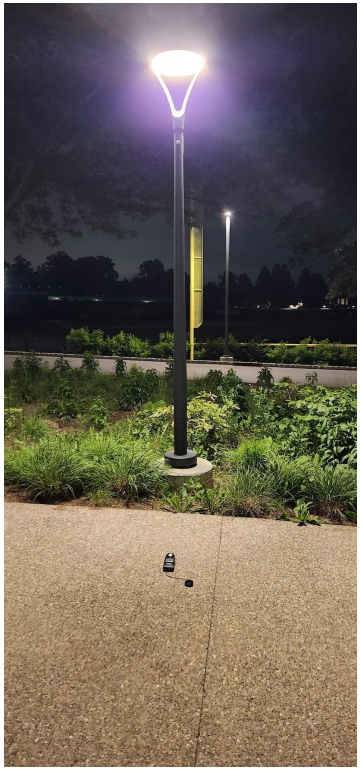
Log of Measurements





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

Log of Measurements

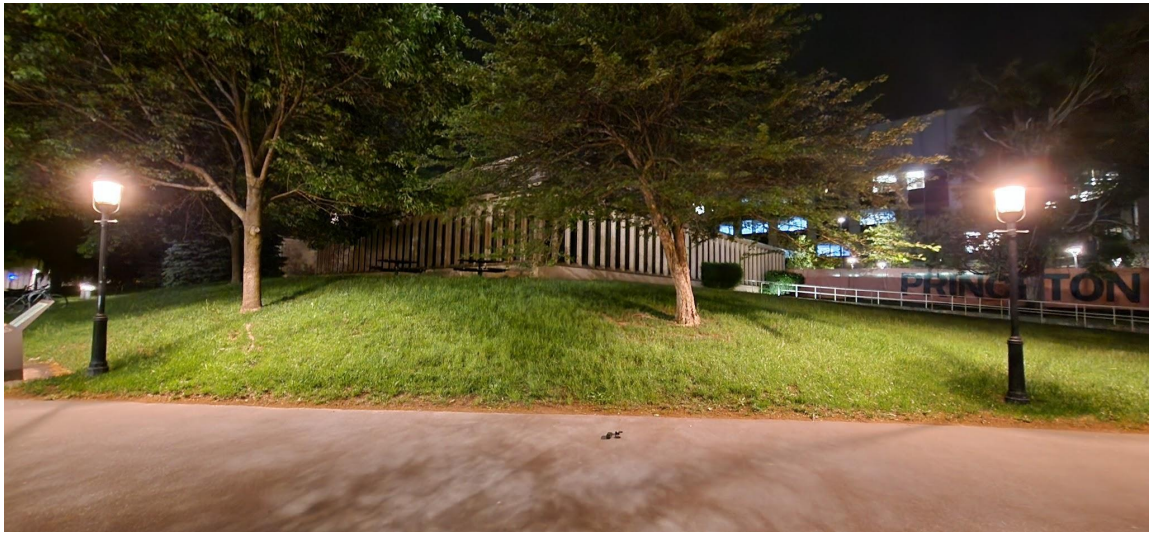


Light meter under walkway lights at the local maximum illuminance. Values are 3.3 FC.

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.