

Stevens Point LED Street Light Project Final Report



Presented by



INGENUITY WELCOME

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Stevens Point LED Street Light Project

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Preface

Wisconsin Energy Conservation Corporation (WECC) contracted with Johnson Controls Inc. (JCI) to provide measurement and verification (M&V) services. The JCI M&V Team provided an assessment of an LED street lighting project installed in Stevens Point's Portage County Business Park, including monitoring, data collection, and data analysis services.

Acknowledgements

The LED Street Lighting Research and Demonstration project was funded by Wisconsin Public Service (WPS) according to terms of an agreement with the State of Wisconsin. Johnson Controls would also like to acknowledge the cooperation provided by WECC, WPS, and the City of Stevens Point during the evaluation period.

Executive Summary

This is a final report summarizing the results of an assessment by Johnson Controls Measurement & Verification Team on the performance of light emitting diode (LED) luminaires in a street lighting application. The project included installation of two different manufacturers' LED fixtures installed in street lights on public roadways in the Portage County Business Park located in Stevens Point, Wisconsin. See Appendix A for the map of the locations and installation pattern. Quantitative light and electrical power measurements as well as surface and aerial digital photographs were taken in multiple phases by the M&V Team. The measurements taken include: photopic illuminance, scotopic illuminance, amps, and volts.

The demonstration street locations for new installed LED street lights were Clem's Way and E.M. Capps Dr. Twelve existing high-pressure sodium (HPS) cut-off fixtures were replaced with LED fixtures on each street. For the purposes of this report, the fixture is defined as containing the housing, ballast or driver, optics and light source. The replacement included the new fixture on the existing support system; the poles, arms, and wiring were all reused for the new LED fixtures. Separate companies were selected through an RFP process to provide the LED fixtures for each street and 25% of these fixtures (3 on each street) were monitored in each of the testing phases. Mounting height for the fixtures is approximately 30 feet above the road surface and the street lights are located on alternating sides of the streets within the test area. LSI fixtures were tested on Clem's Way and Leotek fixtures were tested on E.M. Capps Dr.

The following chart is a summary of power usage changes that have been realized with the installation of the new LED fixtures by both manufacturers. Light level readings can be found in each of the respective sections for the study areas.

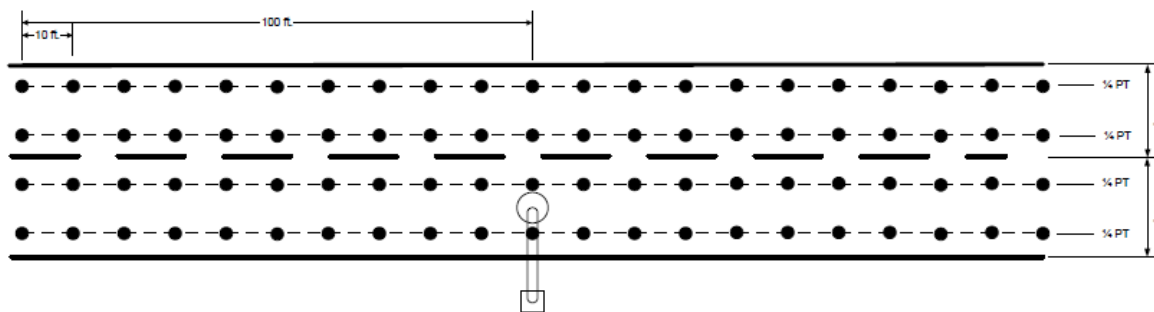
Fixture	Watts/Fixture	Watts/Fixture Reduced	% Change	Annual kWh*	Annual kWh Saving*
HPS	306.1	N/A	N/A	1237.4	N/A
LSI XRM-2-LED-119-CW-UE-BRZ	138.1	168.0	55%	558.2	679.2
Leotek SLN-048-MV-CW-3M-GY LED	156.4	149.7	49%	632.2	605.2
* Annual usage is based on 4,043 hours of operation per year					

As part of the LED lighting assessment, WPS conducted a Community Observation Survey. The purpose of the survey was to obtain feedback from licensed drivers that regularly drive on the streets where the LED fixtures were installed. The survey was completely voluntary and the results are shown in Appendix D.

Methodology

ILLUMINANCE MEASUREMENTS

Photopic and scotopic illuminance measurements were taken on a 25% sample of the 24 fixtures at a height of 36" above ground, after civil twilight, and when ambient light from the moon was at a minimum. Eighty-four measurement points were laid out on a grid for each fixture. Three central street lights on each street located at a spacing of 130' to 150' comprised the test area. This monitoring grid follows as closely as possible Illuminating Engineering Society of North America (IESNA) guidance for photometric measurements of street lighting systems. The field illuminance measurement readings were taken in lux to enable a simplified recorded whole number and then converted to foot candle values. See Appendix B for the individual street grid layout. The photopic values measure the quantity of light that helps in direct object recognition, while scotopic values are significant to peripheral vision.



Typical Photometric Sampling Plan

POWER MEASUREMENTS

Power measurements were logged on the two circuits of Clem's Way that included 12 fixtures for a one week period prior to the retrofit, using a Dent ELITEpro™ data logger. The same power measurement was conducted on the seven fixtures on E.M. Copps Dr. After the retrofit was completed, power measurements were logged two additional times on Clem's Way and three times on E.M. Copps Dr. The pictures below show how the Dent meters were connected in the two cabinets. Once connected, the loggers were left in place each time for a minimum of one week.



**E.M. Copps Dr. panels located on the northeast corner of E.M. Copps Dr. and Weeks St.
Circuits 5 & 6 were measured**



**Clem's Way panel located on the southwest corner of Business Park Dr. and Clem's Way.
Circuits 16 & 18 were measured**

Measurement Dates and Locations

Clem's Way	
9/15/2009 Readings	Original HPS Fixtures
4/13/2010 Readings	New Fixtures Installed Initial Reading
6/9/2010 Readings	Summer Light Levels

*One less reading on Clem's Way due to fixture change

E.M. Copps Dr.	
9/15/2009 Readings	Original HPS Fixtures
1/4/2010 Readings	Initial Light Levels
2/4/2010 Readings	Winter Light Levels
6/9/2010 Readings	Summer Light Levels

FIELD EVALUATION AND DATA COLLECTION

A description of each of the field visits follows:

Measurement Cycle 1 Baseline (Existing Lamps with HPS Cut-off Shoe Box Fixtures)

The first testing cycle was conducted on September 15, 2009, and included measurement and marking of the road pavement per the grid shown in Appendix B and was used for all subsequent field visits. A separate Dent meter was connected to circuits that power the 12 fixtures on Clem's Way and the 12 existing lights on E.M. Copps Dr. These meters were removed a week later. The weather conditions were clear sky, no moon, temperature of approximately 73° F, and civil twilight was at 7:36 p.m. when light meter readings were started.

Measurement Cycle 2 LED Retrofit: (Initial Installation of LED Fixture)

The second testing cycle was conducted on January 4, 2010, a week after initial installation of the LED luminaires. The ground was covered with snow and existing grid marks were identified and repainted where required. Dent meters were installed in an identical manner as in test cycle 1 and removed a week later with the data collected following the guidelines of the project. Weather conditions were partly cloudy sky, no moon, approximate average temperature was 15° F, and civil twilight time was 5:30 p.m. when light meter measurements were started.

Measurement Cycle 3 E.M. Copps Dr. Only (Winter Month LED Fixture)

The third testing cycle was completed on February 4, 2010, for the winter readings for colder temperatures. The ground was again covered with snow and grid marks were identified on E.M. Copps Dr. A Dent meter was installed on the required circuit as previously done on the other cycles. Weather conditions were partly cloudy, no moon, average temperature 18°F, and the civil twilight time was 5:45 p.m. when light meter readings were started.

Measurement Cycle 4 Clem's Way Only (Initial Installation of LSI LED Fixture)

The fourth cycle of testing was completed on April 13, 2010. This was the initial monitoring of the LSI fixtures installed on Clem's Way. The same grid pattern was used and the Dent meter was connected to the same circuits. Weather conditions were partly cloudy sky, no moon, average temperature was 55°F, and the civil twilight time was 6:20 P.M. when light meter readings were started.

Measurement Cycle 5 Clem's Way & E.M. Copps Dr. (Final Summer Month LED fixture)

The fifth cycle of testing was completed on June 9, 2010. Light level readings were taken on both Clem's Way and E.M. Copps Dr. The same grid pattern was used and the Dent meters were connected to the same circuits as previously described. Weather conditions were clear sky, no moon, the approximate temperature was 67°F, and civil twilight was at 9:30 p.m. when testing began.

Measurement & Verification Review - Findings & Conclusions

Clem's Way

The project was to measure the light level and power usage for the original 250 watt HPS fixtures prior to the replacement of the fixtures with new fixtures from LSI (model number XRM-2-LED-119-CW-UE-BRZ). The measurement schedule for the lights is shown below.

Clem's Way	
9/15/2009 Readings	Original HPS Fixtures
4/13/2010 Readings	New Fixtures Installed Initial Reading
6/9/2010 Readings	Summer Light Levels

Power Consumption

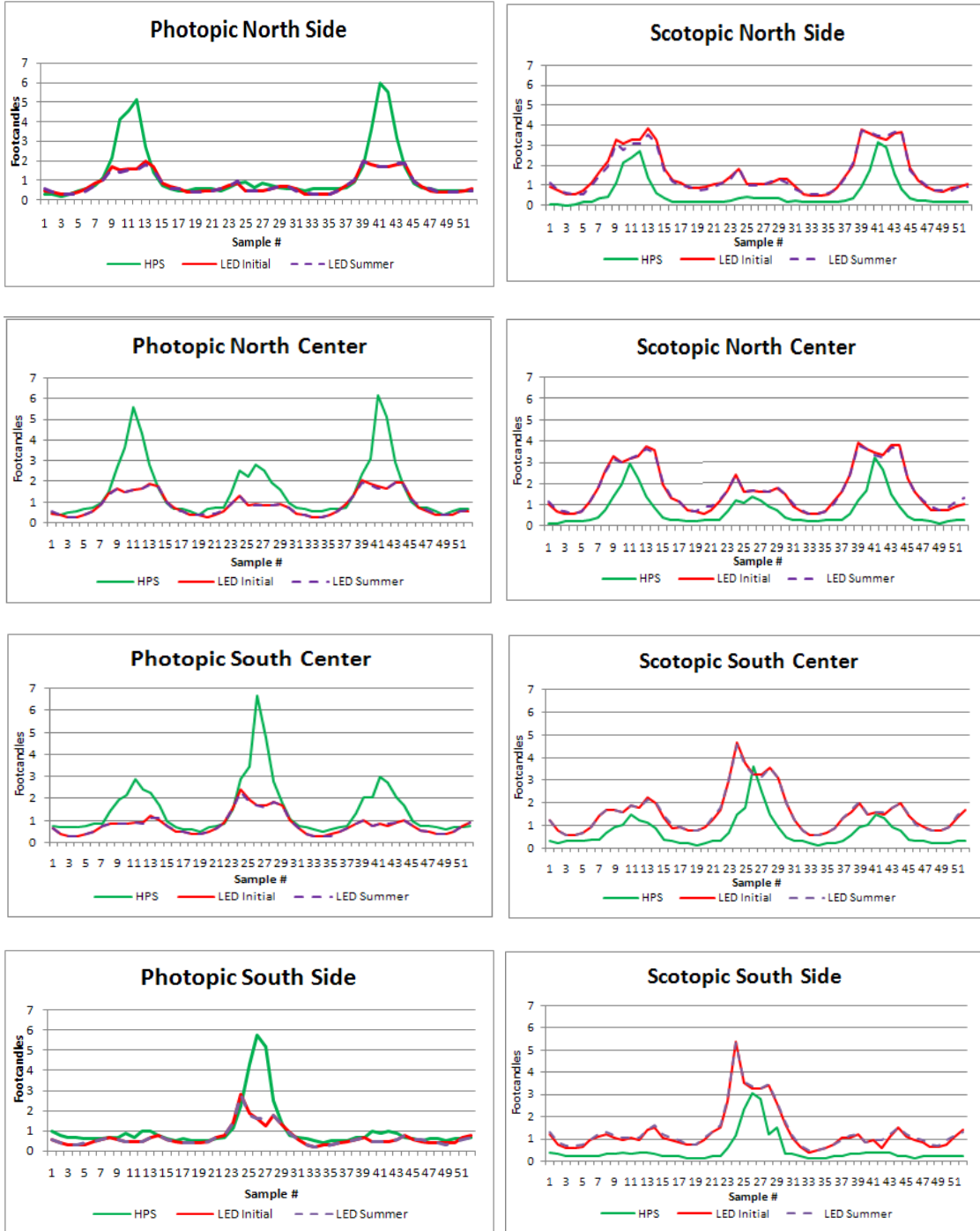
The original HPS fixtures were measured at an average 312 watts per fixture as measured by the Dent ELITEpro meter. The LSI fixtures were measured in the same manner and indicated an average usage of 138 watts per fixture.

Fixture Type	Date of Test	Average Usage per Fixture
Original HPS Fixtures	September 15, 2009	312 watts/fixture
LSI LED Fixture	April 13, 2010	140 watts/fixture
LSI LED Fixtures	June 9, 2010	136 watt/fixture

Light Levels

In conjunction with the power readings, light level readings were also taken during each of the testing periods described above. There were a total of 208 photopic and scotopic readings taken on Clem's Way associated with three fixtures in the test grid. As the graphs below show, the light levels that were monitored in April and June showed no significant change in light output from one reading to the next. It should also be noted that the spikes in the graphs represent readings taken directly under the respective fixtures. See Appendix B for grid and fixture layout.

There were a total of 208 readings taken on a 10' x 10' grid beginning 5' out from the curb and continuing 100' past the last pole in each direction. See Appendix B for the grid layout.

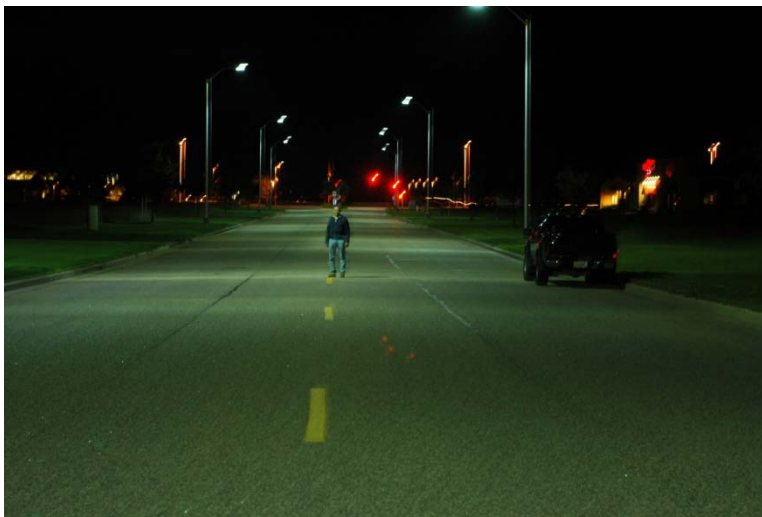


Pictures

Both surface and aerial photos were taken of the fixtures on Clem's Way. The ground level photos were taken before and after the fixtures were replaced. The aerial photos were taken in April 2010 and show the entire area comparing the new LED fixtures with the original HPS fixtures in the area. See Appendix C for additional photos including aerials.



The above photo of the original HPS fixtures was taken in September 2009.



The above photo was taken in June 2010 and shows the street view with the new LSI LED fixtures installed.

E.M. Copps Dr.

The project was to measure the light level and power usage for the original 250 watt HPS light fixtures prior to the replacement of the fixtures with Leotek SLN-048-MV-CW-3M-GY LED fixtures. The schedule for light level readings and power consumption readings was as follows.

E.M. Copps Dr.	
9/15/2009 Readings	Original HPS Fixtures
1/4/2010 Readings	Initial Light Levels
2/4/2010 Readings	Winter Light Levels
6/9/2010 Readings	Summer Light Levels

Power Consumption

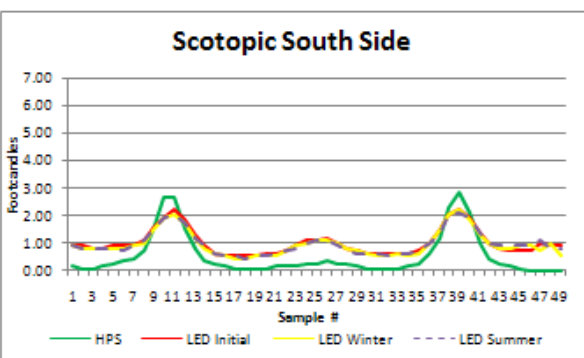
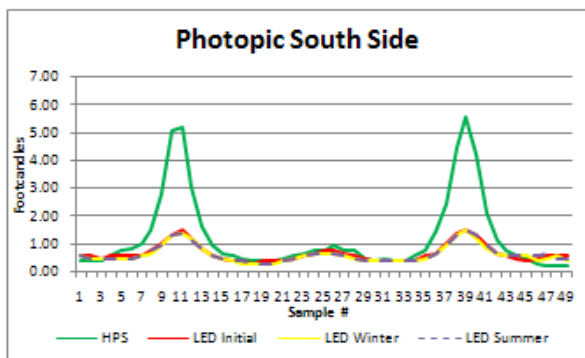
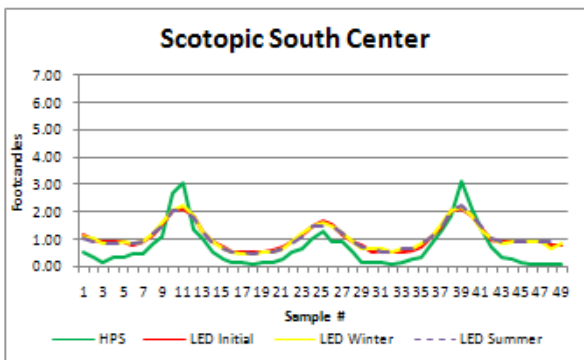
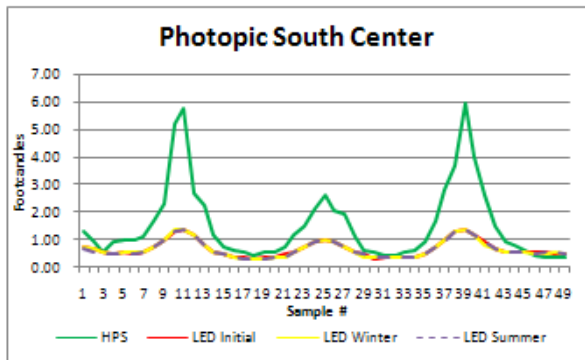
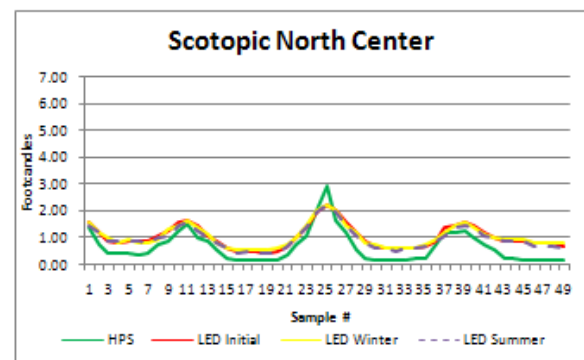
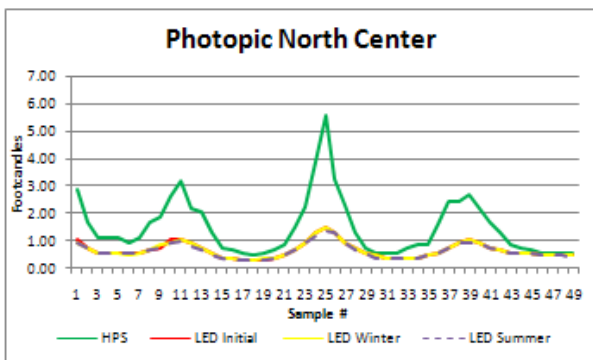
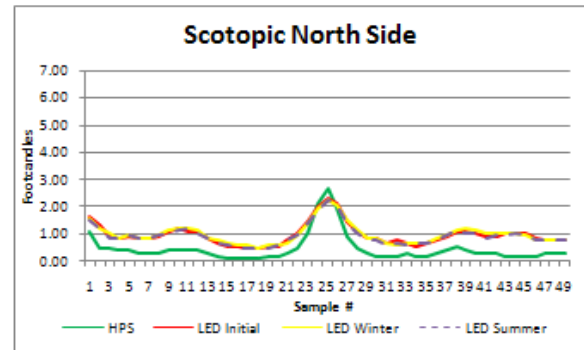
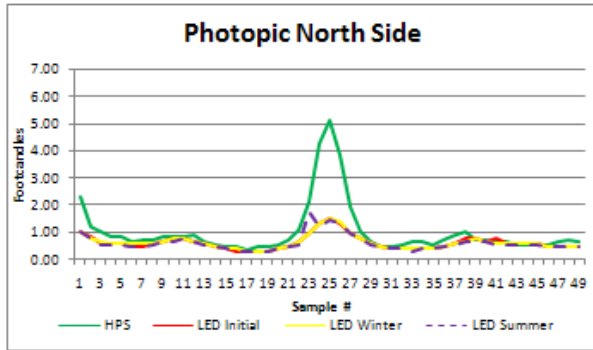
The original HPS lights were measured at an average of 299 watts per fixture as measured by the Dent ELITEpro meter. The Leotek fixtures were measured in the same manner and indicated an average usage of 156 watts per fixture.

Fixture Type	Date of Test	Average Usage per Fixture
Original HPS Fixtures	September 15, 2009	299 watts/fixture
Leotek LED Fixtures Initial	January 4, 2010	156 watts/fixture
Leotek LED Fixtures Winter	February 4, 2010	157 watts/fixture
Leotek LED Fixtures Summer	June 9, 2010	155 watts/fixture

Light Levels

In conjunction with the power readings, light-level readings were also taken during each of the testing periods described above. There were a total of 196 photopic and scotopic readings taken on E.M. Copps Dr. associated with three fixtures in the test grid. As the graphs below show, the light levels that were monitored in April and June showed no significant change in light output from one reading to the next. It should also be noted that the spikes in the graphs represent readings taken directly under the respective fixtures. See Appendix B for grid and fixture layout.

There were a total of 196 readings taken on a 10' x 10' grid beginning 5' out from the curb and continuing 100' past the last pole in each direction. See Appendix B for a grid layout.

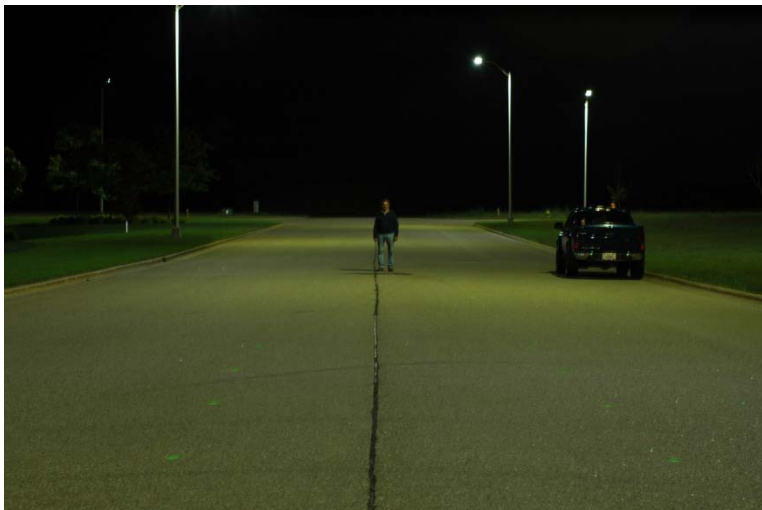


Pictures

Both surface and aerial photos were taken of the fixtures on E.M. Capps Dr. The ground level photos were taken before and after the fixtures were replaced. The aerial photos were taken in April 2010 and show the entire area comparing the new LED fixtures with the original HPS fixtures in the area. See Appendix C for additional photos including aerials.



The above photo of the original HPS fixtures was taken in September 2009.



The above photo was taken in June 2010 and shows the street view with the new Leotek LED fixtures installed.

City Installed Fixtures

During the test period six additional lights were installed on Business Park Drive by the City of Stevens Point. As an additional component of the original study, Johnson Controls was asked to perform a single measurement on three of these lights. The fixtures were manufactured by H Lighting, B Lighting, and L Lighting. Each manufacturer supplied four LED fixtures. The measurements were taken per the grid shown in Appendix B. Single power usage was measured for one sample of each type of light and recorded in amps. Voltages were recorded at the control panel located on the corner of Business Park Dr. and Clem’s Way.

Power Consumption

Energy usage was determined by taking a single reading on one of the four installed fixtures for each manufacturer and calculated using the following equation:

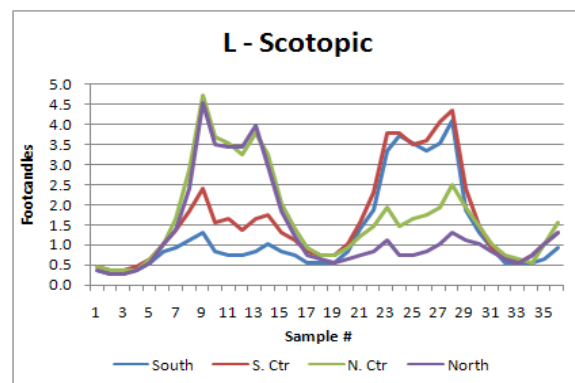
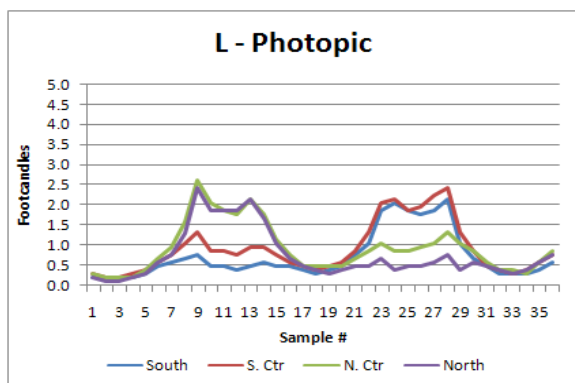
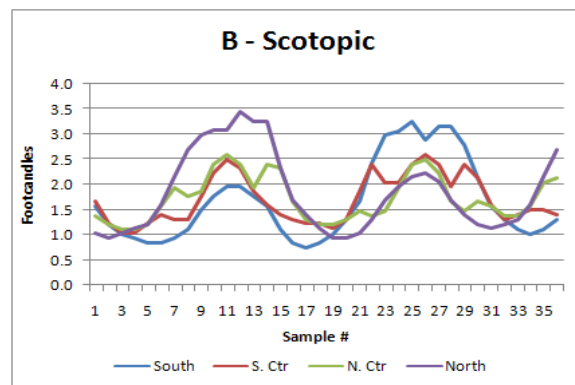
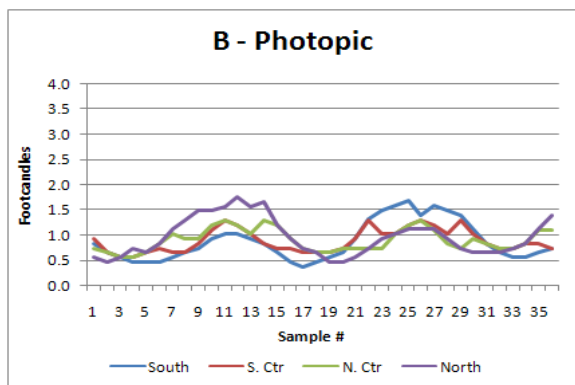
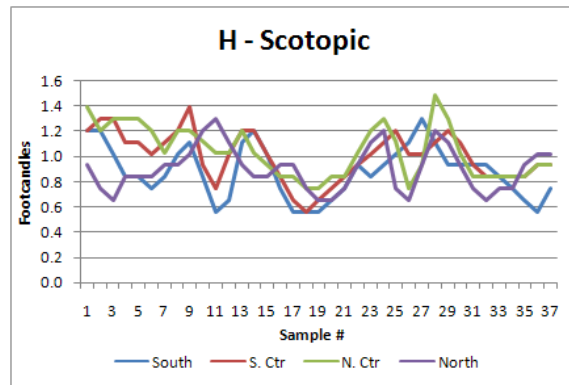
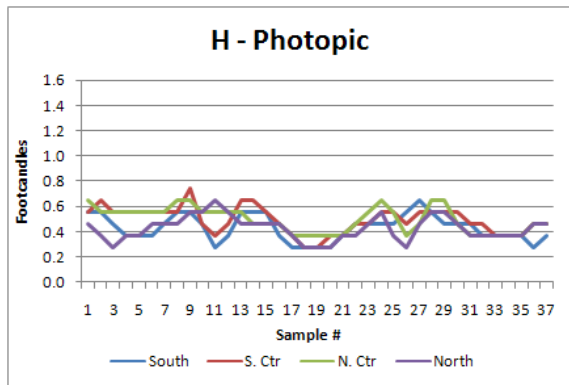
$$\text{Amps} * \text{volts} = \text{watts per fixture}$$

$$\text{Watts per fixture} * 4,043 \text{ hours per yr} / 1,000 = \text{Annual kWh}$$

	Watts/Fixture	Annual kWh*	Annual Savings
HPS	306.1	1,237.40	N/A
H Lighting	92.4	371.7	70%
B Lighting	208.6	839	32%
L Lighting	138.7	558.1	55%
*Annual kWh is based on 4,043 hours of operation			

Light Levels

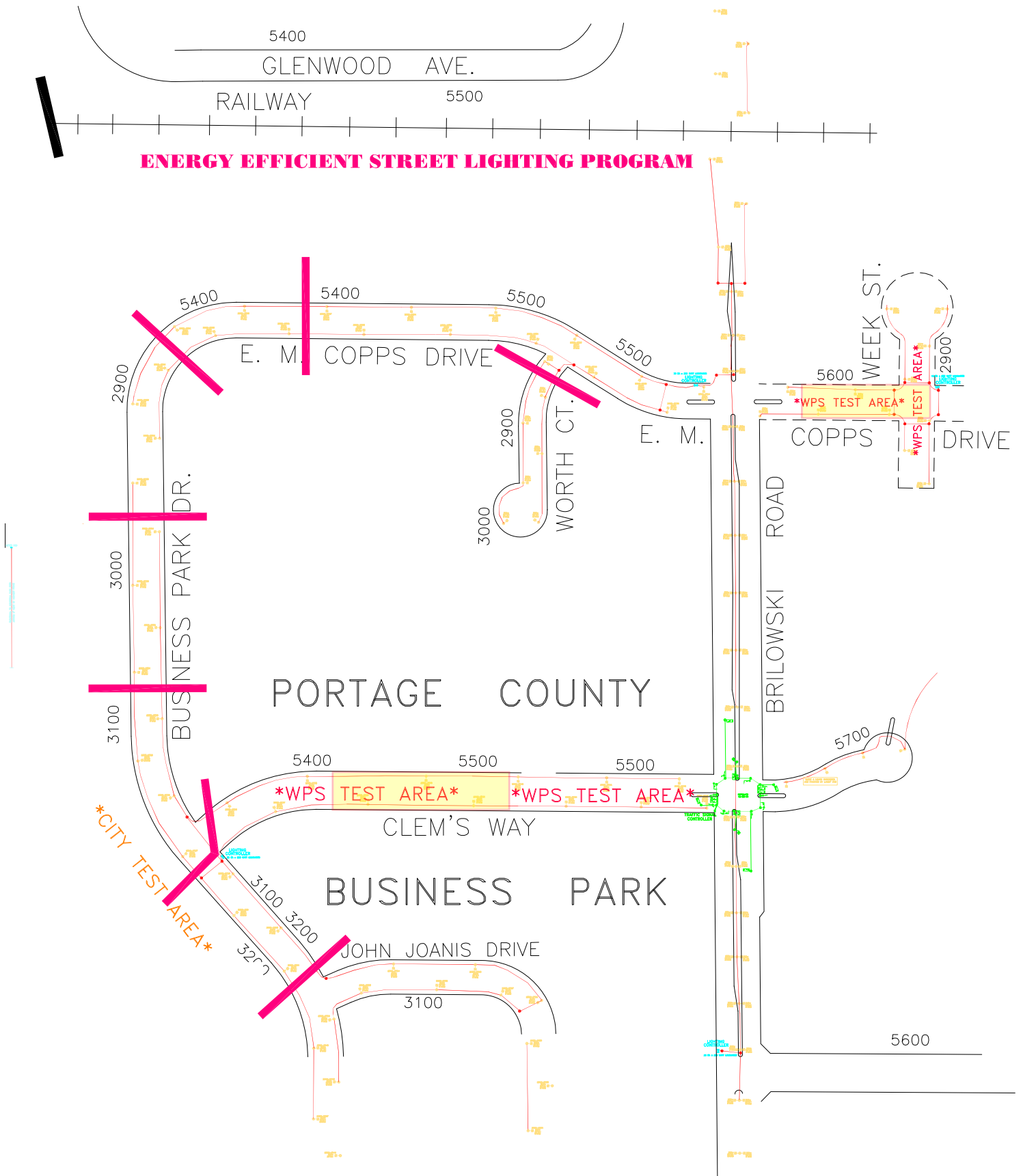
Light levels were recorded following the same procedure that was used on Clem's Way and E.M. Capps Dr. A single set of readings were taken using the same 10' x 10' grid and encompassed two fixtures in each area. The results of the readings are shown below.



Study Observations

Measurements were conducted over a period of nine months so that power usage and light levels were recorded at different outside air temperatures. The results show that there is relatively no change in light levels or power consumption by the LED fixtures at various times of the year. It was also observed during the testing that there was significant variation in the overall visual lighting patterns for lamps provided by the different manufacturers.

Appendix A



Appendix C

Aerial Photographs



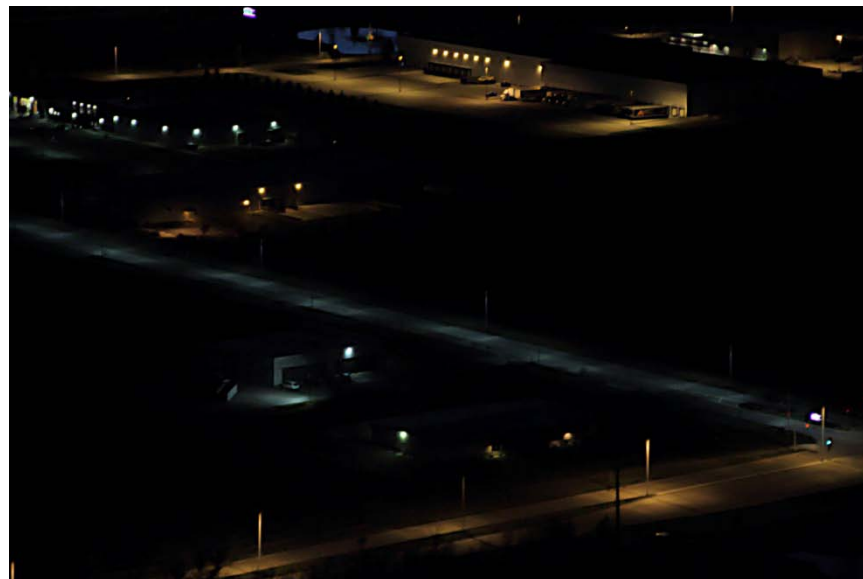
This is a reference daylight photo of Clem's Way looking east.



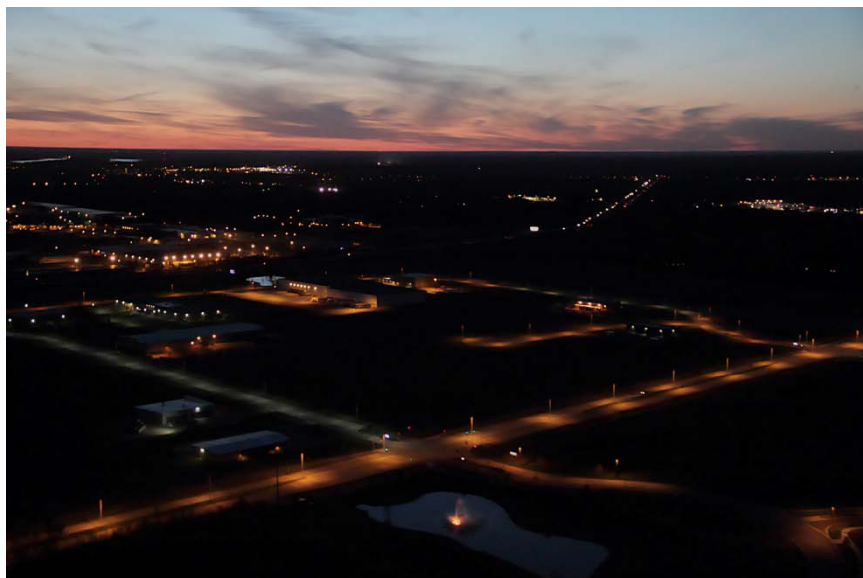
This photo was taken in a similar position to the photo above.



This is a photo of Clem's Way looking west.



Clem's Way looking to the northwest from the corner of Brilowski Road and Clem's Way.



Clem's Way looking to the northwest from the corner of Brilowski Road and Clem's Way.



E.M. Copps Dr. looking to the southeast. The white lights that appear in the lower right corner of the picture were city installed fixtures that were not associated with this study.



E.M. Copps Dr. looking to the west. The area to the left is Clem's Way and the area in the middle of the photo was not associated with this study.

Appendix D

Stevens Point LED Street Lighting Demonstration and
Research Project Community Observation Survey Results

Question 1	Do you feel that the new streetlights installed have improved or not improved visibility for you as a driver (ability to see the roadway and objects that are on it)?
------------	---

Survey 1	No difference
Survey 2	No difference
Survey 3	No difference
Survey 4	No difference
Survey 5	Somewhat Improved
Survey 6	Somewhat Improved
Survey 7	Somewhat Improved
Survey 8	Strongly Improved

Question 2	Do you feel that the new streetlights have improved or not improved visibility for you as a pedestrian?
------------	---

Survey 1	No difference
Survey 2	No difference
Survey 3	Not applicable
Survey 4	No difference
Survey 5	Somewhat improved
Survey 6	Somewhat improved
Survey 7	Somewhat improved
Survey 8	Strongly Improved

Question 3	Do you feel that the new streetlights installed have made it easier or more difficult to recognize people at night?
------------	---

Survey 1	No difference
Survey 2	No difference
Survey 3	No difference
Survey 4	No difference
Survey 5	Somewhat easier
Survey 6	Somewhat easier
Survey 7	Somewhat easier
Survey 8	Much easier

Question 4	Do you feel that the new streetlights installed have created less glare or more glare?
------------	--

Survey 1	No difference
Survey 2	No difference
Survey 3	No difference
Survey 4	No difference
Survey 5	Much less glare
Survey 6	Much less glare
Survey 7	Site 1 More Site 2 Less Glare
Survey 8	Much less glare

Question 5	Do you feel that the new streetlights installed give off the right amount of light or are they too bright or too dim?
------------	---

Survey 1	Right amount of light
Survey 2	No difference
Survey 3	Right amount of light
Survey 4	Right amount of light
Survey 5	Right amount of light
Survey 6	Too dim
Survey 7	Right amount of light
Survey 8	Right amount of light

Question 6	Do you feel that the new streetlights installed create fewer or more dark spots along the street?
------------	---

Survey 1	No difference
Survey 2	No difference
Survey 3	No difference
Survey 4	Somewhat more
Survey 5	Somewhat fewer
Survey 6	Somewhat fewer
Survey 7	Somewhat fewer
Survey 8	Somewhat fewer

Question 7	Have the new streetlights installed affected the business park's overall appearance?
------------	--

Survey 1	No difference
Survey 2	No difference
Survey 3	No difference
Survey 4	No difference
Survey 5	Somewhat improved
Survey 6	Strongly improved
Survey 7	Somewhat improved
Survey 8	Strongly improved

Question 8	When all things are considered do you prefer the new streetlights that were installed or do you prefer the old streetlights?
------------	--

Survey 1	No preference
Survey 2	No preference
Survey 3	No preference
Survey 4	No preference
Survey 5	Somewhat prefer new streetlights
Survey 6	Strongly prefer new streetlights
Survey 7	Somewhat prefer new streetlights
Survey 8	Strongly prefer new streetlights

Question 9	Please tell us what year you were born.
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Survey 1	1971
Survey 2	1958
Survey 3	1967
Survey 4	1954
Survey 5	1946
Survey 6	1950
Survey 7	1954
Survey 8	1980

Question 10	Are you male or female?
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Survey 1	Female
Survey 2	Male
Survey 3	Female
Survey 4	Male
Survey 5	Male
Survey 6	Male
Survey 7	Male
Survey 8	Female

	Comments
Survey 1	None
Survey 2	Didn't notice that they were changed. Hopefully we realize a cost savings and environmental benefits!
Survey 3	None
Survey 4	None
Survey 5	None
Survey 6	The new lights are a huge improvement.
Survey 7	None
Survey 8	If more energy efficient, we like them!

Survey Summary

Count of Question 1	
Question 1	Total
No difference	4
Somewhat Improved	3
Strongly Improved	1
Grand Total	8

Count of Question 3	
Question 3	Total
No difference	4
Somewhat easier	3
Much easier	1
Grand Total	8

Count of Question 2	
Question 2	Total
No difference	3
Not applicable	1
Somewhat improved	3
Strongly Improved	1
Grand Total	8

Count of Question 4	
Question 4	Total
Much less glare	3
No difference	4
Site 1 More Site 2 Less Glare	1
Grand Total	8

Count of Question 5	
Question 5	Total
No difference	1
Right amount of light	6
Too dim	1
Grand Total	8

Count of Question 7	
Question 7	Total
No difference	4
Somewhat improved	2
Strongly improved	2
Grand Total	8

Count of Question 6	
Question 6	Total
No difference	3
Somewhat fewer	4
Somewhat more	1
Grand Total	8

Count of Question 8	
Question 8	Total
No preference	4
Somewhat prefer new streetlights	2
Strongly prefer new streetlights	2
Grand Total	8

Count of Question 10	
Question 10	Total
Female	3
Male	5
Grand Total	8