Maintenance Practices for LED Street Lights

Glenn Cooper
Associate Electrical Engineer
City of Boston –Public Works Department
Street Lighting Section

Maintenance Practices for LED Street Lights Status of Program - 2014

- As of March 31, 2014 – over 33,000 Installs have been completed
- Over next fiscal year – 8,000 to 10,000 additional conversions will be completed
- Balance of system (21,000 lights) to be completed by end of Fiscal Year 2017 (June 2017). We anticipate that all 64,000 electric lights will be completed

Maintenance Practices for LED lights
Lights Installed

- All of the lights currently installed in Boston are still under Manufacturers Warrantee
  - Initial 23,000 units have a five year Warrantee which includes
    - Complete replacement of unit not just the defective component
    - All shipping charges returns and replacements are paid for by the Manufacturer

Maintenance Practices for LED Street Lights
What we have learned thus far

- Initial installation performed November 2010 to March 2011
  - All units installed were cobra Head style installations – Mercury Vapor Lamp Source
  - 3000 Units installed primarily on Residential Streets
    - Of the 3000 initial installs, there have been 97 defective units returned to this manufacturer
      - This equates to a 3 % defective rate over the three and a half year installation

Maintenance Practices for LED Street Lights
Sample of first unit installed in Boston

Maintenance Practices for LED Street Lights

- Second Installation - April 2011 through November 2012
- Again all units installed were Cobra Head Style – Mercury and Sodium Vapor Lamp Source
  - 20,000 lights installed on Residential, collector and Commercial streets throughout the City of Boston
    - Of the 20,000 lights installed, 156 were returned as defective This equates to a .8% defective rate over the past 2 ½ - 3 years

Maintenance Practices for LED Street Lights
Typical Unit installed in Second Phase of Conversion

Maintenance Practices for LED Street Lights

- Third Phase of LED Conversions November 2012 to April 2013
  - Units were to replace all Mercury Vapor Post Top Luminaires – Approximately 3000 units of this classification were targeted
  - Specifically in Downtown residential areas
  - Neighborhood very pleased with installation
  - Units have five year warrantee
  - To date 88 units have been defective
    This equates to 2.9 % defective rate over the past 1 ½ years

Maintenance Practices for LED Street Lighting
Typical unit in third phase of LED Conversion

Maintenance Practices for LED Street Lights

- Fourth Phase (April 2013 to Date)
  - Replacement of 10,000 of what we call in Boston the Shoe box or Rectilinear Luminaire. Mercury Vapor and Sodium Vapor Street Lights are targeted
  - First units to offer 10 year total replacement Warrantee.
    - Unit dates back to the 1960's
    - Units on Residential Streets City-wide
    - To date 6,000 units have been completed
    - Of the 6,000, 30 units have been defective
      This amounts thus far to a defect rate of .5 %over the past year
    - All installation failure rates have been acceptable within industry standards.

Maintenance Practices for LED Street Lights
Out with the old

Maintenance Practices for LED Street Lights In with the new

Maintenance Practices for LED Street Lights

- What have we learned thus far (Engineering)
  - Not all Luminaires are created equal.
    - Specifications are critical to ensure that the products used are of the highest quality available
    - Write specifications that are clear and concise
    - Even with the best Specifications issues arise during installation
      - Minor issues have occurred with the units but the Manufacturers are quick to analyze and revise the manufacturing process

Maintenance Practice for LED Street Lights

- Defects in LED units thus far
  - Majority of failures have been in the driver assembly. These units were replaced by the Manufacturer
  - One manufacturer had exhibited leakage in the LED chamber causing the LED board to fail
  - One Manufacturer's unit started to flash or strobe. This is currently under investigation between the City and the Manufacturer
  - There has been a rise in what we call Major system Failures, but these aren't related to LED installs but due to the aging infrastructure in the City

Maintenance Practices for LED Street Lights

- Impact of LED Installations
  - Decrease of the number of Complaints regarding outages.
    - Prior to Conversion, City responded to over 9000 complaints for light outages
    - FY14 we anticipate to see the number drop to 6500 based on current trends
    - As conversion goes forward, we anticipate the number to drop
    - Crews will switch to Deferred Maintenance such as replacement of old damaged cable, pole replacements and re-splicing of underground cables. Some splices in ground still have friction tape as the primary insulator
    - Complaints even today are still filed by Constituents who feel that they are getting less light then before. Once we explain how LED lights work, they are generally satisfied

Maintenance Practices of LED Street Lights

- Impact on Inventory
  - In process of reduction of Inventory prior to our relocation to a new facility along with the conversion to LED
    - Auctioning off obsolete equipment – HPSV, MV and MH Cobra Heads
    - Reducing overall inventory by 30% due to LED installation along with smaller interim facility
    - Updating inventory processes to streamline operation based on a Kanban system
    - Look into the bar coding of all future street lighting equipment to keep a more up to date inventory system

Maintenance Practices of LED Street Lights

- Inventory
  - Future Inventory
    - With the constant changes in LED technology, we are unsure as to how the future stock room will look
    - Assumptions:
      - There will be an inventory of complete luminaires for replacement of luminaires that reach the 70% threshold as well as replacements due to motor vehicle accidents
      - Inventory of drivers for each luminaire in our inventory. As LED chips reach there optimal output, we anticipate the number of drivers required for inventory should decrease
      - Increase of infrastructure inventory as we switch from luminaire maintenance to infrastructure maintenance. Such items would consist of cable, connectors, conduit, splicing kits

Maintenance Practices for LED Street Lights

- Future recommendations and practices
  - Prior to conversion to LED, existing infrastructure should be investigated and if necessary, replace old components as part of the conversion. It will reduce call backs
  - Consider using long life photocells. It may cost a few dollars more, but it will reduce the need for crews to revisit the location to replace the photocell. One repeat trip back will more than pay for the photocell
  - Ensure that Manufacturer can provide a house shield to minimize light trespass
  - Utilize the same color temperature on all luminaires regardless of roadway types. Uniformity is key to any successful lighting project

Questions or Comments

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Seattle City Light

An LED conversion story

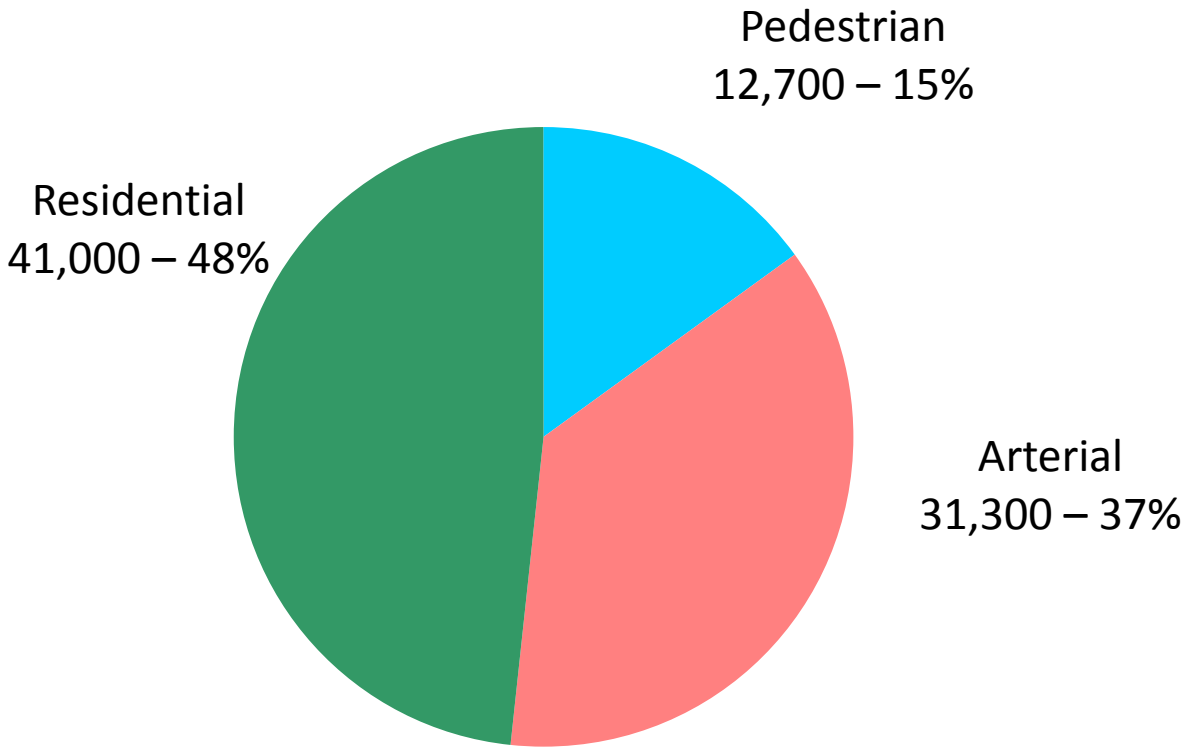
Steve Crume

Streetlight Engineering Manager

MSSLC Maintenance Webinar | April 14, 2014

THE NATION'S GREENEST UTILITY SINCE 1905 SEATTLE CITY LIGHT

SCL Lighting Types by Use
(Streetlights are City Light's 5th largest customer)



85,000 Total Fixtures

Streetlight system maintenance costs

- 4-year re-lamping cycle (HPS)
  - 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

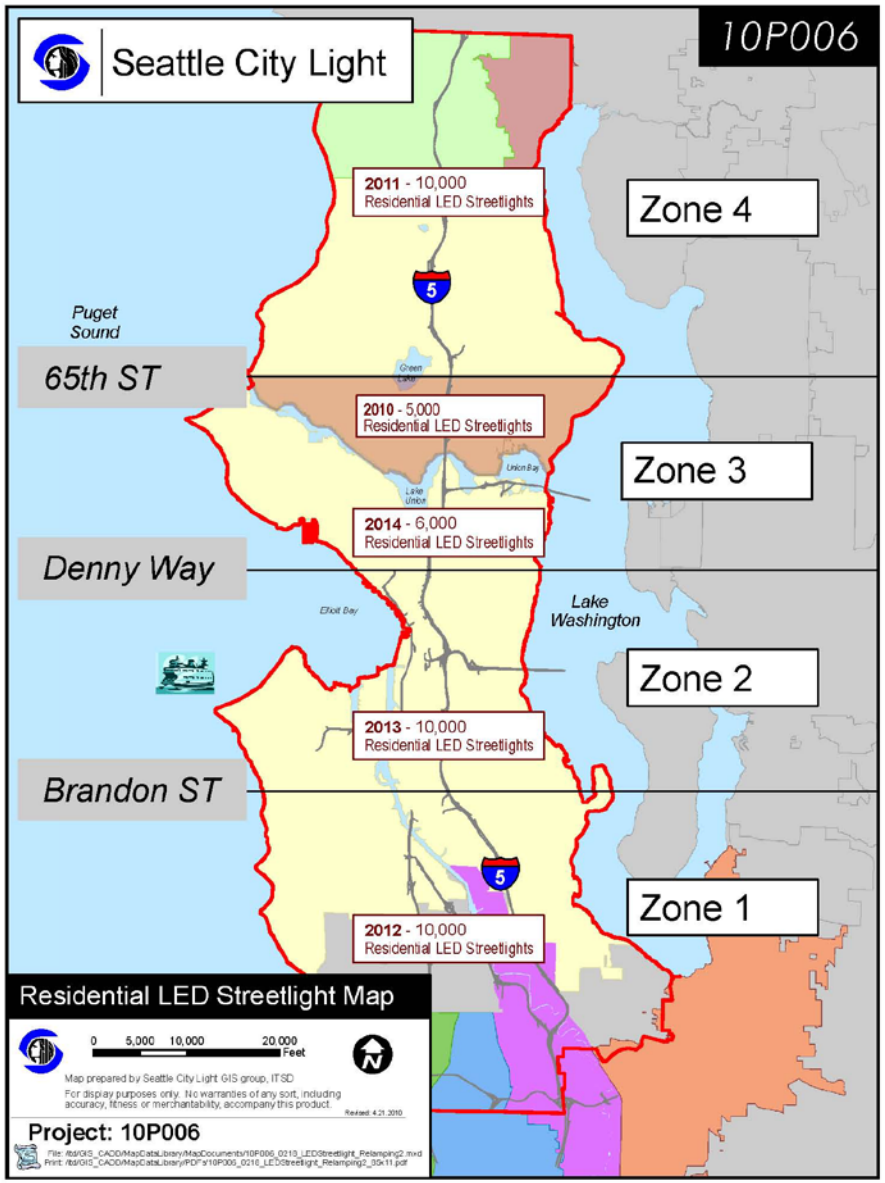
In 2009, we began exploring LED technology

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

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)

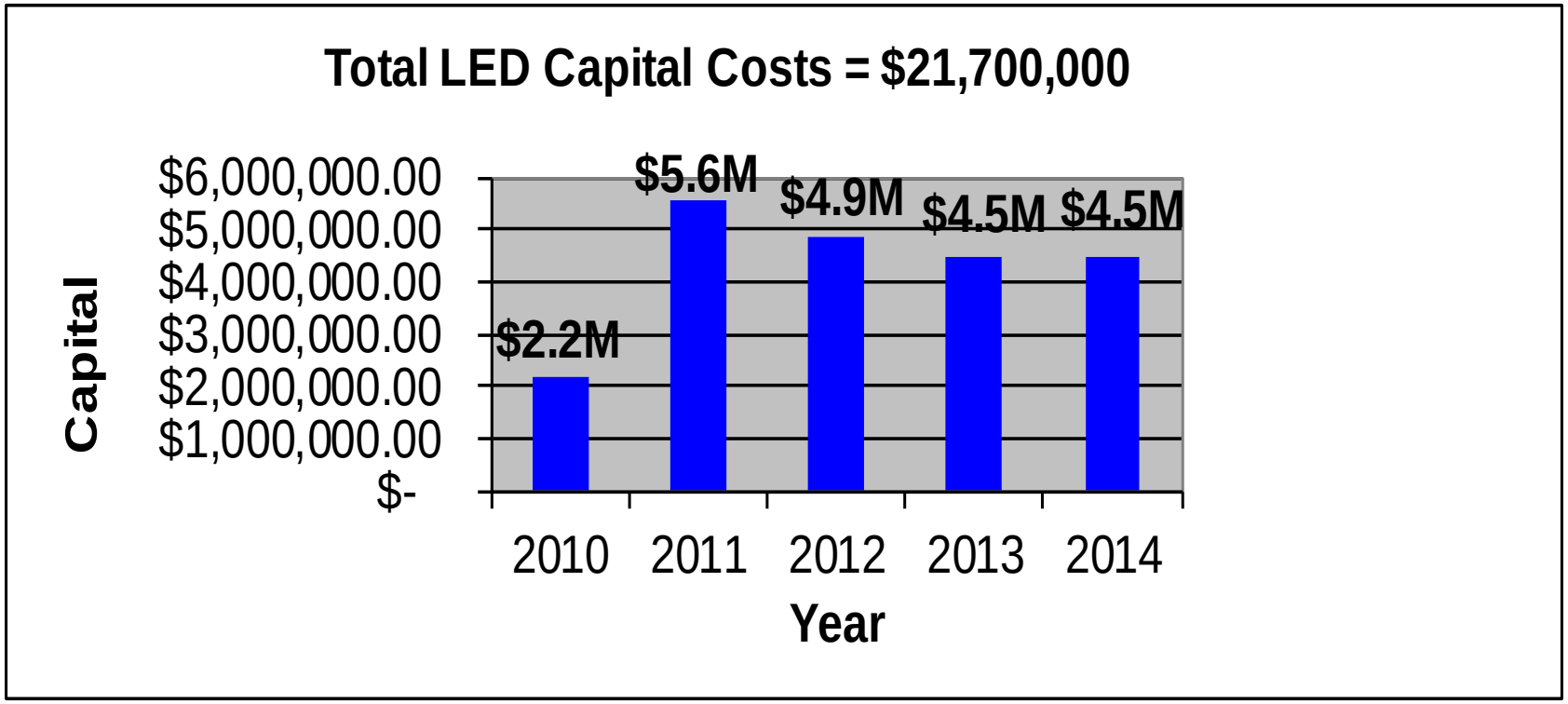
41,000 Total Residential LED Streetlights Converted



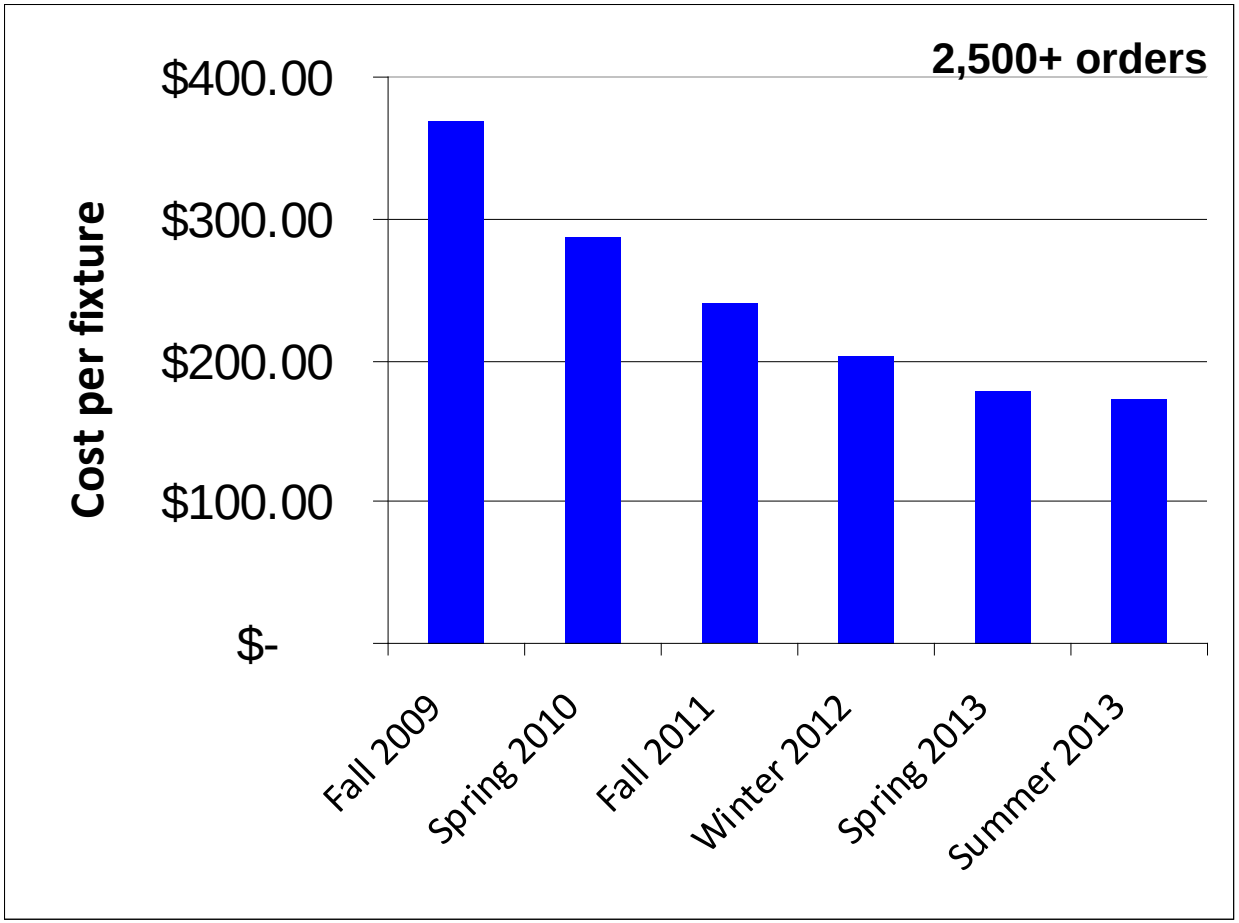
THE NATION'S GREENEST UTILITY SINCE 1905 SEATTLE CITY LIGHT

Seattle City Light

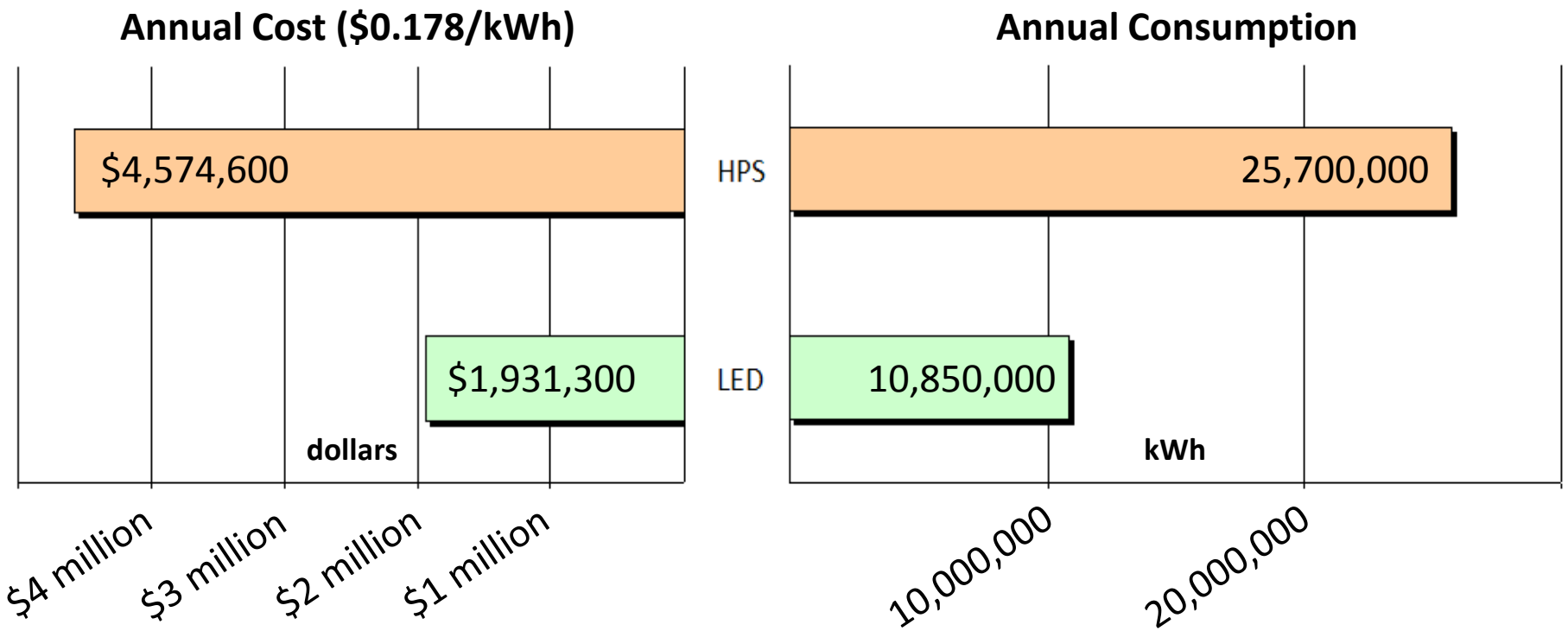
Investment on LED Conversion



Residential LED fixture costs decreased by half in 4 years



To date:



$2,643,300 savings

14,850,000 kWh savings

THE NATION'S GREENEST UTILITY SINCE 1905 SEATTLE CITY LIGHT

Seattle City Light

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)

Residential conversions are completed with arterial conversions ramping up

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

Lessons learned from the field

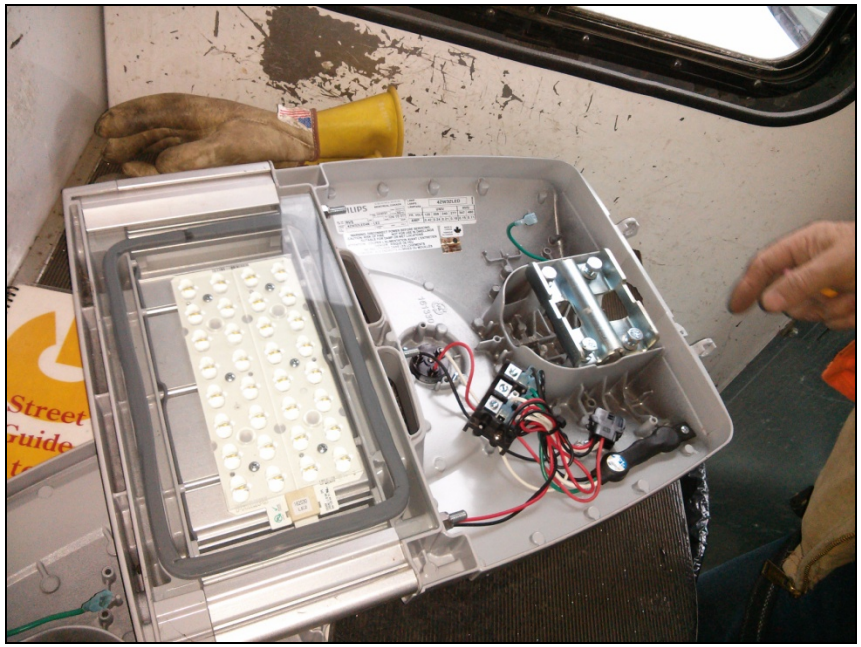
- Customer Complaints
    - Color Quality
    - Light Trespass
    - Visibility
  - Remedy
    - Installing shields
    - Lowering drive current
- Compatibility issues between fixture and PE cell
  - Remedied by additional training

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

3. Sample request

4. Fixture/housing analysis | Mock-up

5. In-situ light level evaluation



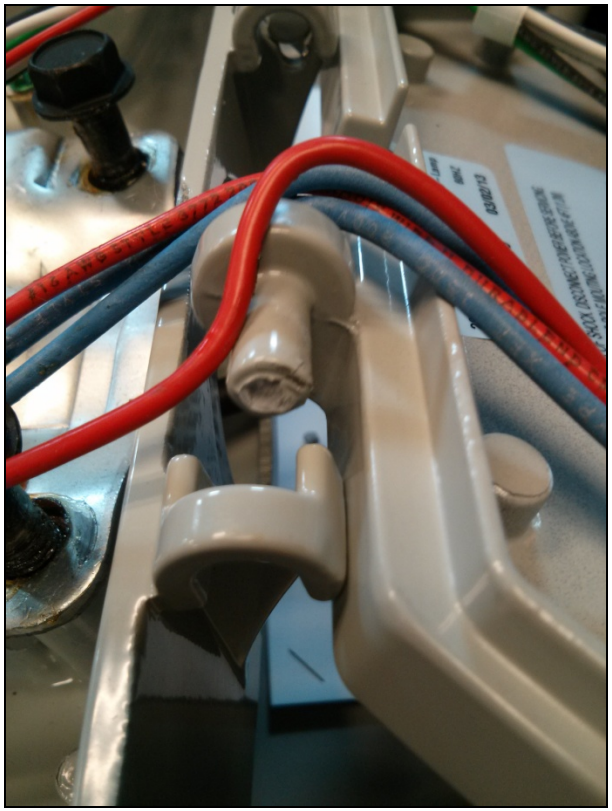
- Lab study to confirm light-level claims
- Evaluate each fixture for handling issues

Fixture count: **10**

Seattle City Light

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

3. Sample request



4. Fixture/housing analysis | Mock-up

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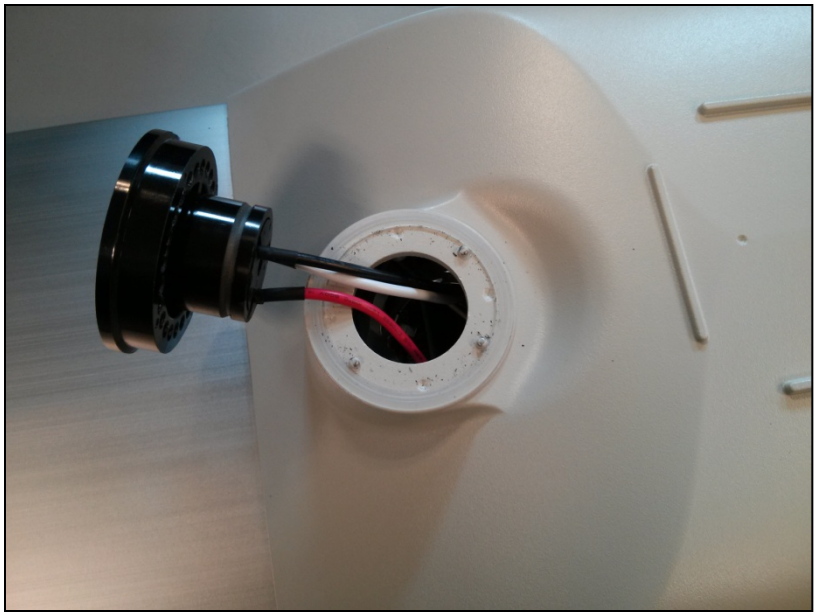


Fixture count: **3**

Other maintenance considerations

- 10 year warranty on new luminaires
- Use 20 year life photocells
- Reduces load on streetlight circuits
- Eliminates vibration caused failures on bridge structures
- LED conversion & group re-lamping have reduced outages from several thousand to less than 200

Resources

- Department of Energy

  Municipal Solid-State Street Lighting

  http://www1.eere.energy.gov/buildings/ssl/consortium.html
- Illuminating Engineering Society

  ies.org
- Seattle City Light

  seattle.gov/light/engstd

Municipal Solid-State STREET LIGHTING CONSORTIUM

IES Illuminating ENGINEERING SOCIETY

Seattle City Light

THE NATION'S GREENEST UTILITY SINCE 1905 SEATTLE CITY LIGHT

Seattle City Light

Thank you!

Steve Crume

Streetlight Engineering Manager

Seattle City Light

Stephen.Crume@seattle.gov

Seattle City Light

City of Las Vegas Street Light Upgrade

Patrick Batte' AIA LEED AP
City of Las Vegas
Architectural Project Manager

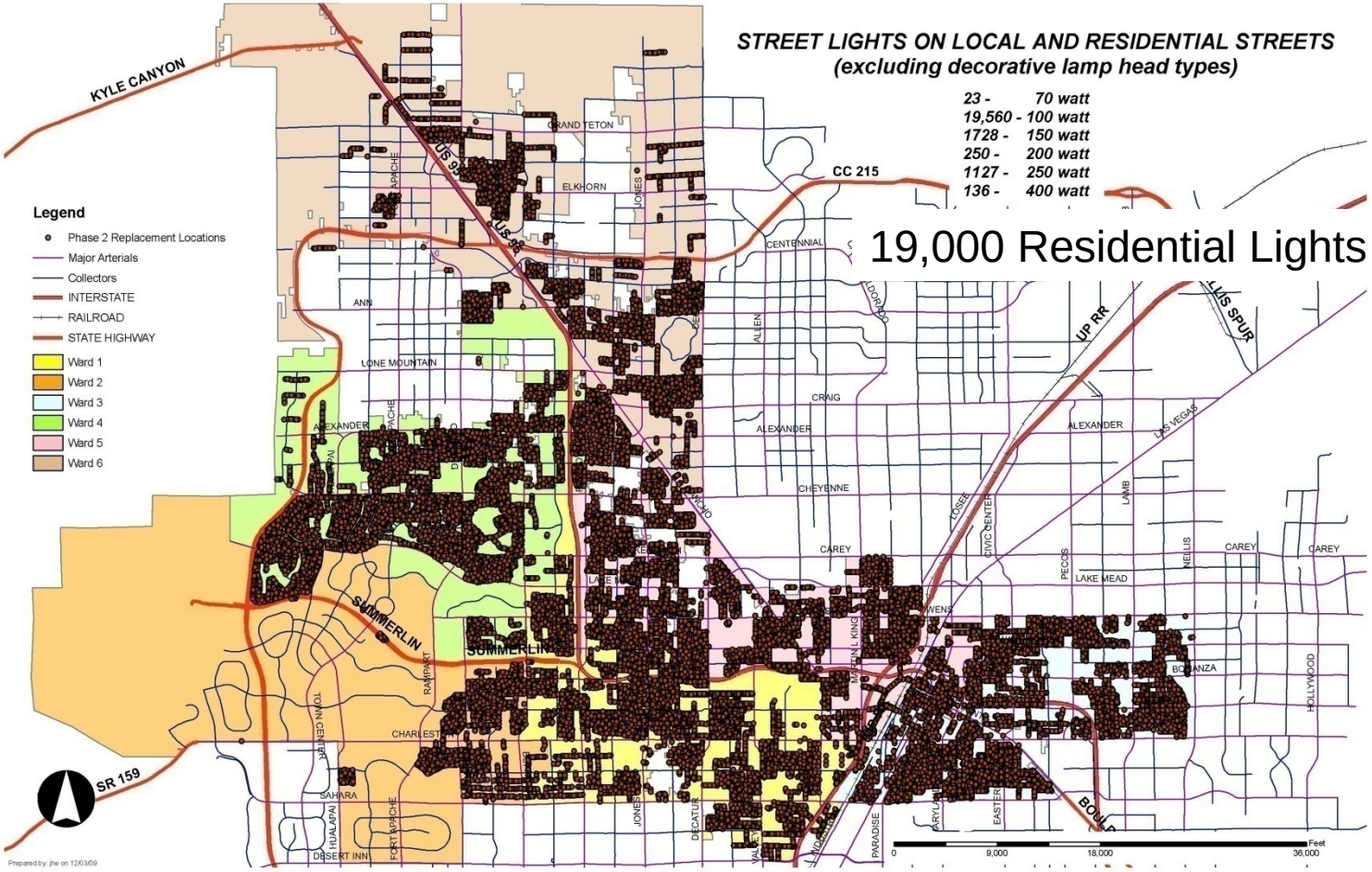
City of Las Vegas

- 600,000 Habitants
- 135.9 Sq. Miles
- Six Districts (Wards)
- Part of Las Vegas Valley with a population of 2,000,000
- 54,000 Streetlights Total
- 19,000 Residential Streets-Converted to LED May 2013
- 21,000 Commercial Streets-Converted to LED May 2013
- 4,000 Intersections- 2014
- 10,000 Decorative Commercial Lights-2015

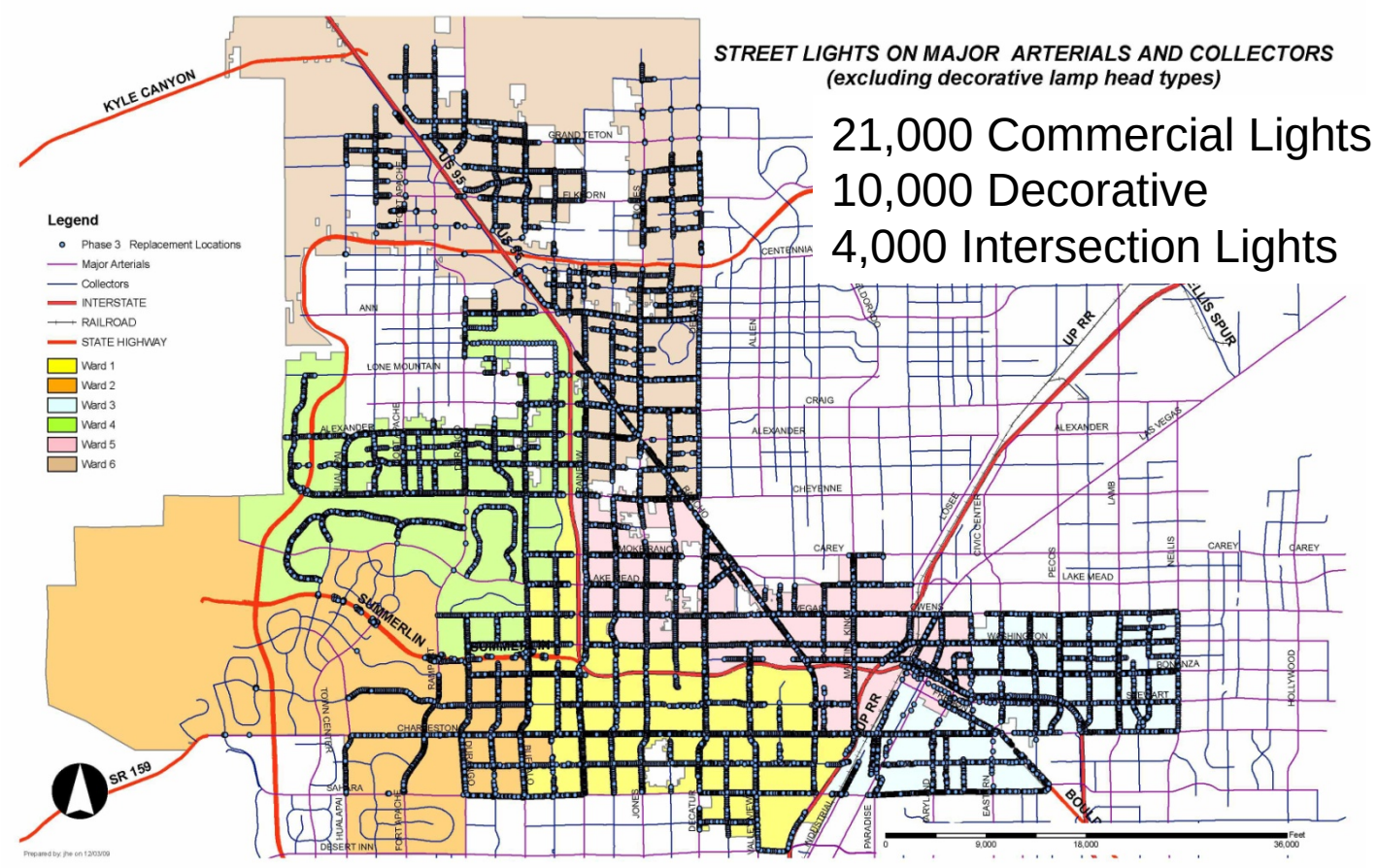
All Public Lighting is Metered

Public Works

City of Las Vegas



City of Las Vegas



Streetlight Upgrade-Testing Phase

- 4 month process-5 Different Products
- City staff Measured Illumination Levels by RP-8.
- Testing of Brands Occurred at Same Location
- Additional Fixture - Staff Examination for Service and Maintenance

Staff lab evaluation of fixture type for service and maintenance

Streetlight Upgrade-Evaluation Phase

- Percentage Point System based on five categories /

1. Durability-10%
2. Serviceability-20%
3. Energy Savings-20%
4. Illumination Evaluation-25%
5. Cost-15%

City of Las Vegas Street Light Fixture Evaluation and Testing RFP — RFP No. 100240-TF

Equipment Evaluation Score Card

Local

FIXTURE	Durability - Section 1.0/10%							Serviceability - Section 2.0/20%											Energy Savings - Section 3.0/30%							Lighting Evaluation - Section 4.0/25%			Cost - Section 5.0/15%	
	1.1	1.2	1.3	1.4	1.5	1.6	Total Weighted	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	2.11	Total Weighted	3.1	3.2	3.3	3.4	3.5	3.6	3.7	Total Weighted	4.1	4.2	Total Weighted	5.0	Total Weighted
A	5	5	5	2	6	6	5.80	10	10	10	0	5	10	5	5	5	0	1	13.56	5	5	0	3	0	0	0	11.82	10	8	22.5	0.66	9.9
B	5	5	0	3	5	5	4.60	10	10	0	10	5	10	5	5	0	10	5	15.56	5	0	0	3	4	0	0	10.91	10	10	25	0.71	10.66
C	5	5	5	3	5	4	5.40	10	0	10	10	5	10	0	0	5	10	1	13.56	5	5	0	3	0	0	0	11.82	10	6	20	0.23	3.50
D	5	5	5	10	7	8	8.0	10	10	10	10	5	10	5	5	5	10	10	20.00	5	5	0	3	4	0	0	15.45	10	8	22.5	0.66	9.92
E	5	5	0	8	10	6	6.80	10	10	10	10	5	10	5	5	5	10	7	19.33	5	0	0	3	4	0	0	10.91	0	5	6.25	1.0	15

A zero score in any evaluation section marked yellow indicates failure to meet minimum requirements listed in the RFP

Arterial

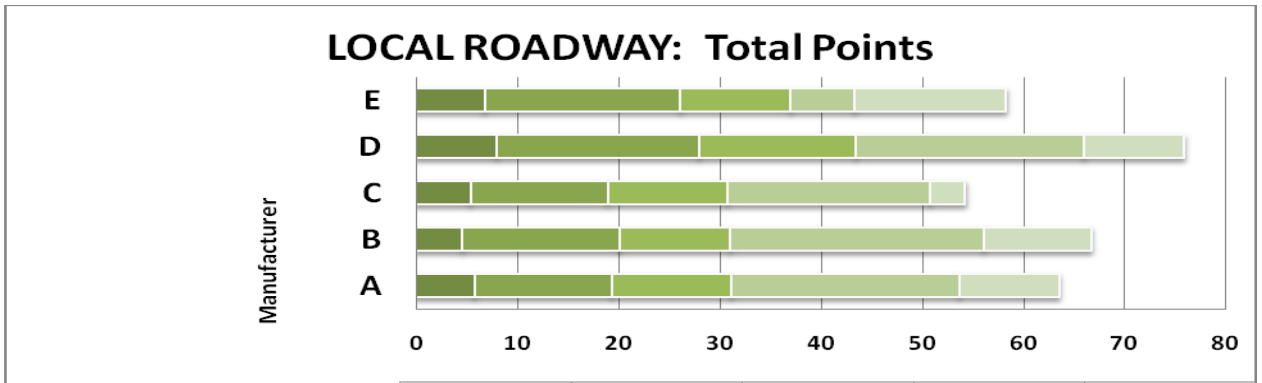
FIXTURE	Durability - Section 1.0/10%							Serviceability - Section 2.0/20%											Energy Savings - Section 3.0/30%							Lighting Evaluation - Section 4.0/25%			Cost - Section 5.0/15%	
	1.1	1.2	1.3	1.4	1.5	1.6	Total Weighted	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	2.11	Total Weighted	3.1	3.2	3.3	3.4	3.5	3.6	3.7	Total Weighted	4.1	4.2	Total Weighted	5.0	Total Weighted
A	5	5	5	2	2	6	5.00	10	10	10	10	5	10	5	5	5	10	7	19.33	5	0	0	3	0	0	0	7.27	9	5	17.5	0.75	11.3
B	5	5	5	9	5	5	6.80	10	10	10	10	5	10	5	5	5	10	9	19.78	5	5	0	3	4	0	0	15.45	0	10	12.5	0.42	6.2
C	5	5	5	1	3	4	4.60	0	0	0	0	5	0	0	5	0	0	1	2.44	5	0	0	0	0	0	0	4.55	0	10	12.5	0.16	2.4
D	5	5	5	9	7	8	7.80	10	10	10	10	5	10	5	5	5	10	9	19.78	5	5	0	3	4	5	0	20.00	8	6	17.5	0.44	6.6
E	5	5	5	7	10	6	7.60	10	10	10	10	5	10	5	5	5	10	8	19.56	5	5	0	3	4	5	0	20.00	0	5	6.25	1	15.0

2.6 - Tooless entry (Section 4Q)
2.10- Weight greater than 25 lbs.(Section 4V)
3.5-Power savings greater than 40% of HPS fixture (Section 3.1)
4.1-Illumination distribution meeting RTC (Section 3A, 4H)

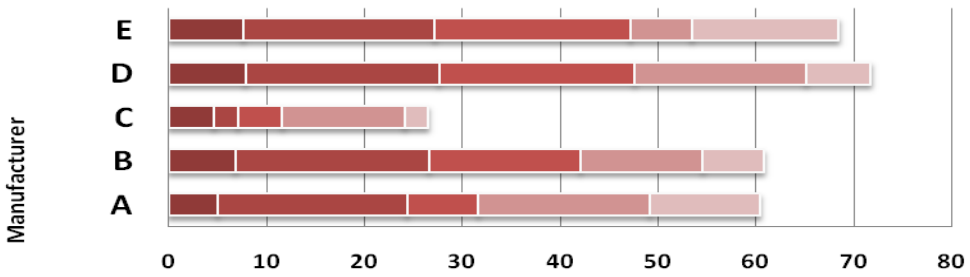
Streetlight Upgrade-Evaluation Phase-Service/ Maintenance Category

- M1 – Luminarie have a slim, low profile design?
- M2 – Is Luminarie constructed of Extruded aluminum with cast aluminum components?
- M4 – Is Luminarie equipped with a shorting cap for future 3-prong twist lock socket?
- M5 – Is Luminaire able to be mounted on standard horizontal tenon?
- M6 – Is Luminaire adjustable for fixture leveling (+/- 5 degrees)?
- M7 – Is the ballast/driver located within the housing and easily accessible.
- M8 – Is Luminaire clearly labeled with full catalog number?
- M10 – Is Luminaire equipped with integrated bubble level?
- M11 – Are all serviceable parts free from sharp edges or corners?
- M12 – Luminaire weight. Actual weight of the fixture.
- M13 – Is internal wiring rated for 105 degree Celsius and routed away from heat generating components?
- M14 – Are all covers provided for access to serviceable parts securely attached but easily removable?

Streetlight Upgrade-Evaluation Phase



	A	B	C	D	E
Durability - Section 1.0/10%	5.8	4.6	5.4	8.0	6.8
Serviceability -					
Energy Savings					
Lighting Evalua 4.0/2					
Cost - Section 5					



	A	B	C	D	E
Durability - Section 1.0/10%	5.0	6.8	4.6	7.8	7.6
Serviceability - Section 2.0/20%	19.3	19.8	2.4	19.8	19.6
Energy Savings - Section 3.0/30%	7.3	15.5	4.5	20.0	20.0
Lighting Evaluation - Section 4.0/25%	17.5	12.5	12.5	17.5	6.3
Cost - Section 5.0/15%	11.3	6.2	2.4	6.6	15.0

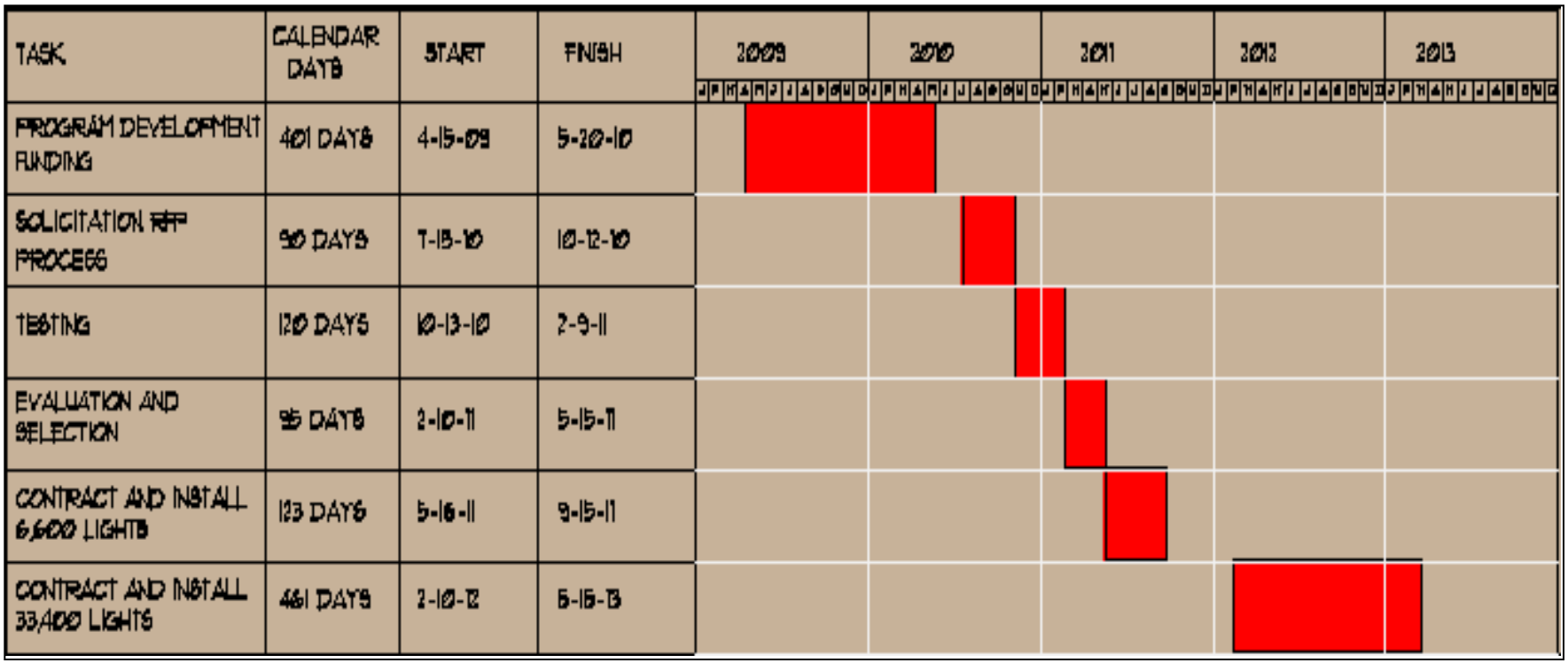
Street Light Upgrade
Contract and Installation Phase

- 6,600 LED Lights-1st Phase:

•Started May 2011 Completed September 2011

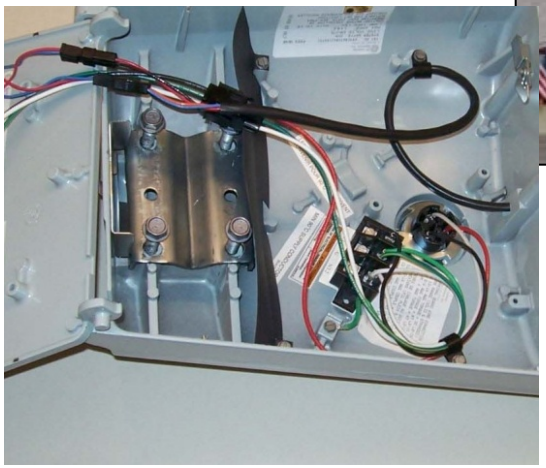
33,400 LED Lights-2nd Phase:

•Started February 2012 Completed May 2013



Streetlight Upgrade-Lessons Learned

- Existing Infrastructure- old conductors, large wire unable to fuse at new terminal blocks. Manufacturer built UL listed terminal block with intergretated fuse.
- Light trespass- Complaints regarding reduced light on private property. Masking used in lieu of shields. Public outreach a solution.
- Bubble Level- Not effective on bottom of fixture. On top of fixture or omit.
- Cul de sac – Directional light from LED coverage issues.
- Viability –Vegetation still a cause of lighting issues.

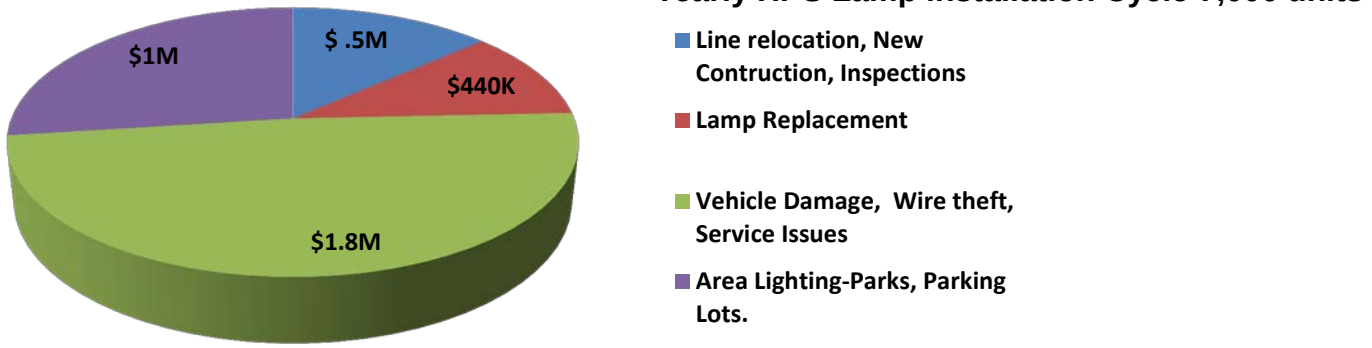


Streetlight Upgrade-Maintenance-Moving Forward

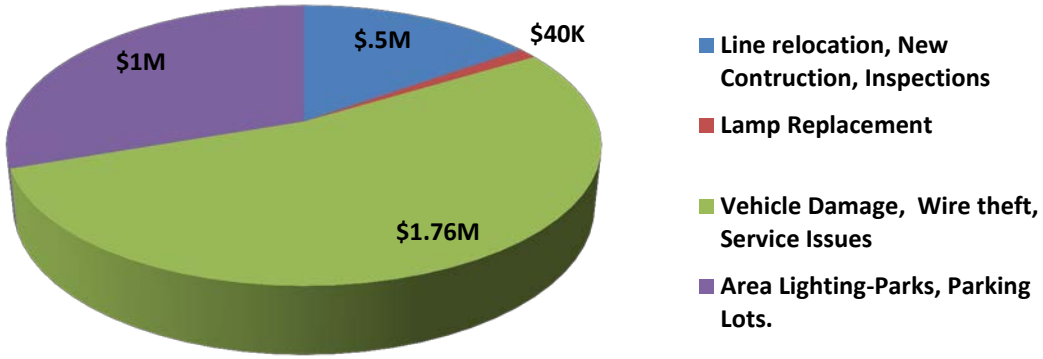
- Outages and Public Complaints-80% reduction in service call requests.
- Warranty replacement- Less than .05%
- Staff Reduction by Attrition- Staff reassigned to repairs and other deferred maintenance issues, such as photocell relocation and replacement,circuit repairs, infrastructure upgrades,installations,retrained to maintain and program traffic signals.
- Improving Customer Service-Staff being trained to provide better service with more time to dedicate on other assets.
- Improved Inventory Control- less bulbs, and miscellanous parts in warehouse. GIS Database more accurate regarding field fixtures and quanities. 30% storage area reduction.

Streetlight Upgrade-Maintenance-Moving Forward

City of Las Vegas Maintenance Costs 2010 $3.74M Budget

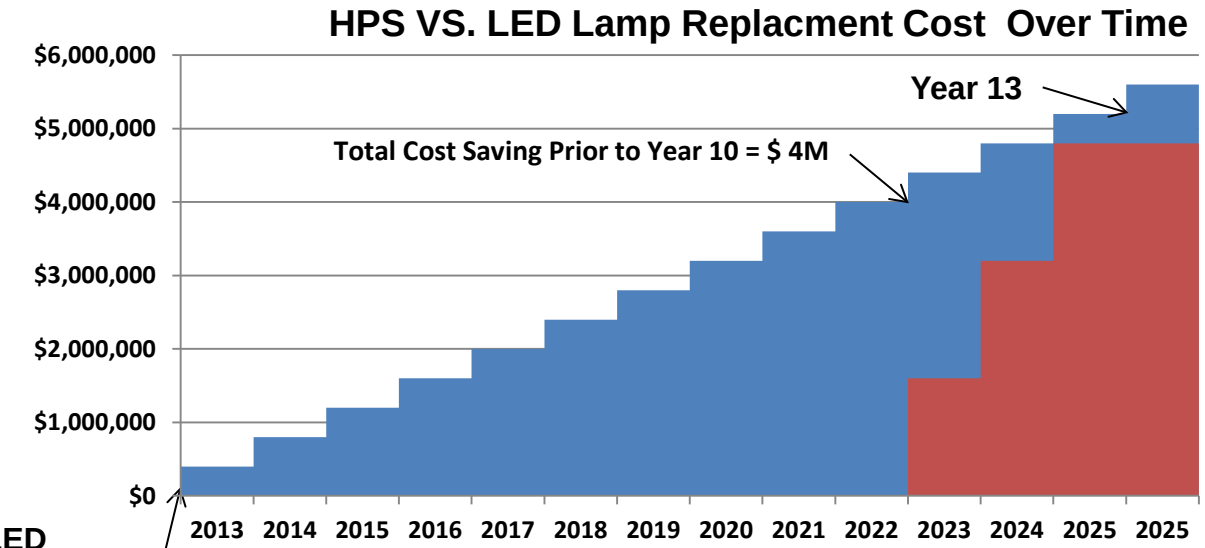


City of Las Vegas Maintenance Costs 2013 $3.3M Budget



Streetlight Upgrade-Maintenance Budget

- Plan Ahead for LED Replacement- Require a future retrofit in specifications.

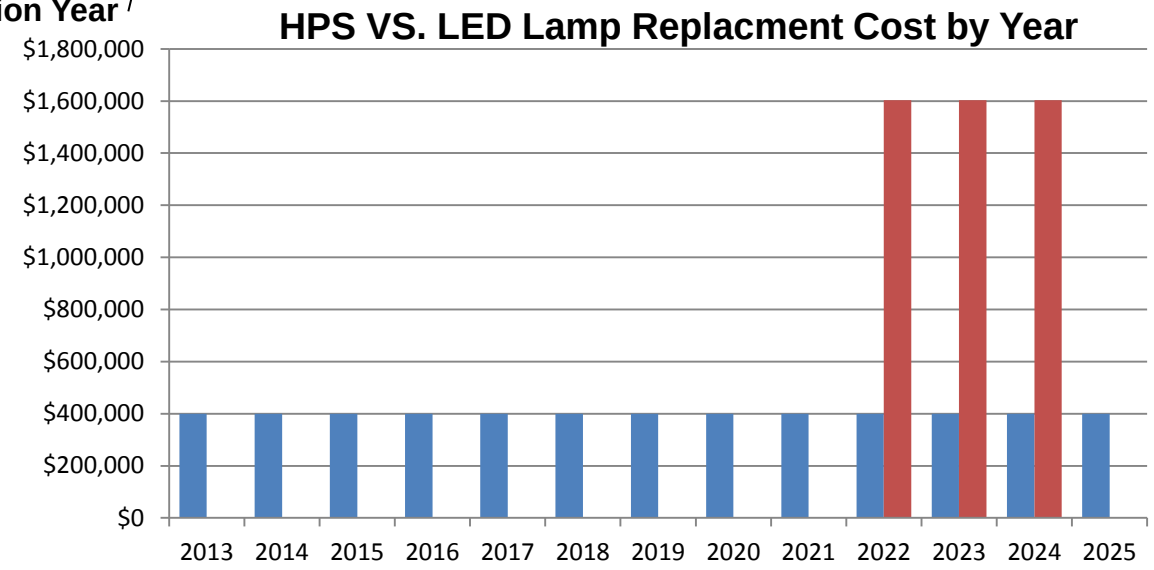


HPS Year 13=$5.2M

LED Year 13=$4.8M

$400K @ 4% over 10 years = $4.8M

2013 LED Installation Year



Total savings year 13

HPS $5.2M

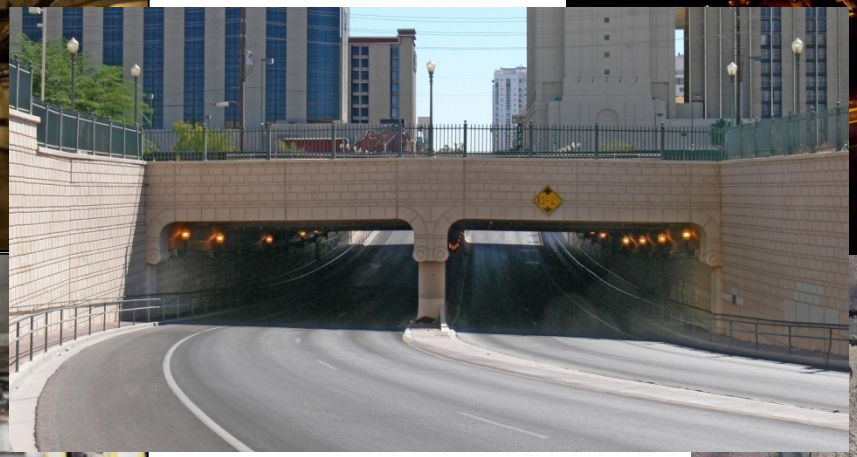
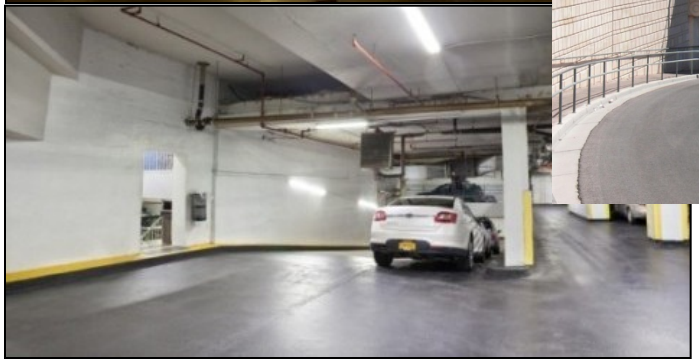
LED $4.0 M

$1.2 M

Future- 2014-2016

- Intersections 4,000 – (8) 120W replacing (4) 400W
- Bridges and Underpass Locations.
- Parking Garages
- 10,000 Decorative Lights to LED – RFP Process
- Replace 12,000 Lights on 200 City Properties with LED
- Inverse ratio photo cell 1.5fc turn on (ANSI standard) and a .9 fc turn off. previous type a 1.5 fc on with a 1.5 fc X 1.5 = 2.25 fc off. saves about .5 hr/fixture/day on the back end (dawn).




Thank you!

Questions?

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