



**Seattle City Light**

# An LED conversion story

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**Streetlight Engineering Manager**

National League of Cities – Mobile Workshop | November 13, 2013



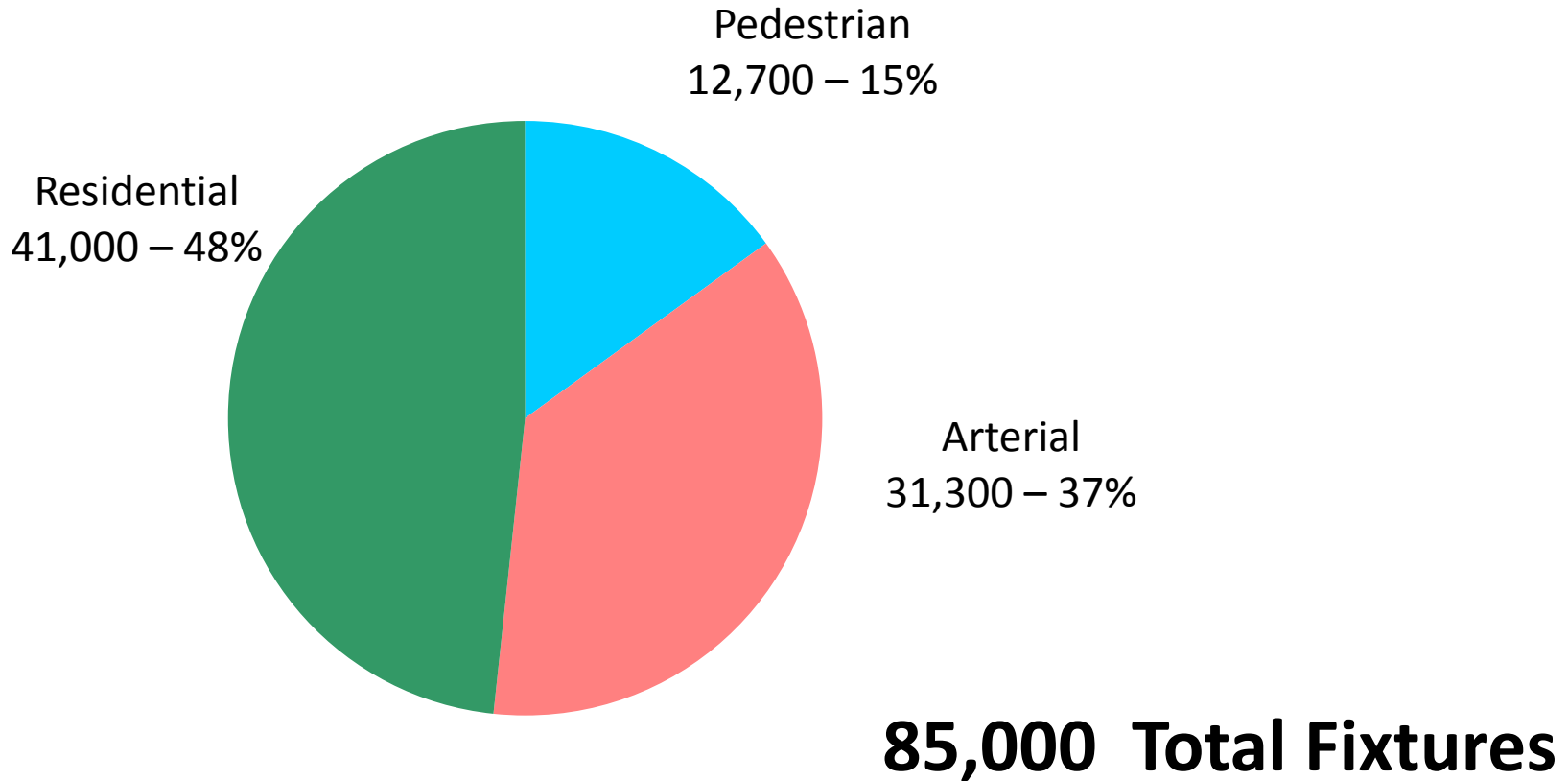
# SCL Streetlight History

- **1869** - City of Seattle Charter granted the Seattle City Council the power to provide street lighting
- **1885** - the Seattle Light Department, now Seattle City Light (SCL), maintained streetlights and managed power accounts for independent power suppliers throughout the central business district
- **1905** - City's first power plant became operational making SCL responsible for both streetlights and power generation
- **1999** - Jurisdiction of arterial streetlights from Seattle Department of Transportation to SCL made SCL responsible for operations and maintenance of residential and arterial street lighting

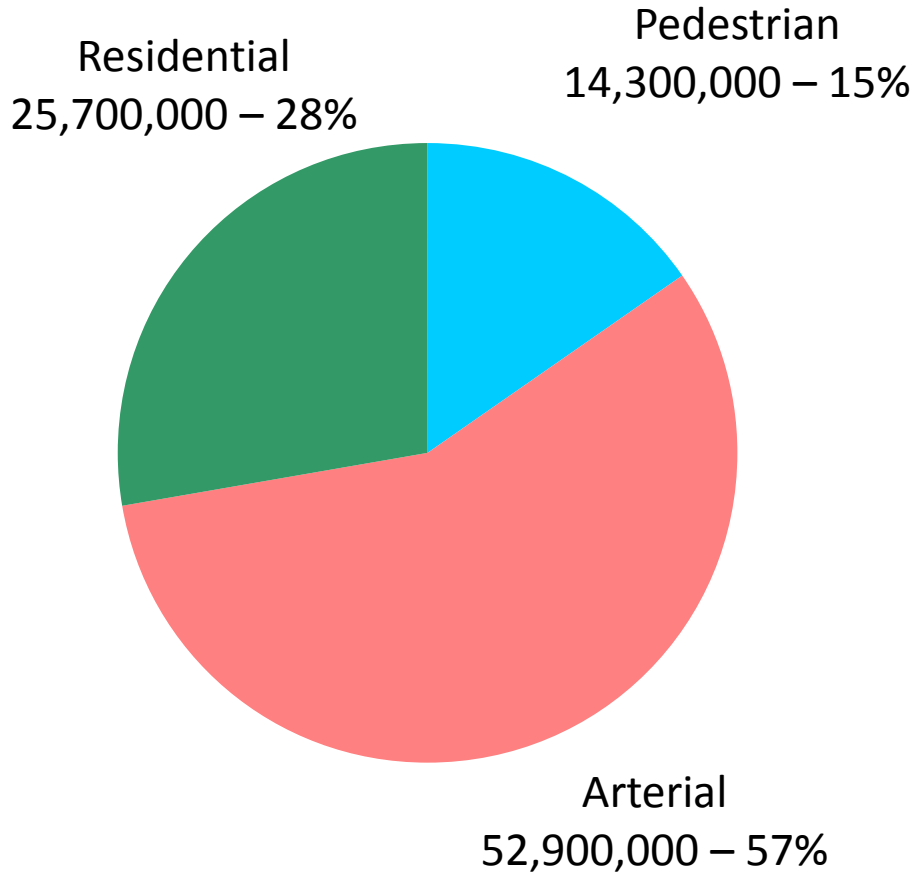




# SCL Lighting Types by Use



# HPS streetlight system energy use



Billed to the City:

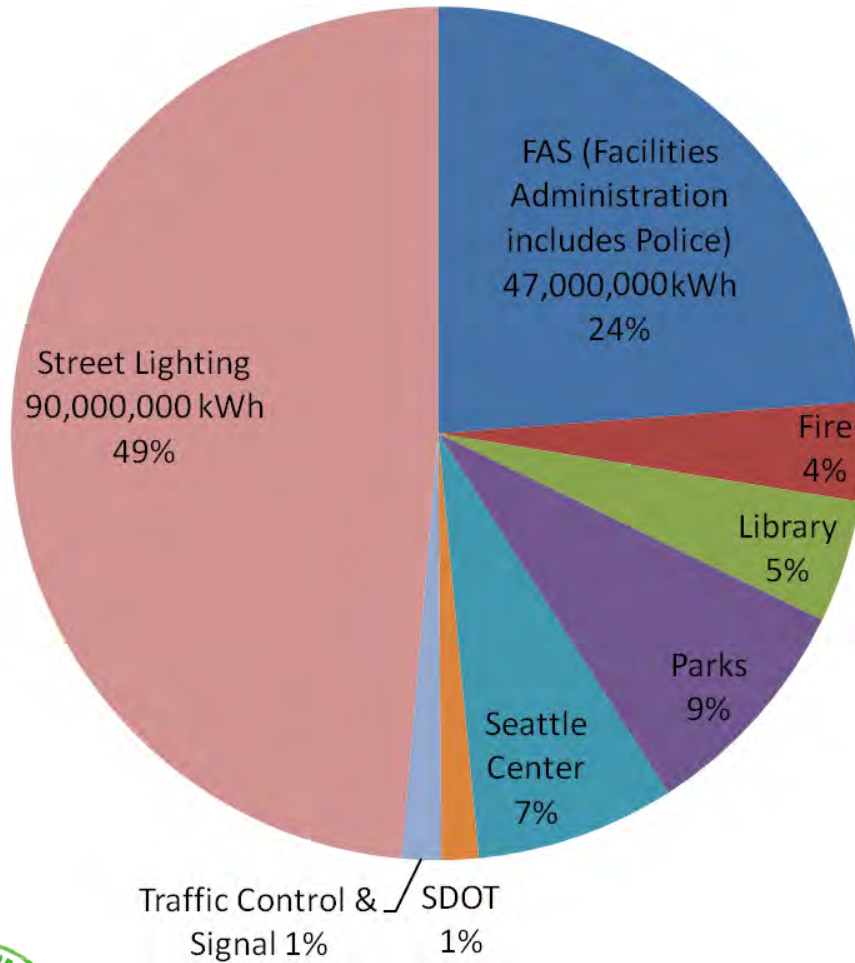
- 90 million kWh/yr
- \$0.145/kWh

\$13 million/yr



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# City of Seattle – General Fund Municipal Electricity



**Total: 197,410,000 kWh**

- The largest user of GF expense electricity, Street Lighting consumes enough energy to displace all administrative and specific use facilities
- Streetlights are City Light's 5<sup>th</sup> largest customer



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# Streetlight system maintenance costs

- 4-year re-lamping cycle
  - 21,000 re-lamps per year
- Annual cost for labor and materials
  - \$1.4 million



# Annual O&M cost of HPS system = \$14.4 million

- Total annual cost of HPS system
  - Operation \$13 million
  - Maintenance \$1.4 million
- \$14.4 million





# Difficulty maintaining a fully operating system

- Slow repair response to streetlight failures
  - Up to 4 months to respond to one streetlight
- At one point, there were 5,000 trouble tickets in queue
  - Hence the scheduled re-lamping every 4 years
- Installed fixtures exceeded design life
  - Caused ballast inefficiency
  - Affected light output



# Mayor's Accountability Agreement

- Improve customer experience and rate predictability
- Continue conservation and environmental stewardship leadership
- Enhance organizational performance



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## **In 2007, we began exploring LED technology**

- Longer life
- Less maintenance
- Energy efficient
- Whiter light



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# Initial LED goals

- Reduce energy use by 40%
- Reduce carbon footprint
- Lower maintenance costs
- Improve customer service
- Increase system reliability
- Improve operation on bridges (vibration resistance)



# Various pilot projects were conducted

- Experimented with various LEDs
- Installed pilots in specific neighborhoods representing demographics of Seattle
- Solicited feedback from residents near pilots



# Residential streetlights were chosen for conversion

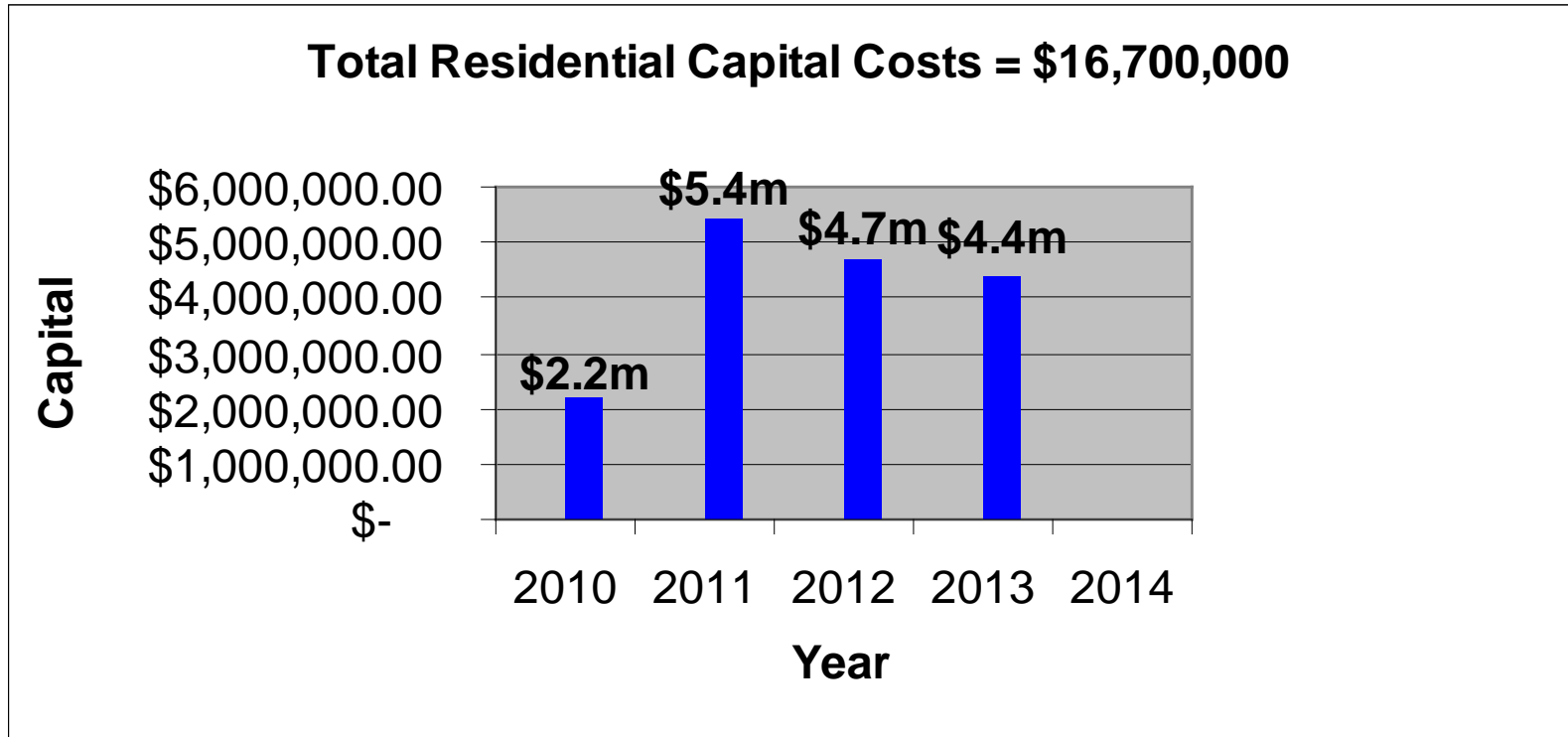
- Fixtures were affordable and available
- Only fixture that offered payback within design life
- Residential light levels are not governed by standards
- Addresses a larger customer base



# 41,000 Total Residential LED Streetlights Converted



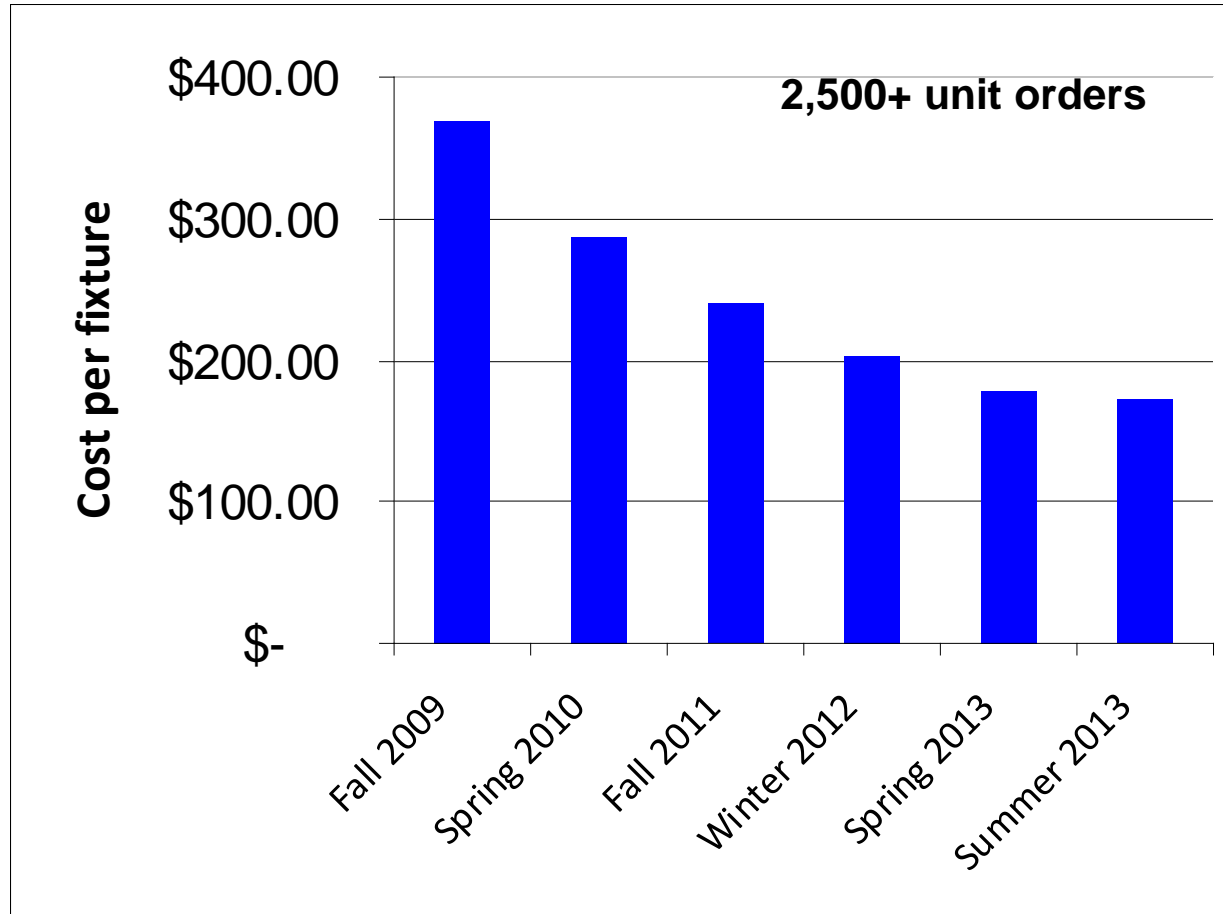
# Investment on Residential System



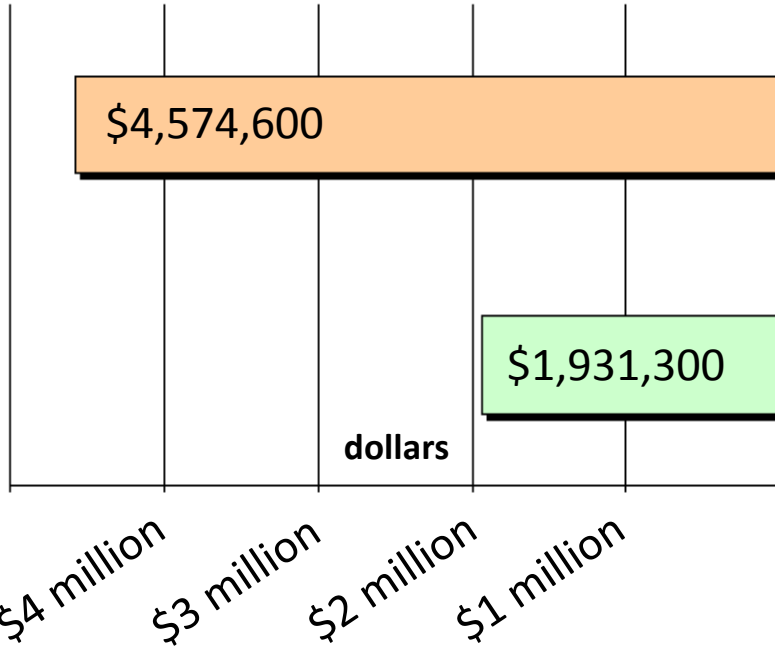
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# LED fixture costs has decreased by half in 4 years (Residential Lights)

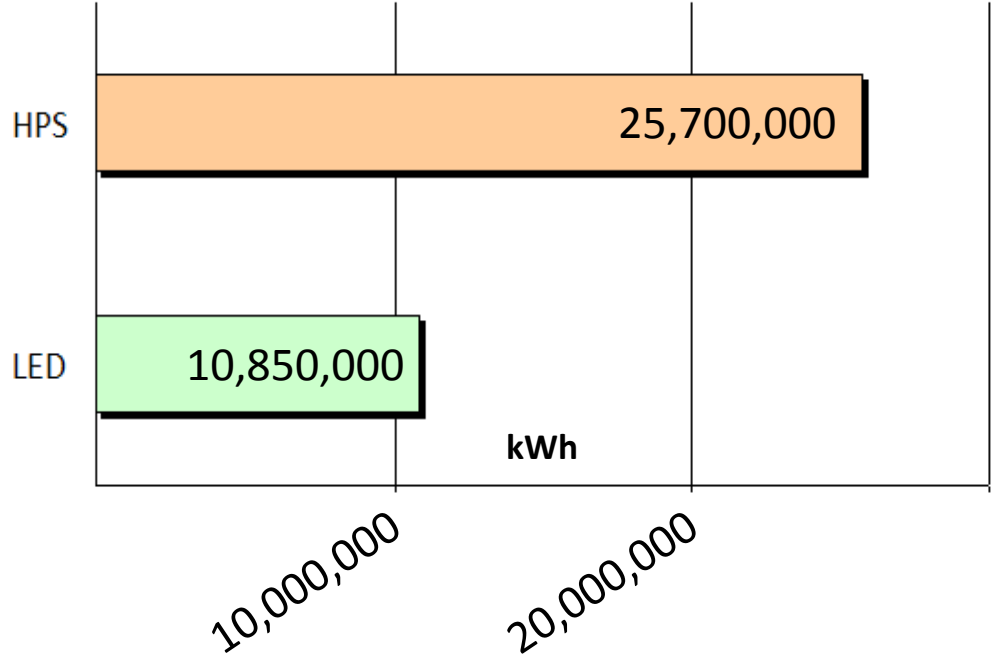


### Annual Cost (\$0.178/kWh)



**\$2,643,300 savings**

### Annual Consumption



**14,850,000 kWh savings**



# LED Streetlight Program Savings

Residential LED Installations				
	Units Converted	Savings Per LED	Monthly Savings	Annual Savings at end of period
All Residential Streets Completed	41,000	\$ 5.16	\$211,560.00	\$2,538,720.00

Cleaning Costs (prorated based on 1 cleaning cycle every 7.5 years)

(\$246,000.00)



# Current status of the residential LED program

- Residential payback = **7.5 years**
- Current averaged energy reduction > **57%**
- Manufacturer warranty extended to **10 years**
  
- Lower volume of complaints due to LED conversion



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# Residential conversions are completed with arterial conversions ramping up

<b>2013</b>	Arterial conversion has begun with 1800 units
<b>2014 – 2018</b>	Arterial LED conversion *
<b>2019+</b>	Decorative/pedestrian, and flood lighting LED conversion



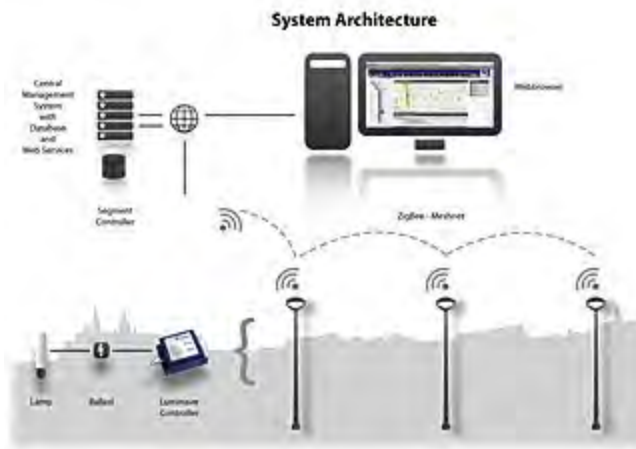
# Lessons learned from the field

- Customer Complaints
  - Color Quality
  - Light Trespass
  - Visibility
- Remedy
  - Installing shields
  - Lowering drive current
- Compatibility issues between fixture and PE cell
  - Remedied by additional training

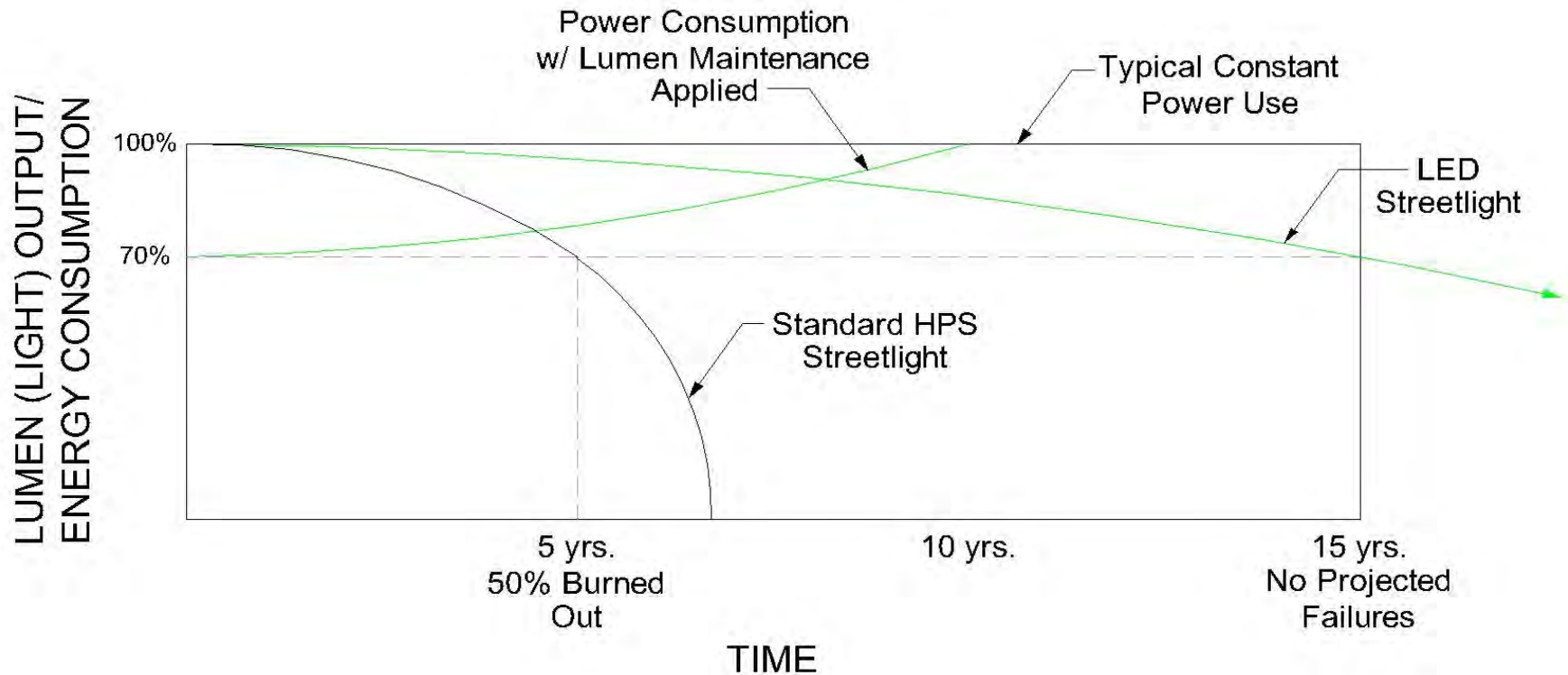


# Future plans

- Remote monitoring system
- Adaptive controls
- Unique controls for different users



# Lumen maintenance through controls can offer extended service life





# Establish a process to evaluate fixtures

1. Specify design requirements
2. Datasheet/test report evaluation
3. Sample request
4. Fixture/housing analysis | Mock-up
5. In-situ light level evaluation



# 1. Specify design requirements

- 2. Datasheet/test report evaluation
- 3. Sample request

- 4. Fixture/housing analysis | Mock-up
- 5. In-situ light level evaluation

SITE PARAMETERS		
<b>ROADWAY DATA:</b>	Roadway width – curb to curb	25 ft
	IES pavement class.	<input type="checkbox"/> R1 <input type="checkbox"/> R2 <input checked="" type="checkbox"/> R3 <input type="checkbox"/> R4
	Posted speed limit	✓ ≤ 25 mph
<b>SIDEWALK DATA:</b>	Sidewalk width	5 ft
	Edge of sidewalk to edge of roadway pavement	5 ft
<b>LIGHT POLE DATA:</b>	Luminaire mounting height	25 ft
	Arm length, horizontal	6 ft
	Luminaires per pole	1
	Pole set-back from edge of pavement	3 ft
	In-line pole spacing (one pole cycle)	130 ft
	Layout	<input checked="" type="checkbox"/> One side <input type="checkbox"/> Opposite <input type="checkbox"/> Staggered <input type="checkbox"/> Median



# 1. Specify design requirements

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PERFORMANCE CRITERIA: APPLICATION		
ROADWAY		
<b>PHOTOPIC ILLUMINANCE:</b>	Maintained average horizontal at pavement	0.4 fc
	Avg:min uniformity ratio	6.0 : 1
<b>PHOTOPIC LUMINANCE:</b>	Maintained average luminance	n/a
	Avg:min uniformity ratio	n/a
	Max:min uniformity ratio	n/a
<b>VEILING LUMINANCE:</b>	Max. veiling luminance ratio	0.4



# 1. Specify design requirements

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PERFORMANCE CRITERIA: LED LUMINAIRE		
<b>INPUT POWER:</b>	Max. nominal luminaire input power @ 525mA	52 W
<b>NOMINAL CCT:</b>	Rated correlated color temperature	4000 K +/- 300 K
<b>BUG<sup>1</sup> RATING:</b>	Max. nominal backlight-uplight-glare ratings: UH & UL = 0; BVH = 0.2% of luminaire lumens; BH = 5% of luminaire lumens; FVH = 0.2% of luminaire lumens	B1-U0-G1
<b>VOLTAGE:</b>	Luminaire input voltage	120-277V
<b>FINISH:</b>	Luminaire housing finish color	Gray
<b>WEIGHT:</b>	Maximum luminaire weight	30 lb
<b>EPA:</b>	Maximum effective projected area	0.9 ft <sup>2</sup>
<b>MOUNTING:</b>	Mtg. method	<input type="checkbox"/> Post-top <input checked="" type="checkbox"/> Side-arm <input type="checkbox"/> Trunnion/yoke <input type="checkbox"/> Swivel-tenon
	Tenon nominal pipe size (NPS)	
<b>VIBRATION:</b>	ANSI test level	<input checked="" type="checkbox"/> Level 1 (normal) <input type="checkbox"/> Level 2 (bridge/overpass)
<b>DRIVER:</b>	Control signal interface	<input checked="" type="checkbox"/> Not required <input type="checkbox"/> Required

<sup>1</sup> The deprecated “cutoff” classification system cannot be accurately applied to LED luminaires.



# 1. Specify design requirements

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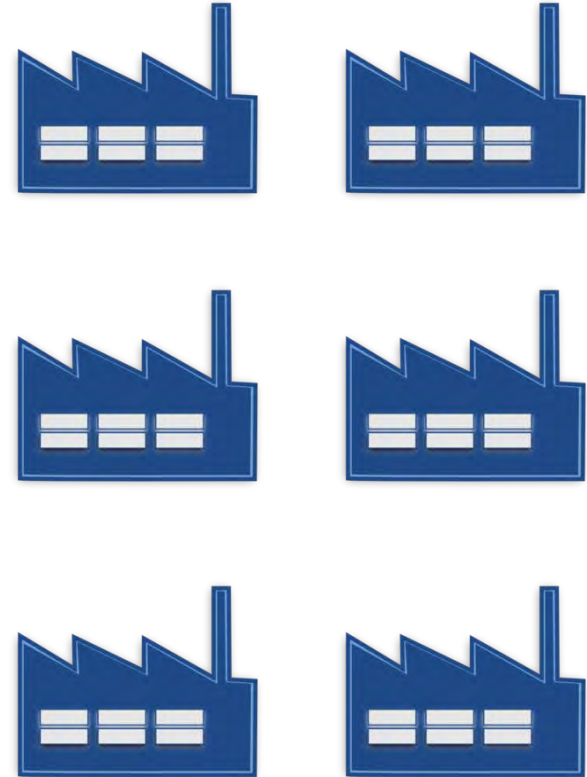
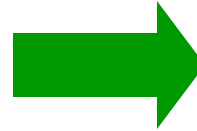
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Specification for LED Roadway Luminaire Product Review

**APPENDIX A APPLICATION-BASED SYSTEM  
SPECIFICATION LUMINAIRE TYPE "A -  
Residential"**

SITE PARAMETERS		
<b>ROADWAY DATA:</b>	Roadway width – curb to curb	25 ft
	IES pavement class.	<input type="checkbox"/> R1 <input type="checkbox"/> R2 <input checked="" type="checkbox"/> R3 <input type="checkbox"/> R4
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PERFORMANCE CRITERIA: APPLICATION		
ROADWAY		
<b>PHOTOPIC ILLUMINANCE:</b>	Maintained average horizontal at pavement	0.4 fc
	Avg:min uniformity ratio	6.0 : 1
<b>PHOTOPIC LUMINANCE:</b>	Maintained average luminaire	n/a
	Avg:min uniformity ratio	n/a
	Max:min uniformity ratio	n/a
<b>VEILING LUMINANCE:</b>	Max. veiling luminance ratio	0.4
SIDEWALKS		
<b>PHOTOPIC ILLUMINANCE:</b>	Maintained average horizontal at pavement	0.2 fc
	Avg:min uniformity ratio (horizontal)	n/a
	Maintained min. vertical illum. at 4.9 ft, in directions of travel	0.1 fc
PERFORMANCE CRITERIA: LED LUMINAIRE		
<b>INPUT POWER:</b>	Max. nominal luminaire input power @ 525mA	52 W
<b>NOMINAL CCT:</b>	Rated correlated color temperature	4000 K +/- 300 K
<b>BUG<sup>1</sup> RATING:</b>	Max. nominal backlight-uplight-glare ratings: UH & UL = 0; BVH = 0.2% of luminaire lumens; BH = 5% of luminaire lumens; FVH = 0.2% of luminaire lumens	B1-U0-G1
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	Tenon nominal pipe size (NPS)	2 inches
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# 1. Specify design requirements

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4. Fixture/housing analysis | Mock-up
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- Long-term support of luminaires is a major factor in decision-making
- Weeds out in-home manufacturers
- Identifies the big-players
  - Fixture quality
  - Warranty support

Fixture count: **30**



1. Specify design requirements
- 2. Datasheet/test report evaluation**
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- Created a tracking spreadsheet listing all LED fixtures received
- Compare characteristics to eliminate undesired fixtures

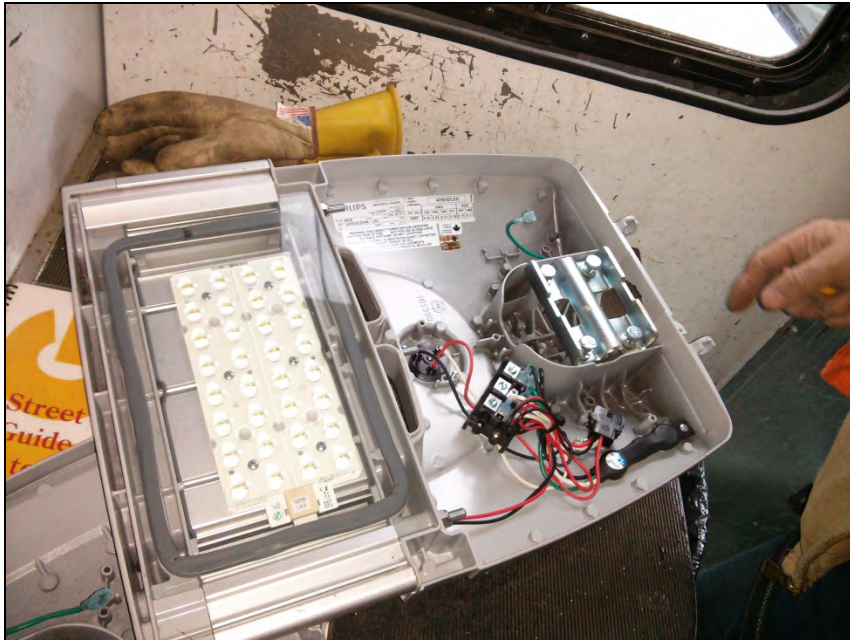
Fixture count: **10**



1. Specify design requirements
2. Datasheet/test report evaluation

### 3. Sample request

4. **Fixture/housing analysis | Mock-up**
5. In-situ light level evaluation



- Lab study to confirm light-level claims
- Evaluate each fixture for handling issues

Fixture count: **10**



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1. Specify design requirements
2. Datasheet/test report evaluation

### 3. Sample request

### 4. Fixture/housing analysis | Mock-up

5. In-situ light level evaluation



Fixture count: **10**

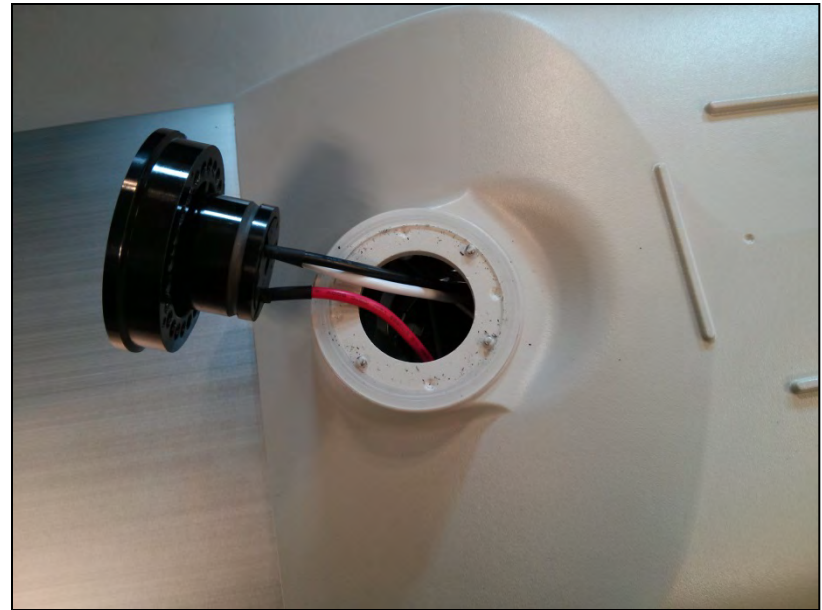


1. Specify design requirements
2. Datasheet/test report evaluation

### 3. Sample request



4. **Fixture/housing analysis | Mock-up**
5. In-situ light level evaluation



Fixture count: **3**



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1. Specify design requirements
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4. Fixture/housing analysis | Mock-up

## 5. **In-situ light level evaluation**



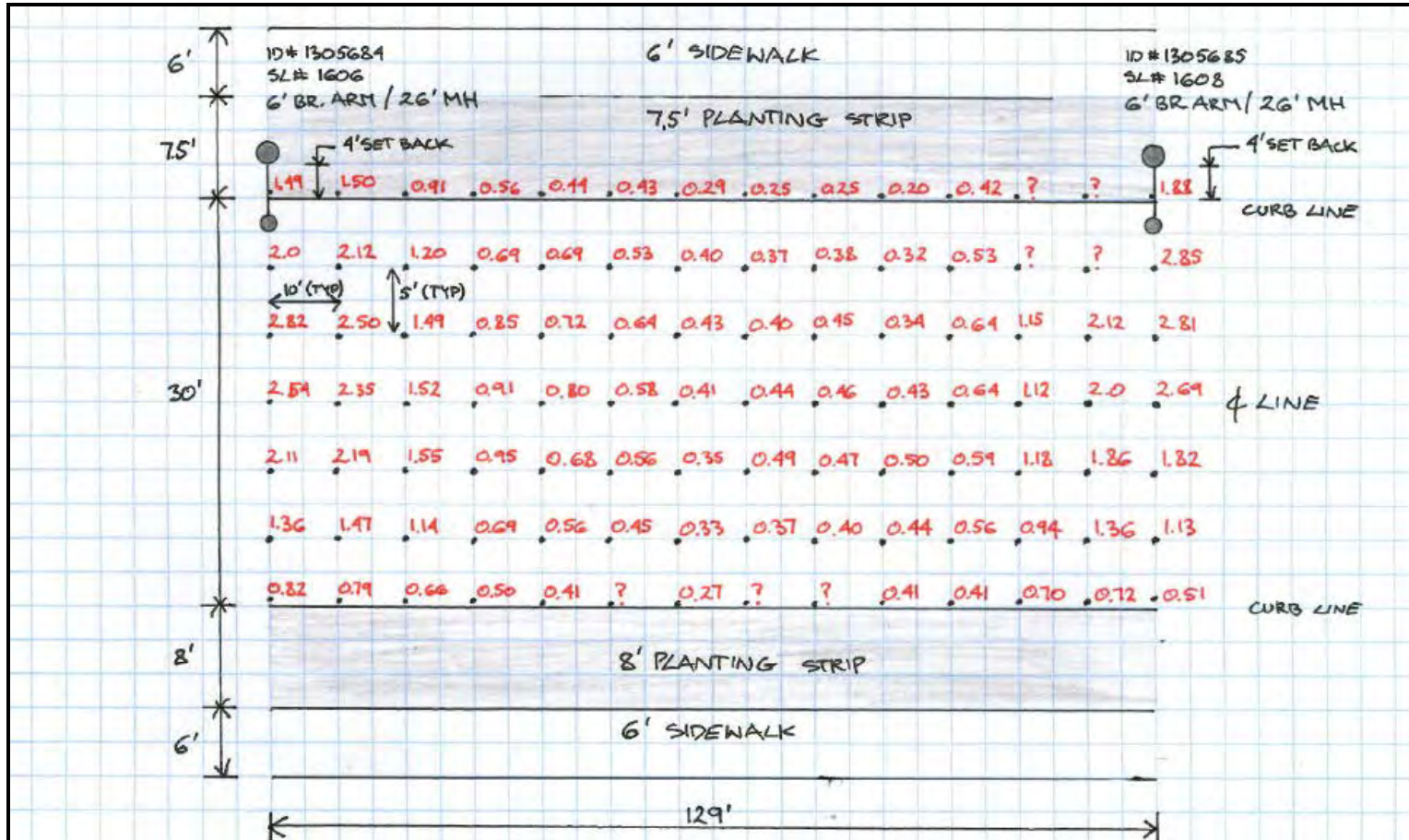
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1. Specify design requirements
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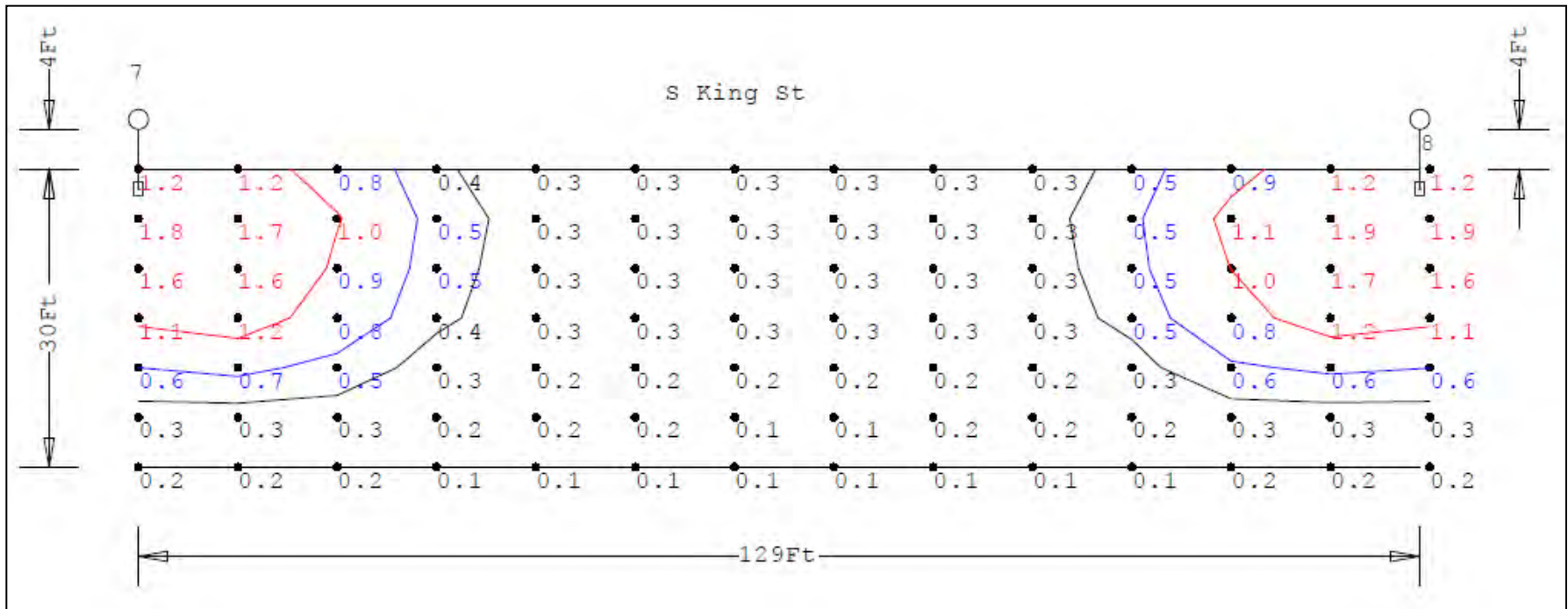
## 5. In-situ light level evaluation



1. Specify design requirements
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3. Sample request

4. Fixture/housing analysis | Mock-up

## 5. In-situ light level evaluation



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**Lessons learned = A lot.**

- Be meticulous and methodical
- Collaborate with asset management during pilot stages



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# Resources

- Department of Energy

## Municipal Solid-State Street Lighting

<http://www1.eere.energy.gov/buildings/ssl/consortium.html>

- Illuminating Engineering Society

[ies.org](http://ies.org)

- Seattle City Light

[seattle.gov/light/engstd](http://seattle.gov/light/engstd)



**Thank you!**

**Questions?**

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Seattle City Light

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