

A nighttime photograph of an outdoor pedestrian space. A curved, illuminated walkway leads through a landscaped area with trees and large, white, rock-like structures. The scene is lit with warm, yellow light, creating a serene atmosphere.

Lighting for Outdoor Pedestrian Spaces

Randy Burkett, RBLDI

Nancy Clanton, Clanton Associates

Shirley Coyle, Cree Lighting

Naomi Miller, PNNL

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Shirley Coyle, LC
VP Specification Sales, Cree Lighting



Nancy Clanton, PE, FIES, FIALD, LC, LEED Fellow
CEO, Clanton & Associates Engineering



Randy Burkett, FIALD, FIES, LC
Lighting Designer, Randy Burkett Lighting Design, Inc.



Naomi Miller, FIES, FIALD
Designer/Scientist, Pacific Northwest National Laboratory



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Learning Objectives

At the end of the this course, participants will be able to:

1. Apply principles of design that support visibility and beauty, without making spaces spooky
2. Identify nighttime spaces that are creative and uplifting while still providing visibility
3. Design outdoor spaces that feel safe without overlighting or wasted light
4. Understand the balance of light levels, uniformity and luminaire choices to enhance an outdoor space





Session Agenda – Lighting for Outdoor Pedestrian Spaces

- Design Considerations
- Design Process
- By the numbers: Metrics and Calculations
- Wrap Up / Q&A





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Nancy Clanton
PE, FIES, LC, IALD, LEED Fellow
President, Clanton & Associates



DESIGN CONSIDERATIONS FOR PEDESTRIAN LIGHTING



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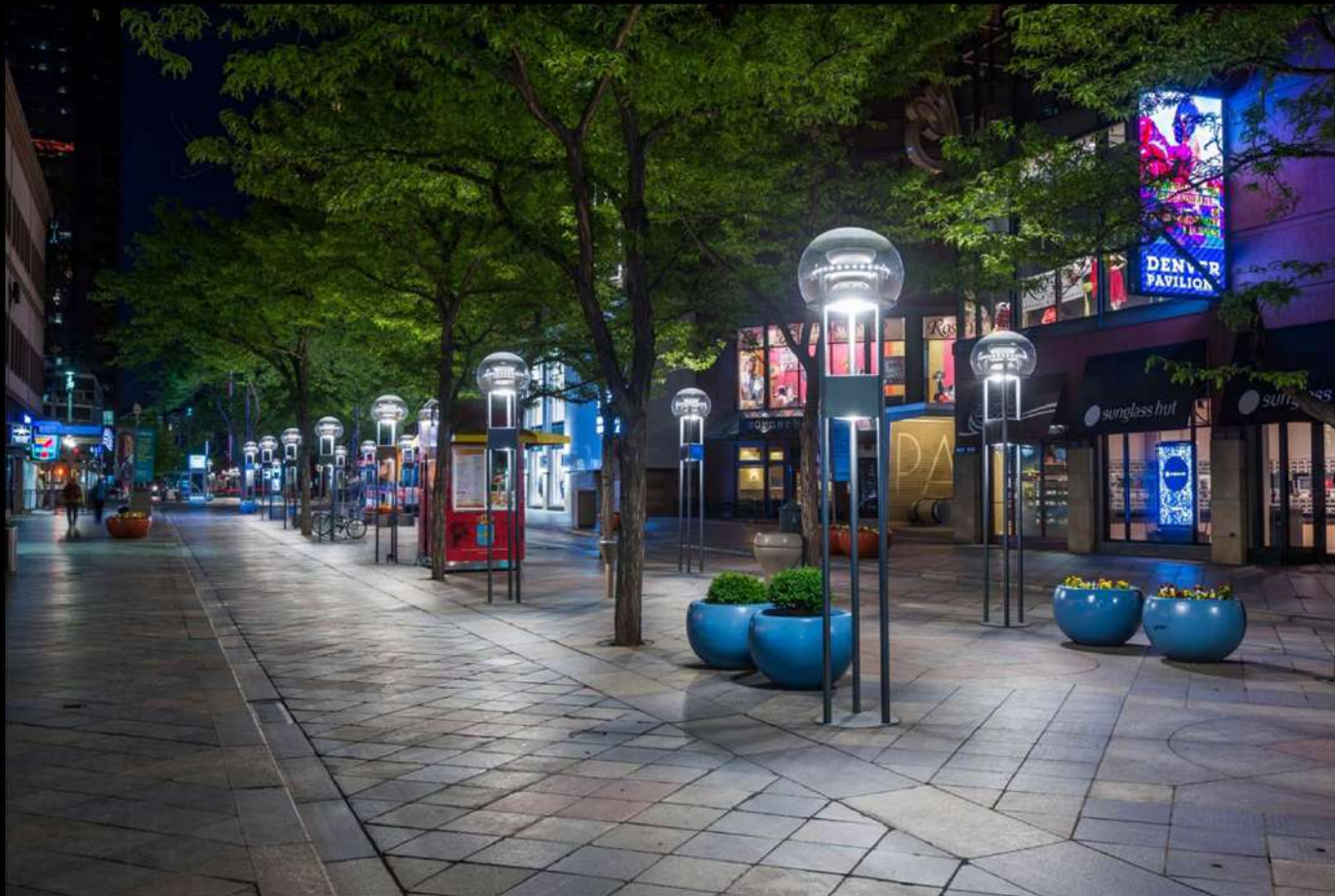
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10 lx | 25 lx | 50 lx

10 lx | 25 lx | 50 lx

10 lx | 25 lx | 50 lx

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cd/m2
189.287
75.356
30
11.943
4.754
1.892
0.753
0.3
0.119
0.047



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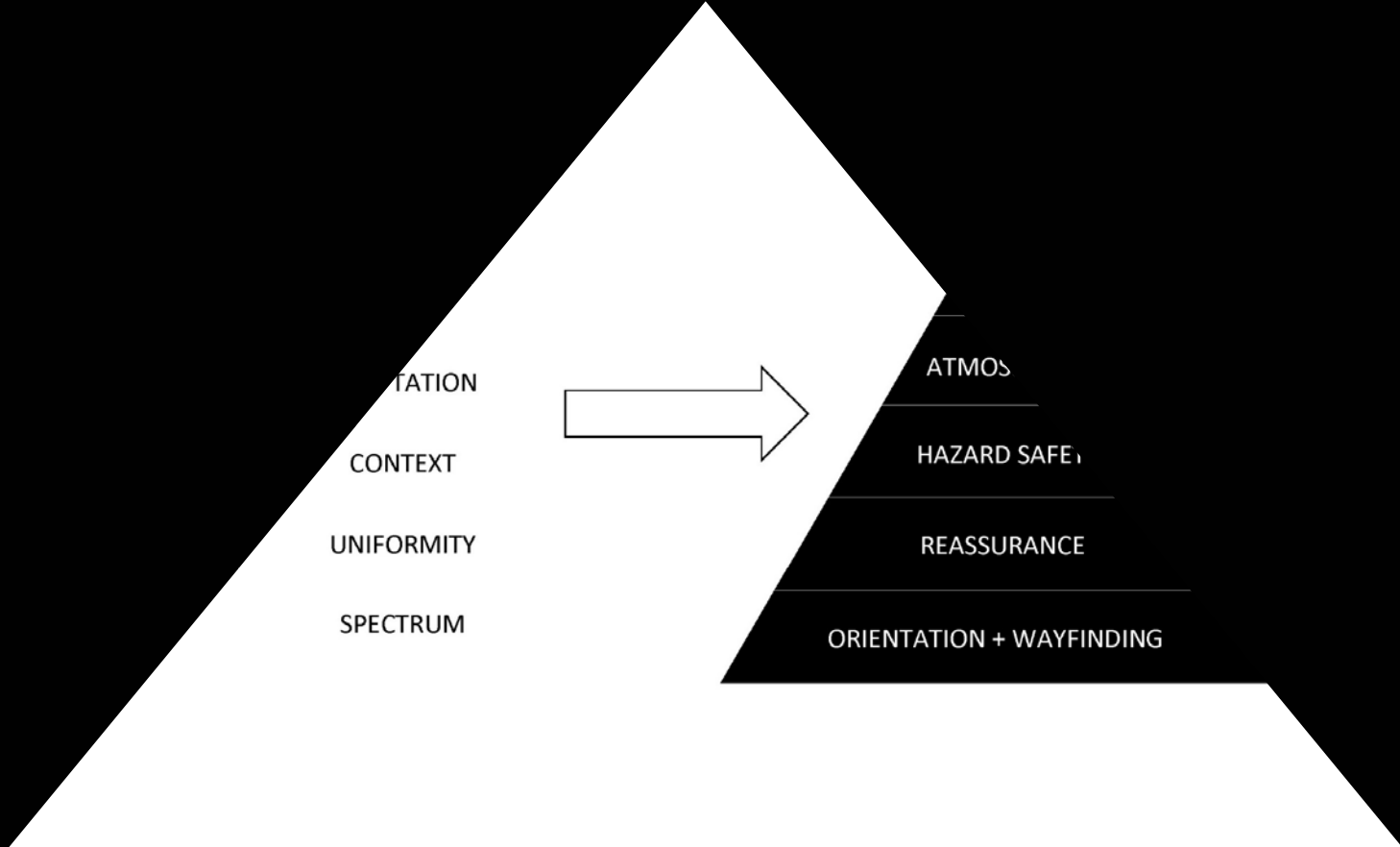


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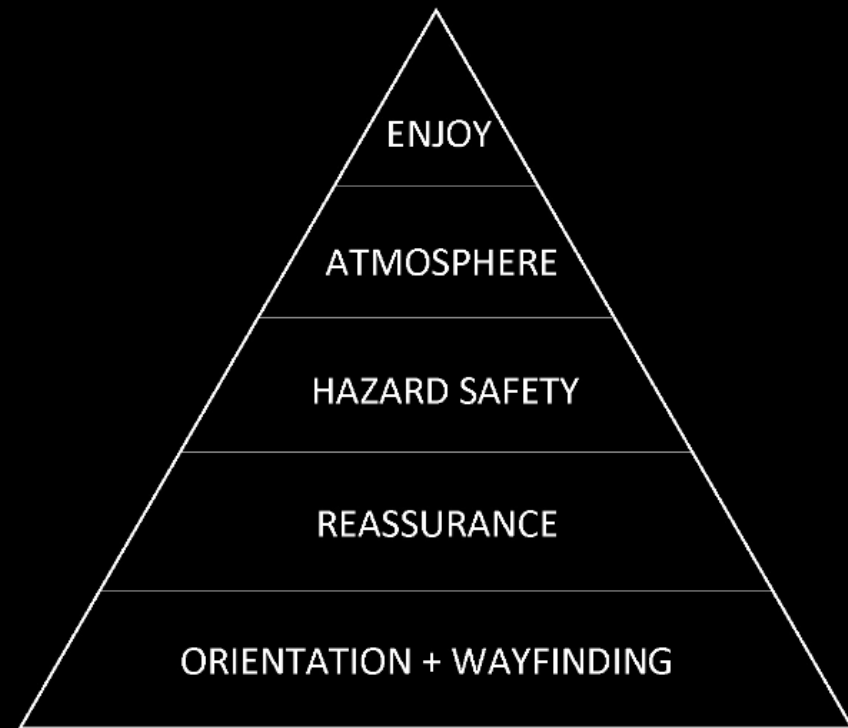


Randy Burkett
FIALD, IES, LC
President, RBLD

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THE DESIGN PROCESS FOR PEDESTRIAN LIGHTING



THE DESIGN PROCESS FOR PEDESTRIAN LIGHTING



- Community Goals
- Lighting Zone
- Spatial Character
- Points of interest defining the environment
- Visual coherency and understanding
- The color of light and its role
- Task needs
- Luminance ratios
- Patterns
- Uniformity



HIERARCHY AND CONTEXT



- Lighting relating to the principles, ideas and intended hierarchical relationships of the visual environment
- Lighting's role imparting information and creating impressions about spatial character
- Cultural and historic issues
- Functional context
- Architectural perspective
- Lighting enhancing the appropriate visual cues
- Adjacencies
- A spatial framework and visual coherency
- Night and day



HIERARCHY AND CONTEXT

Defining Community Goals and Themes



- Community Goals
- Synergistic themes in architecture and lighting
- Spatial Character
- Communication with stakeholders, clients...
- Mutual understanding of design objectives
- Prioritizing community objectives
 - Identifying when not to light
 - Sensitivity to light pollution and light trespass.
 - Nighttime ambience and beauty, architecture or nature
 - Crime prevention and pedestrian reassurance
 - Project economics, energy and sustainability



HIERARCHY AND CONTEXT

Transitions among Tasks, Zones, or Light Levels



- Task diversity
- Task complexity
- Unique visual needs – user age, terrain, etc.
- Glare
- Transitioning
 - Abrupt transitions between spaces can appear more interesting, emotional or dramatic. The subtle use of multiple CCT's or even the bold use of color can create the dynamic transition
 - Subtle transitions providing consistent, restrained visual processing
- Lighting tools – intensity, uniformity, color, etc.

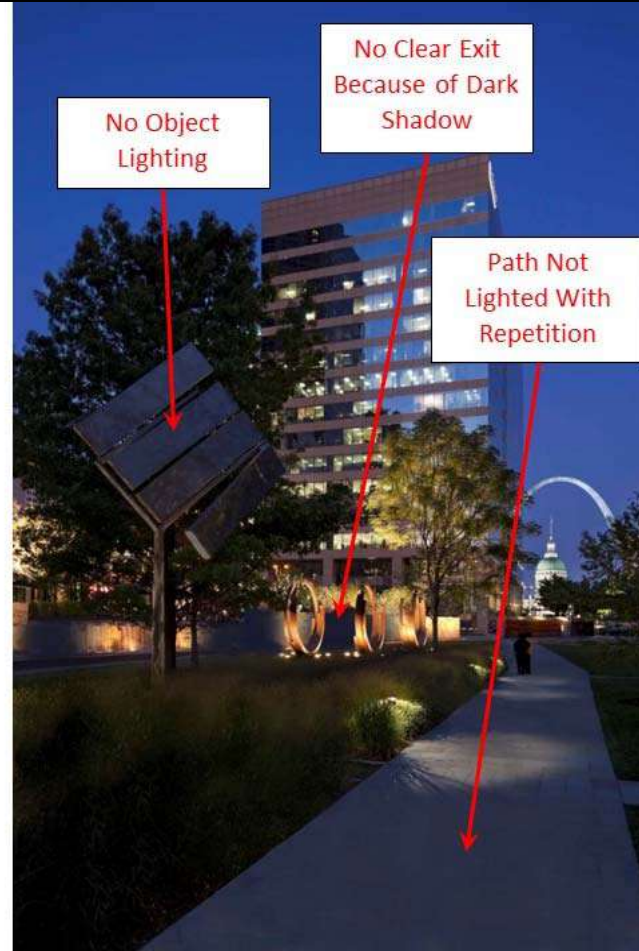


ORIENTATION AND WAYFINDING



- Conscious and subconscious understanding of one's surroundings
- Revealing vertical and horizontal surfaces
- Light supporting observation and detection.
- Looking to the horizon, to boundaries, to vertical objects near and far; to both static and moving features, and to pathways.
- Understand the defined environment
 - Architecture, buildings, towers, bridges
 - Sculptures, monuments, and hardscape
 - Water features
 - Landscape and flora elements
- A Sense of Place





ORIENTATION AND WAYFINDING



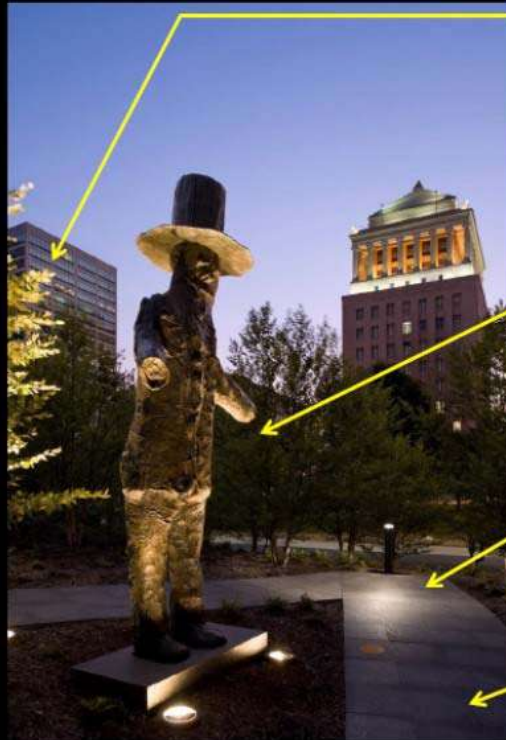
- Conscious and subconscious effort to move and navigate in an environment
- Communication of perceptual information
- Pedestrian confidence
- Coherency
- Hierarchy
- Logic and simplicity
 - Understanding human needs
 - Patterns
 - Recognizable contrast
 - Predicable visual cues
- A Sense of Place



Visual Coherency



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Uplighted tree to softly illuminate path and heighten pedestrian form recognition.

Uplighted art to reveal form and texture

Way finding - Heightened pathway luminance to identify changes or decision points.

Reduced pathway luminance at art to heighten contrast.



REASSURANCE



- Objectivity / subjectivity
- Providing comfort to make someone feel less worried, less afraid or doubtful, and imbue confidence the objective or task is met.
- Light's role in revelation; detection of people
- Potential threat identification
- Status of boundaries and egress points
- Visual coherency and understanding
- Importance of the vertical plane
- Boundary and peripheral illumination
- Facial Expression Recognition
- Other Visual Cues
- Security is different than reassurance





Soft perimeter brightness adds sense of safety and security, and helps minimize concealment.

Spill light to sidewalk provides functional illumination and better facial light



TERRAIN AND OBJECT SAFETY



- (Terrain) Ability to detect and avoid obstacles or hazards within the path
- Role of illuminance - horizontal and vertical
- Predictability - scanning the visual field
- Identification and differentiation
- Glare

- (Object) Ability to identify and avoid static or moving objects not normal to terrain
- Importance of peripheral revelation
- Do not over-light
- Reaction and navigation



ATMOSPHERE AND ENJOYMENT



- Emotional responses and perception of space
- Glare reduction
- Uniformity
- Lighting levels
- Luminance ratios and pattern
- Patterns
- CCT and spectrum
- Architecture, materiality, texture, reflectance, and function
- Enjoyment?
- The choreographed environment





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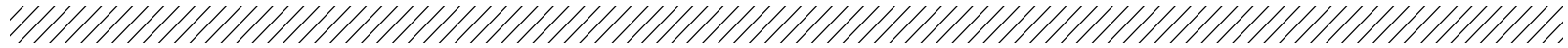


Naomi Miller
FIES, FIALD, LC
Pacific Northwest National Laboratory

Lighting for Outdoor Pedestrian Spaces

Naomi's stuff:

**The Handy Table
And How to Use It**



Lighting for People in Outdoor Environments

Lighting Zone 0 (LZO) – No ambient electric light

LZO

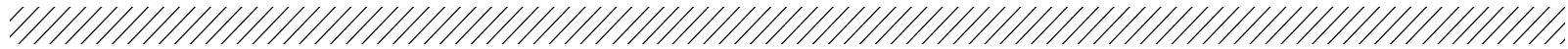
Areas where the natural environment could be seriously and adversely affected by small amounts of electric lighting at night. This includes biological cycles of flora and fauna, and human enjoyment and appreciation of the natural environment. Human activity is sparse and is subordinate in importance to the natural environment. There is no expectation for man-made lighting.

Examples: Critical dark environments, such as especially sensitive wildlife preserves, turtle nesting beaches, parks, and areas near astronomical observatories. Communities may designate areas as LZO in order to preserve a naturally dark region for future generations.



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Lighting for People in Outdoor Environments

Lighting Zone 1 (LZ1) – Very low ambient electric light

LZ1

Developed areas within a natural environment and areas of human activity that are inherently dark at night. Electric lighting at night could adversely affect the biological cycles of flora and fauna, or could interrupt the quiet, dark character of the area. The vision of humans when outside is typically adapted to the darkness and they do not expect to see man-made lighting except where absolutely necessary to improve visibility and safety. In these limited areas, low light levels are appropriate. Lighting is expected to be non-continuous (i.e. pools of light rather than uniform lighting along a path or roadway). After curfew, both light levels and uniformity may be reduced in some areas.

Examples: Residential sections in small communities; developed areas in local and state parks, recreation areas, wetlands and wildlife preserves; developed areas in natural settings; sensitive night environments; zoos; rural areas.



<https://media-cdn.tripadvisor.com/media/photo-o/0a/fb/c1/04/evergreen-lodge-fire.jpg>



LZ2

Lighting for People in Outdoor Environments Lighting Zone 2 (LZ2) – Low ambient electric light

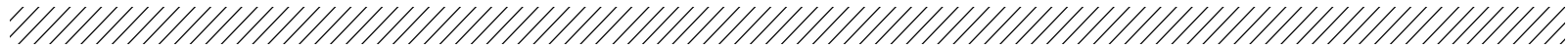
Areas of human activity (i.e. habitation, recreation and/or work) where electric lighting may be required for safety and convenience at night. The vision of humans when outside is typically adapted to low light levels, and they expect to see man-made lighting in areas where lighting is necessary to improve visibility and safety. In these areas, the light levels provided are low-to-moderate. Lighting is expected to be non-continuous (e.g. pools of light at crosswalks or intersections, rather than uniform lighting along a path or street). After curfew, both light levels and uniformity may be reduced in some areas as activity levels decline.

Examples: Low-density suburban and urban neighborhoods and suburban commercial districts. This zone is intended to be the default condition for the majority of city residential areas.



Photo: Peter Warski
https://miro.medium.com/max/8064/1*eaAgjrpQQDGM1M-4ssvNg.jpeg



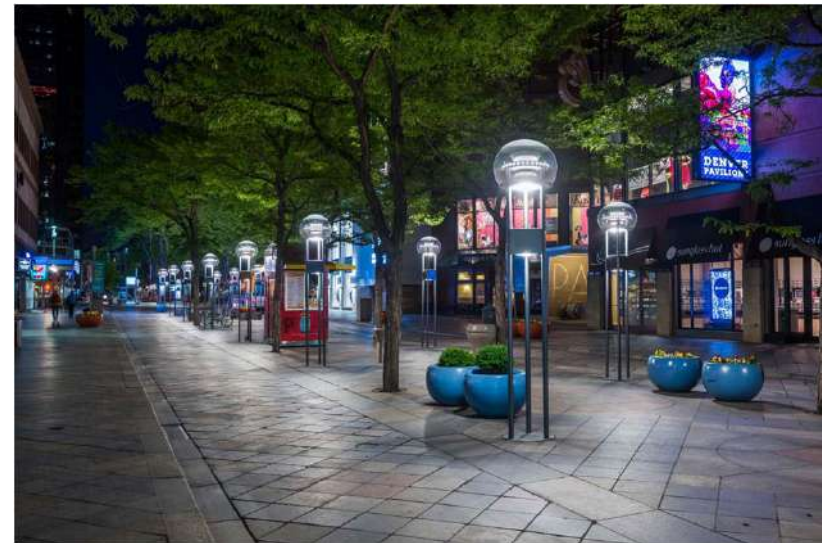


LZ3

Lighting for People in Outdoor Environments Lighting Zone 3 (LZ3) – Medium ambient electric light

Areas of human activity (i.e. habitation, recreation and/or work) where electric lighting may be continuous and is required for safety and convenience at night. The vision of humans when outside is typically adapted to moderately low light levels, and they have moderate expectations of man-made lighting. Lighting is expected to be continuous (e.g. lighting delivered fairly evenly along the length of a path or street). After curfew, both light levels and uniformity may be reduced in some areas as activity levels decline.

Examples: Medium to high-density urban neighborhoods and districts, shopping and commercial districts, industrial parks and districts.



LZ4

Lighting for People in Outdoor Environments Lighting Zone 4 (LZ4) – High ambient electric light

Areas of high levels of human activity at night, including significant interaction among pedestrians and/or vehicles. The vision of humans when outside is typically adapted to moderate light levels. Lighting is continuous and is required for safety and convenience. Expectations for man-made lighting are high, both in terms of light levels and uniformity along pathways or streets. However, both light levels and uniformity may be reduced after curfew hours in some areas as activity levels decline.

Examples: Reserved for very limited applications with special or extraordinary lighting requirements, such as central business districts of cities, urban cultural areas with nighttime theatre or events, theme parks, or areas immediately surrounding professional level sports fields and stadiums.



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Lighting for Pedestrians in Outdoor Spaces

Lighting Recommendations Table - Lighting for Human Vision, Visibility, and Reassurance

Recommendations vary by space character and needs:

- Lighting zone (LZ1 – LZ4); LZ0 is addressed by Outdoor Environmental Lighting Committee)
- Task or space type

Outdoor lighting recommendations are seldom static, single-number targets

- It is incumbent on the lighting designer/engineer to evaluate multiple factors to arrive at appropriate design goals



Photo: Peter Warski

https://miro.medium.com/max/8064/1*eaAgjrpQQDGM1M-4ssvNg.jpeg



Lighting for Pedestrians in Outdoor Spaces

Lighting Recommendations Table (Draft) - Lighting for Human Vision, Visibility, and Reassurance

This table presents

- A RANGE of recommended illuminance values for human vision, visibility, and reassurance (horizontal and/or vertical, and average-to-minimum uniformity)
- Recommendations for responsible design (Optical control/controls/spectrum)

BSR/IES RP-43: Lighting for Pedestrians in Outdoor Spaces Table A-1 Lighting Zone 1	Lighting for Human Vision, Visibility, and Reassurance						Lighting for Responsible Design			
	Recommended Average Maintained Illuminance Targets						Optical Control		Controls	Spectrum
<i>Areas where lighting might adversely affect flora and fauna or disturb the character of the area. The vision of human residents and users is adapted to low light levels. Lighting may be used for safety and convenience but it is not necessarily uniform or continuous.</i>	<i>Illuminances are at height of Task Surface above finished grade (AFG)</i>									
	Horizontal Illuminance			Vertical Illuminance			Glare/Uplight Ratings		Time, Seasonal, and/or Occupant based, etc.	Control Short Wavelength Content
	Target Eh @ Height AFG		Uniformity	Target Ev @ Height AFG		Uniformity				
	Lux @ m	(Fc @ Ft)	Ratio (Ave:Min)	Lux @ m	(Fc @ Ft)	Ratio (Ave:Min)	Max Glare Rating (G)	Max Uplight Rating (U)	Min % Light Reduction at Curfew	Metric in Progress ⁷ (VH, H, M, L)
APPLICATION TASK/AREA (SEE TABLE 5.1) ⁸										
Reassurance and Pedestrian Walkways										



Lighting for Pedestrians in Outdoor Spaces

Lighting Recommendations Table (Draft) - Lighting for Human Vision, Visibility, and Reassurance

BSR/IES RP-43: Lighting for Pedestrians in Outdoor Spaces Table A-1 Lighting Zone 1 <i>Areas where lighting might adversely affect flora and fauna or disturb the character of the area. The vision of human residents and users is adapted to low light levels. Lighting may be used for safety and convenience but it is not necessarily uniform or continuous.</i> APPLICATION TASK/AREA (SEE TABLE 5.1) ⁸	Lighting for Human Vision, Visibility, and Reassurance Recommended Average Maintained Illuminance Targets						Lighting for Responsible Design			
	<i>Illuminances are at height of Task Surface above finished grade (AFG)</i>						Optical Control		Controls	Spectrum
	Horizontal Illuminance			Vertical Illuminance			Glare/Uplight Ratings		Time, Seasonal, and/or Occupant based, etc.	Control Short Wavelength Content
	Target Eh @ Height AFG		Uniformity	Target Ev @ Height AFG		Uniformity				
Lux @ m		(Fc @ Ft)	Ratio (Ave:Min)	Lux @ m		(Fc @ Ft)	Max Glare Rating (G)	Max Uplight Rating (U)	Min % Light Reduction at Curfew	Metric in Progress ⁷ (VH, H, M, L)
Reassurance and Pedestrian Walkways										
Common pedestrian areas for parks, malls, campuses, and commercial spaces										
walking Surfaces (general and adjacent to landscape) ^{2, 3}										
Min	2 @ 0.00		(0.2 @ 0.0)	10:1			G1	U1	50%	M
Max	4 @ 0.00		(0.4 @ 0.0)							
Walking Surfaces (adjacent to architecture/exits/hardscape)										
Min	5 @ 0.00		(0.5 @ 0.0)	10:1			G1	U1		M
Max	10 @ 0.00		(1 @ 0.0)							
Walking Surfaces (adjacent to waterfront) ^{1, 5}										
Min	5 @ 0.00		(0.5 @ 0.0)	8:1			G1	U1		H or M ⁹
Max	10 @ 0.00		(1 @ 0.0)							

Lighting for Pedestrians in Outdoor Spaces - Table

How to select target illuminance (WEIGHTING FACTORS)

- Usage levels
- Path priorities
- Seasonal changes
- Adjacencies
- Client preferences, social settings, cultural expectations
- Pavement condition
- Hazards or obstacles, and wayfinding (including reflectances of materials)
- Mixed travel types (Bikes? Skateboards?)
- Safety and visibility of pedestrians
- Glare from luminaires affecting visibility
- Age of users

Weighting Factors for Variance from Target Illuminance	Reduces need for light (-1)	No impact on need (0)	Increases need for light (+1)	Values
Usage levels	Low usage	Normal usage	High usage	
Path priorities	Tertiary	Secondary	Primary	
Seasonal changes	Winter snow			
Adjacencies	"Borrowed" light, glare concerns, or light unwanted	Neutral	Light wanted to improve perception of safety and activity. Older pedestrians are a critical population.	
Client preferences, social settings, and cultural expectations	Wants less light or prefers less uniformity	Neutral	Wants more light or prefers higher uniformity	
Pavement condition	No level variation, high quality surface		Rough, uneven surface	
Hazards or obstacles, and wayfinding	Curbs, level changes, stairs, or obstacles have finishes that enhance contrast. Or, retroreflective materials are used to create contrast		Level changes, tripping hazards, and obstacles do not use high-contrast materials	
Mixed travel types			Bicycles, skateboards, or other non-motorized vehicles in addition to foot traffic	
Safety and visibility of pedestrians	Subordinate to environmental issues	Neutral	Enhanced safety and/or visibility required	
Glare from luminaires	Reduced glare for pedestrians, allowing clear visibility of pavement, objects, and surrounds		Higher glare for pedestrians, necessitating a higher ambient light level	
Age of users	Users and supervisors predominantly less than 25 years old	Broad range of user ages	Users predominantly over 60 years old	
Total:				

S T I M U L I N G



A Project Weighting Factor Example:

A dedicated bike and pedestrian path in an environmentally sensitive area near a river. The path is used for pedestrians only and is smooth, well-maintained, and the route is fairly straight. The path has continuous overhead lighting using a 12' pole height, and downward-only luminaires selected with a BUG "U" rating of U0 for limiting uplight and a "G" rating of G1 for glare control. Light source is a 3000 K LED, with moderate blue content for minimal disruption to wildlife while maintaining good color visibility. All ages of bicyclists and pedestrians use the path.

Project: A dedicated bike and pedestrian path in an environmentally sensitive area near a river. The path is used for pedestrians only and is smooth, well-maintained, and the route is fairly straight. The path has continuous overhead lighting using a 12' pole height, and downward-only luminaires selected with a BUG "U" rating of U0 for limiting uplight and a "G" rating of G1 for glare control. Light source is a 3000 K LED, with moderate blue content for minimal disruption to wildlife while maintaining good color visibility. All ages of bicyclists and pedestrians use the path.

If total is $\geq +4$, go to the high end of the illum range

If total is ≤ -4 , go to the low end of the illum range

In between, target the middle of the range.

Weighting Factor	Score
Usage levels	0
Path priorities	0
Seasonal changes	0
Adjacencies	-1
Client preferences and cultural expectations	-1
Pavement condition	-1
Hazards or obstacles, and wayfinding	0
Mixed travel types	+1
Safety and visibility of pedestrians	-1
Glare from luminaires	-1
Age of users	0
TOTAL	-4



Lighting for Pedestrians in Outdoor Spaces

Lighting Recommendations Table (Draft) - Lighting for Responsible Design

BSR/IES RP-43: Lighting for Pedestrians in Outdoor Spaces Table A-1 Lighting Zone 1 <i>Areas where lighting might adversely affect flora and fauna or disturb the character of the area. The vision of human residents and users is adapted to low light levels. Lighting may be used for safety and convenience but it is not necessarily uniform or continuous.</i> APPLICATION TASK/AREA (SEE TABLE 5.1) ⁸	Lighting for Human Vision, Visibility, and Reassurance						Lighting for Responsible Design				
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	<i>Illuminances are at height of Task Surface above finished grade (AFG)</i>						Glare/Uplight Ratings	Time, Seasonal, and/or Occupant based, etc.	Control Short Wavelength Content		
	Horizontal Illuminance			Vertical Illuminance							
Target Eh @ Height AFG	Uniformity		Target Ev @ Height AFG	Uniformity		Max Glare Rating (G)	Max Uplight Rating (U)	Min % Light Reduction at Curfew	Metric in Progress ⁷ (VH, H, M, L)		
Lux @ m	(Fc @ Ft)	Ratio (Ave:Min)	Lux @ m	(Fc @ Ft)	Ratio (Ave:Min)						
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Min	5 @ 0.00	(0.5 @ 0.0)	8:1			G1	U1		H or M ⁹		
Max	10 @ 0.00	(1 @ 0.0)									

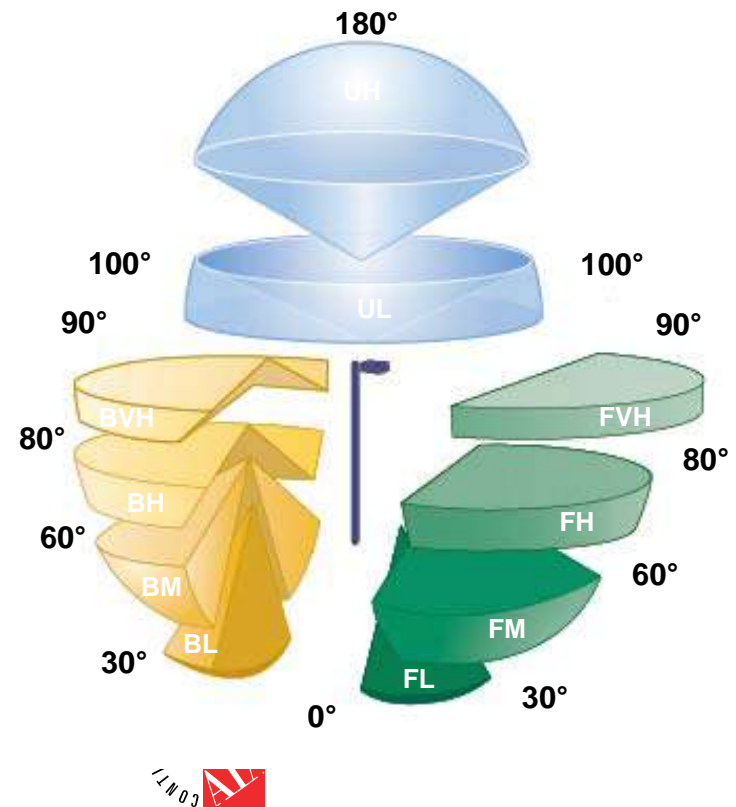
Lighting for Pedestrians in Outdoor Spaces

Lighting Recommendations Table (Draft) - Lighting for Responsible Design – Optical Control

TM-15 defines zonal lumen thresholds for:

- Backlight
- Uplight
- ‘Glare’

B-U-G Ratings



Lighting for Pedestrians in Outdoor Spaces

Lighting Recommendations Table (Draft) - Lighting for Responsible Design – Controls

Ways to turn OFF or DIM down the lights when human occupancy is lower, when disruption of wildlife habitats is a high priority, or when outdoor usage is discouraged (curfews)

- Occupancy/vacancy sensors
- Time clocks
- System-wide lighting controls
- Spectral switching

Table lists maximum recommended dimmed level for curfew and blank cell if dimming not advisable.



Lighting for Pedestrians in Outdoor Spaces

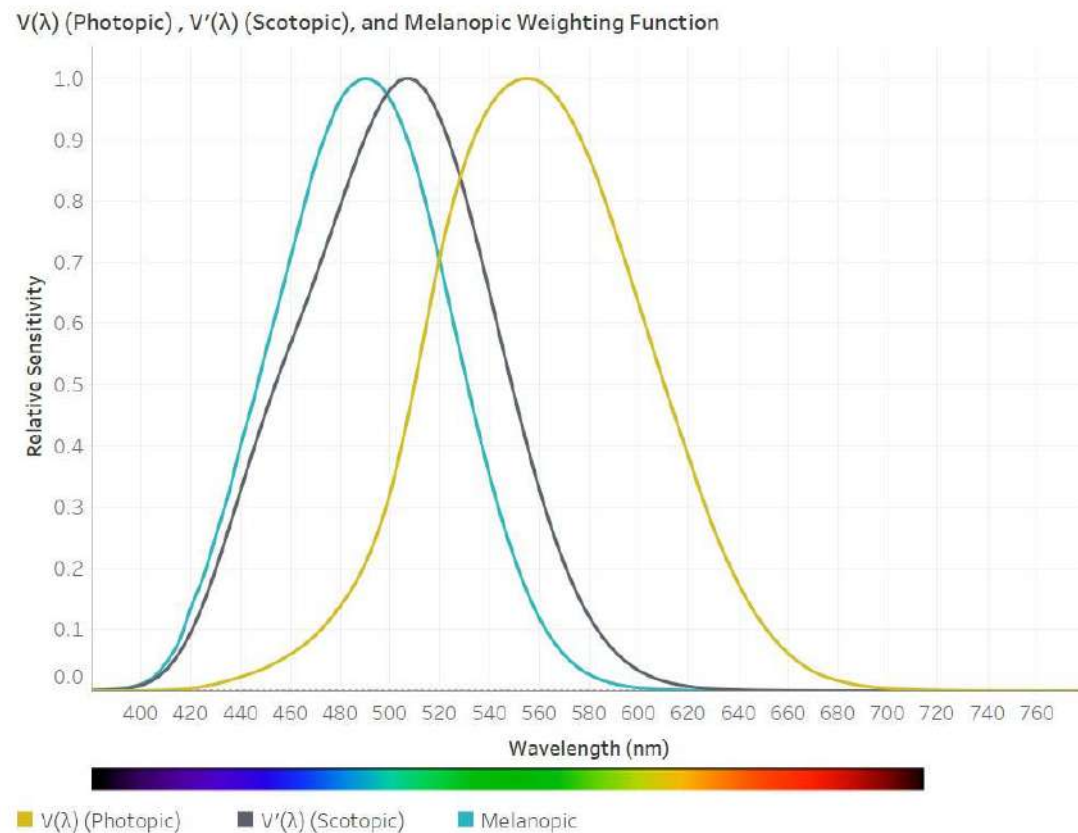
Lighting Recommendations Table (Draft) - Lighting for Responsible Design – Spectrum

Light source - metrics of short wavelength content light source

ipRGC controls human pupil size in addition to other non-visual functions. Its photopigment is called “Melanopsin”. No color information is communicated. It seems to signal day vs night conditions

The melanopic weighting function may pertain to:

- Wildlife responses *on average*
- Human melatonin responses *pretty closely....*
- Sky glow (*roughly*)



Lighting for Pedestrians in Outdoor Spaces

Lighting Recommendations Table (Draft) - Lighting for Responsible Design – Spectrum

In the meantime... Use CCT as the metric of short wavelength content

The IES, CIE, and miscellaneous groups are arm-wrestling over appropriate metrics for spectral control. In the meantime, use these:

- Very High (VH) = no restriction on spectral content
- High (H) < ~4000 K LED blue content
- Medium (M) < ~3000 K LED blue content
- Low (L) < 2400 K LED or HPS or PC Amber LED blue content

CCT is a poor metric, but it's the best we have until the scientific eggheads duke it out. It is a VERY rough metric of the blue content of a light source for concerns about human light exposure at night, exposure of some wildlife at night, and to estimate impact on skyglow.



Thanks to COVID-19 for making all these webinars necessary.

Thanks to LEDUCATION for making these webinars possible.

Hang in there, all of you!

Naomi.Miller @ PNNL.gov



This concludes The American Institute of Architects Continuing Education Systems Course



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Lighting for Outdoor Pedestrian Spaces

Q&A

