Downtown Lighting System Study

City of Stillwater, Minnesota

SEH No. STILL 152259

September 27, 2020

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September 27, 2020

RE: Downtown Lighting System Study
City of Stillwater, Minnesota
SEH No. STILL 152259

Mr. Shawn Sanders
City Engineer/Public Works Director
City of Stillwater, Minnesota
216 North 4th Street
Stillwater, MN 55082

Dear Mr. Sanders:

Short Elliott Hendrickson Inc. (SEH) has prepared this Lighting System Study to assess the condition of existing lighting systems within the Downtown Area, and to provide data and strategies for ongoing lighting system improvements. This information was prepared upon request of the City.

If you have any questions, please feel free to contact me at 651.245.5284.

Sincerely,

Ken Taillon

Ken S. Taillon
Project Manager

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Downtown Lighting System Study
City of Stillwater, Minnesota

SEH No. STILL 152259

September 27, 2020

This report was prepared by me or under my direct supervision.

Ken Taillon

Ken S. Taillon
Project Manager

Date: September 25, 2020

Short Elliott Hendrickson Inc.
3535 Vadnais Center Drive
St. Paul, MN 55110-5196

Executive Summary

SEH reviewed the condition of the existing lighting systems within the Downtown Area. The poles are comprised of two general styles - 15' decorative fiberglass anchor base poles and 35' steel or aluminum anchor base poles. All light poles are equipped with High Pressure Sodium (HPS) luminaires that have wattages that are more than necessary for the intended use. Lighting controller cabinets are comprised of five painted steel cabinets and one anodized aluminum cabinet, all mounted on concrete bases. The underground electrical systems are comprised conductors in conduit. Some of the conduits within the downtown area are equipped with circuits that energize 120-volt receptacles for Christmas displays.

Summary of Existing Lighting Systems

There are two existing lighting systems within the Downtown area that are in need of rehabilitation. Both systems were installed under Xcel Energy maintenance contracts. The contract associated with 35' poles has terminated leaving the responsibility for maintenance in the City's hands. The 15' decorative pole system is still under an Xcel contract with less than four years remaining. Regardless, both systems have reached the end of their useful life and need to be replaced.

The existing underground conductor systems have reached the end of their useful life. Underground conductor faults are common in both systems.

All of the steel lighting controllers are showing signs of deterioration and need to be replaced. Some of the locks are not functioning which leaves the cabinets accessible to the public. There is noticeable corrosion on the circuit breaker buses, and some cabinets have a fair amount of dirt covering the internal components due to failed door seals. One of the cabinet is in serviceable condition.

The 35' light poles are also close to the end of their useful life. The condition of the poles has degraded due to the steel poles reacting with salty conditions characteristic of our Minnesota winters. Even though some poles may appear to be sound, we don't know the full effect of these conditions without further structural analysis.

The short decorative fiberglass poles are in acceptable condition, though some luminaires on these poles are loose and may have corroded set screws, a condition which makes them difficult to tighten onto the pole tenon. The set screws may need to be drilled out to remove the luminaires for servicing.

Detailed descriptions and images of system conditions are included in the body of the report.

Recommendations

Considering the condition and expense of refurbishing and/or replacing the majority of the poles within the Downtown Area, it is our recommendation that the City remove all the underground conductors, existing poles and luminaires, and all but one of the lighting controllers, and replace them with completely new lighting equipment. We also recommend that the City install luminaires employing with LED technology.

We recommend the installation of new aluminum poles that are powder coated or anodized and powder coated. Anodized aluminum poles would not require any maintenance associated with the coating system, and the LED luminaires would not need to be addressed for a minimum of 20 years.

It is recommended to replace the existing lighting systems in their entirety if budget permits.

We recommended that the City implement some of the maintenance practices outlined in the Lighting Maintenance Guide to other existing lighting systems throughout the City. This will help extend the useful life of existing and new systems.

Proposed Lighting Systems

A complete system replacement provides an opportunity for the City to install state-of-the-art lighting equipment that will have a useful life that is many years longer than that of the existing systems. Lighting equipment, installation methods and technology have greatly improved since the installation of the existing systems. The City may want to consider implementing solid state lighting controls with their new lighting system to further reduce overall operating and maintenance costs.

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September 2020

Downtown Lighting System Study

Prepared for City of Stillwater, Minnesota

1.0 Project Overview/Introduction

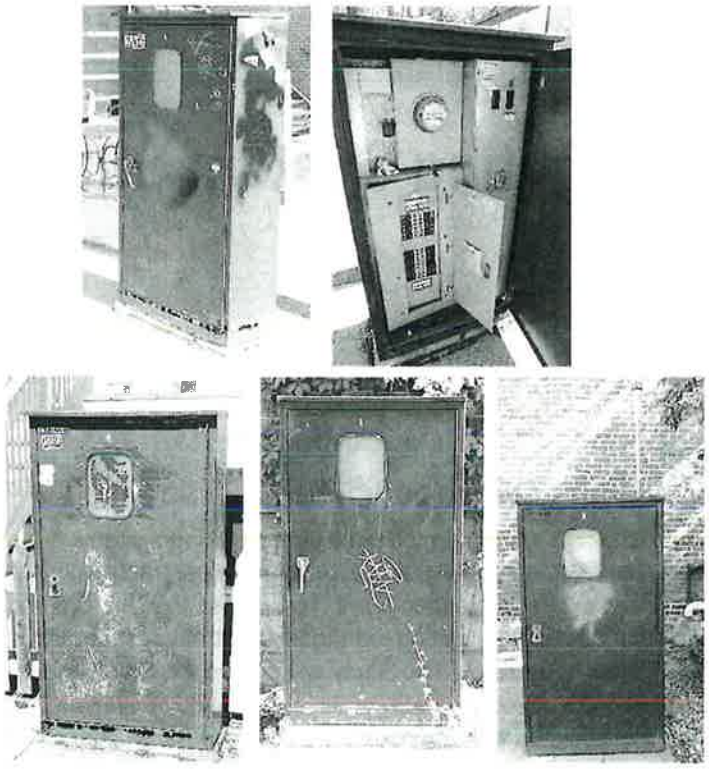
The aging City and Xcel Energy owned street lighting systems are nearing their end of life. In addition, some street lighting maintenance contracts with Xcel Energy have expired, or will expire within four years. To address this, the City requested a Study that will aid in developing lighting management strategies for existing and new Downtown lighting systems. The Study will enable the City to evaluate the construction costs associated with replacement lighting systems. The Study is limited to systems associated with approximately 204 Downtown light poles.

2.0 Lighting System Condition Assessment

This task started with a kickoff meeting with City staff and included the review of all as-built lighting documents and data provided by the City. A field identification and condition assessment of lighting systems and equipment was conducted. We have identified electrical and structural characteristics and serviceable life of the individual lighting systems. This task enabled us to prepare an exhibit of the lighting systems, equipment and their condition at locations within the project area.

See Appendix A for Existing Pole Location Map

2.1 Control Cabinets A, B, C, and D



Description:

- 150A main breaker
- 20A and 40A 2/P branch breakers
- Branch circuit conductors in conduit
- Painted steel enclosure
- Installed in 1991
- Fabricated by EMI
- Xcel Energy

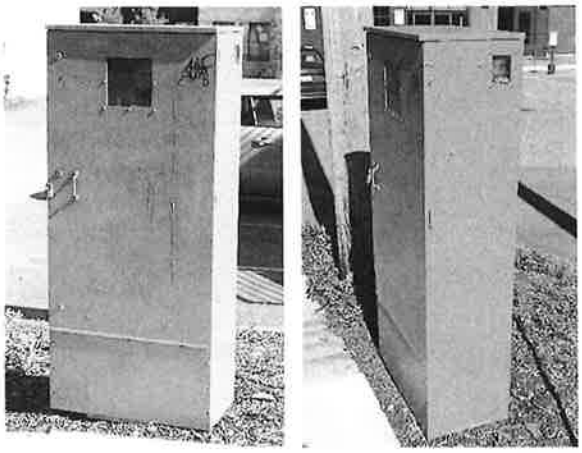
Findings:

- Most cabinets rusted through
- Most cabinets vandalized
- Probable code violations
- All cabinets have meter sockets
- Cabinet "A" is equipped with a meter for seasonal decoration receptacle circuits
- Type THWN branch circuit conductors – meets minimum code requirement
- Cabinet enclosures have reached end of life
- Equipment pad suitable for reuse.

Recommendation:

- Replace cabinet with contemporary design fabricated of anodized aluminum
- All cabinets can be metered to serve lighting and receptacle circuits
- Existing conductors could be connected to new cabinet in short term
- Exercise care when handling/maintaining existing THWN conductors in cold temperatures – insulation may crack.

2.2 Control Cabinet E



Description:

- No access, main breaker size unknown
- Branch circuit conductors in conduit,
- Painted steel enclosure
- Replaced since installation of original EMI cabinet
- Fabricator unknown
- Xcel Energy

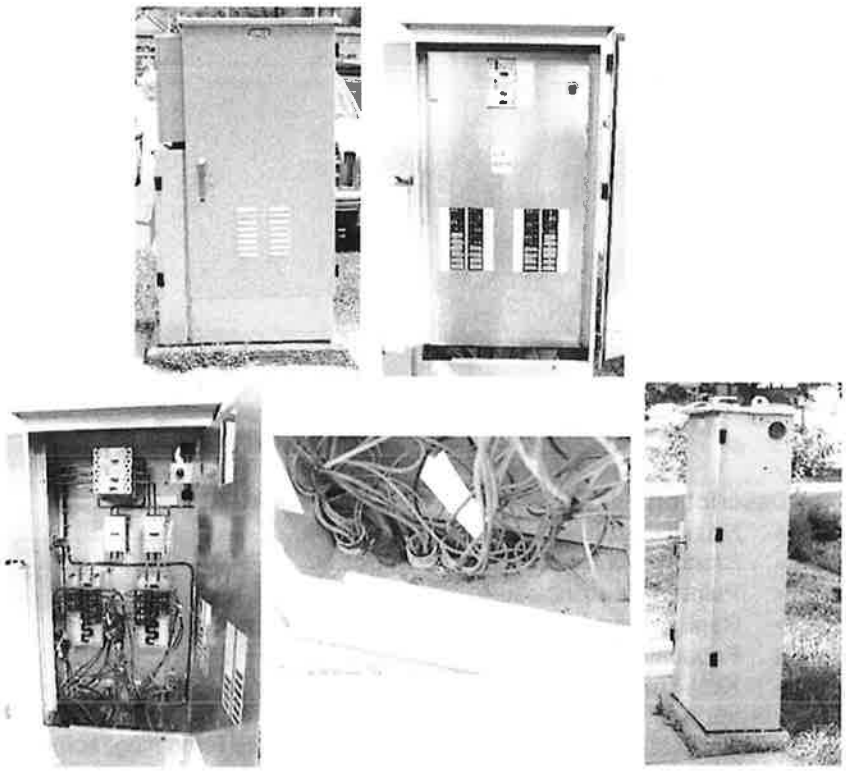
Findings:

- Cabinet enclosure has numerous years of life remaining, some construction screws missing
- Possible code violations
- Cabinet is equipped with socket
- Cabinet "E" is equipped with a meter for seasonal decoration receptacle circuits
- Type THWN branch circuit conductors – possible Type USE conductor to nearby pole
- Mounted to screw-in anchor base
- Cabinet is loose on base

Recommendation:

- Cabinet could remain in place in short term, ultimately replace cabinet with contemporary design fabricated of anodized aluminum
- Configure meter socket to serve lighting and receptacle circuits
- Existing conductors could be connected to new cabinet in short term
- Exercise care when handling/maintaining existing THWN conductors in cold temperatures – insulation may crack.

2.3 Control Cabinet F



Description:

- MnDOT Type L2 cabinet
- Two 100A Main Breakers
- Branch circuit conductors in conduit,
- Anodized aluminum enclosure
- Fabricated by Povolny Specialties
- Installed 2012
- Xcel Energy

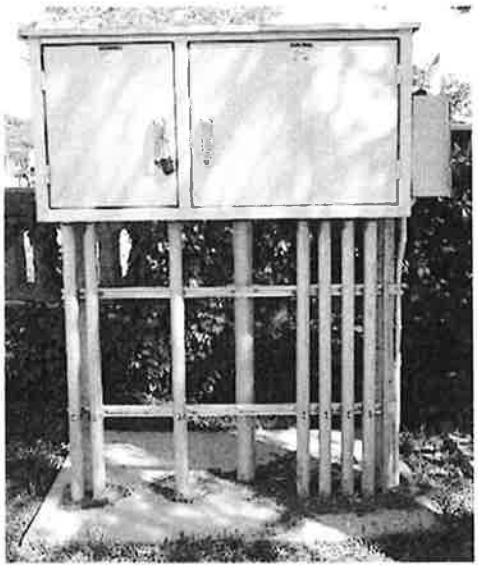
Findings:

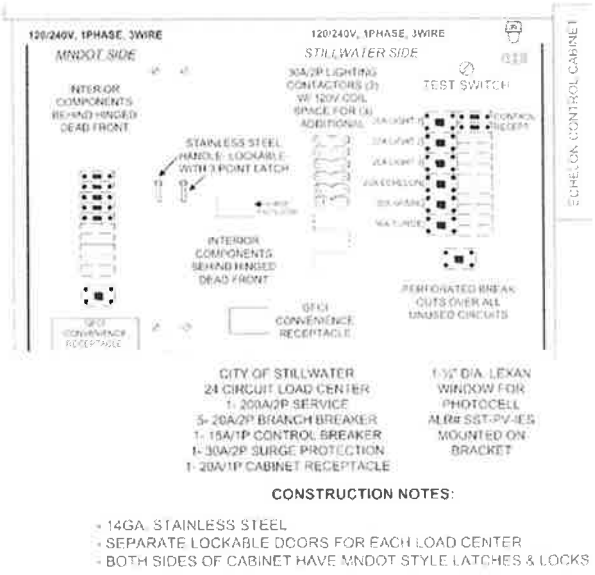
- Cabinet enclosure and internal equipment have decades of service remaining
- Current construction, no code violations
- Cabinet is equipped with socket
- Cabinet "F" is equipped with a meter for seasonal decoration receptacle circuits
- Receptacles are metered, lighting is unmetered
- Type THWN branch circuit conductors
- Equipment pad suitable for reuse

Recommendation:

- Cabinet should remain in place
- Configure meter socket to serve lighting and receptacles
- Exercise care when handling/maintaining existing THWN conductors in cold temperatures – insulation may crack.

2.4 Control Cabinet New- Lift Bridge Concourse





Description:

- Stillwater/MnDOT combination cabinet
- Stillwater side is independent from MnDOT side
- 200A Main Breaker
- Metered City cabinet
- Anodized enclosure
- Installed in 2019
- Xcel Energy, maintained by City

Findings:

- Cabinet is new.
- Echelon lighting controls energized from Stillwater compartment
- Space for future breakers
- Empty conduit stubs for future access

Recommendation:

- This cabinet can be used to supplement or replace cabinets C and D

2.5 Downtown Roadway Lighting Units – Aluminum with LED Luminaire

Description:

- 35' round tapered aluminum pole with 4' single member arm
- Utility style LED luminaire
- Many poles are equipped with a side mount HPS shoebox luminaire
- Poles mounted on existing concrete base or replacement screw-in anchor base
- Replacement poles for failed steel poles
- Installed in 2018 - 2019

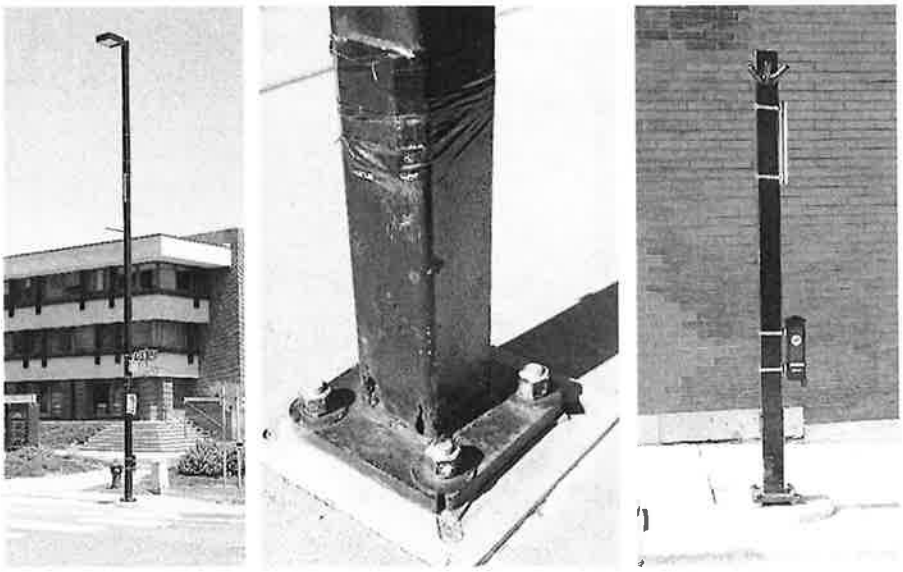
Findings:

- No receptacles or other pole accessories
- Not suitable for seasonal decorations - lacks wind load capacity
- Poles are in excellent condition
- Concrete bases are in acceptable condition
- Steel screw-in anchor bases in good condition

Recommendation:

- Could be relocated from Main Street to side street locations where failed steel poles have been removed
- Use existing concrete bases for new poles

2.6 Downtown Roadway Lighting Units – Square Straight Steel Pole with Shoebox Luminaire



Description:

- 35' flange base square straight steel pole
- 250W HPS shoebox side-mount luminaire
- Equipped with flag holders, banner arms, seasonal display brackets and a GFCI receptacle street sign
- Majority mounted on existing concrete base
- Installed in 1999

Findings:

- Current pole finish is presentable but not protective of steel structure
- Rust is undermining coating system of some poles
- Many poles have numerous years of usable life remaining
- Most handhole access doors are missing
- Some poles are not plumb
- Concrete bases are in acceptable condition
- Occasional steel screw-in anchor base

Recommendation:

- Replace HPS luminaire with new side-mount LED luminaire
- Pole shaft metal thickness near the flange should be reviewed annually with a UT gauge for loss of structural integrity
- Touch up pole paint finish if pole is left in pace for extended period of time
- Ultimately replace poles with new

2.7 Downtown Roadway Lighting Units – Tapered Fluted Fiberglass Pole with Hexagonal Lantern

Description:

- 15' fiberglass fluted pole
- 70W & 100WHPS lantern style post top luminaire
- Mounted on existing concrete base
- Installed in 1999

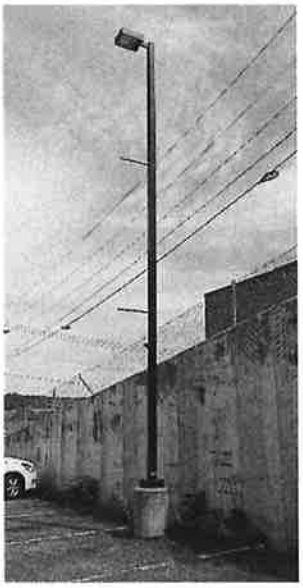
Findings:

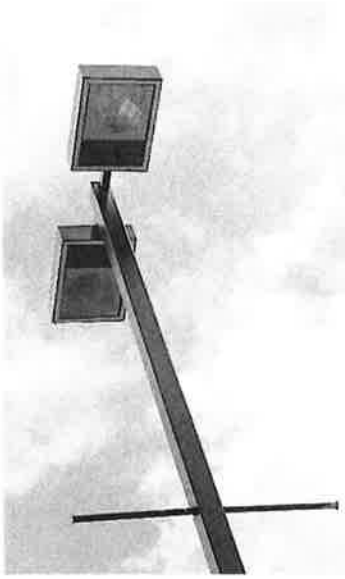
- Bell bases are scuffed and dinged due to snow removal activities
- Majority of poles have numerous years of usable life remaining
- Concrete bases are in acceptable condition
- Some luminaires are loose on pole top tenons

Recommendation:

- Replace HPS luminaire with new post top LED luminaire
- Touch up pole paint finish
- Poles can be commercially pressure washed and painted in place

2.8 Downtown Parking Lot Lighting Units





Xcel or city.

Description:

- 35' flange base square straight steel pole
- 250W HPS shoebox side-mount luminaire
- Equipped with flag holders, banner arms, occasional street sign
- Most mounted on extended concrete bases, occasional flush concrete base
- Installed various dates

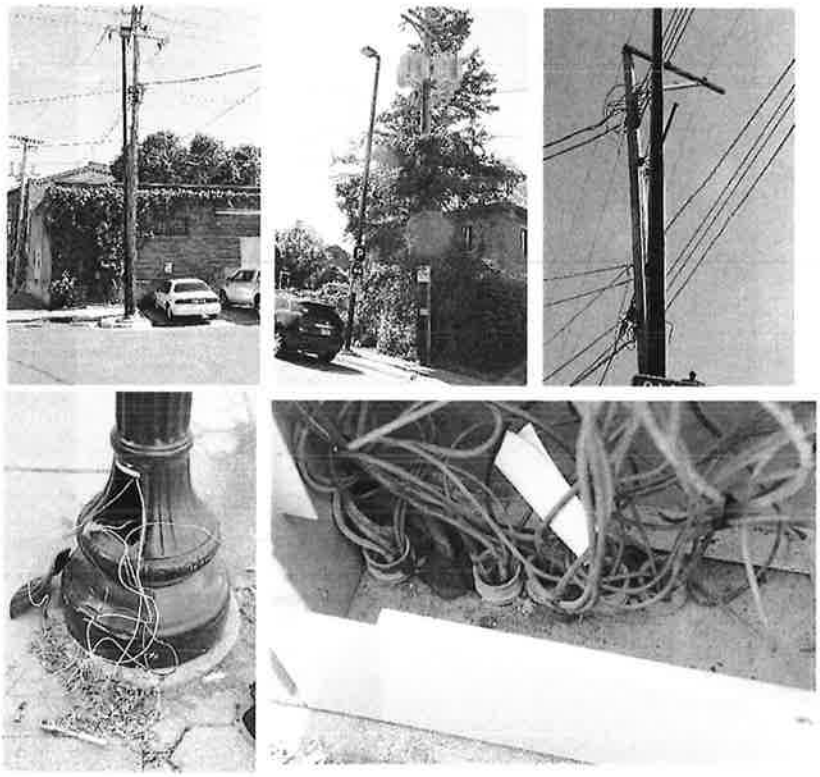
Findings:

- Poles in good condition relative to those along roadways
- Anchor bolt covers are intact
- Some handhole doors missing
- Finish is in good condition but most have chips

Recommendation:

- Poles can remain in place
- Replace HPS luminaire with new side-mount LED luminaire
- Pole shaft metal thickness near the flange should be reviewed periodically with a UT gauge for loss of structural integrity
- Touch up pole paint finish if pole is left in pace for extended period of time
- Repair or replace handhole doors

2.9 Existing System Issues and Considerations



Description:

- 35' steel poles at locations other than Main Street
- Internal pole conductors feeding luminaires
- Failing and inferior underground conductors

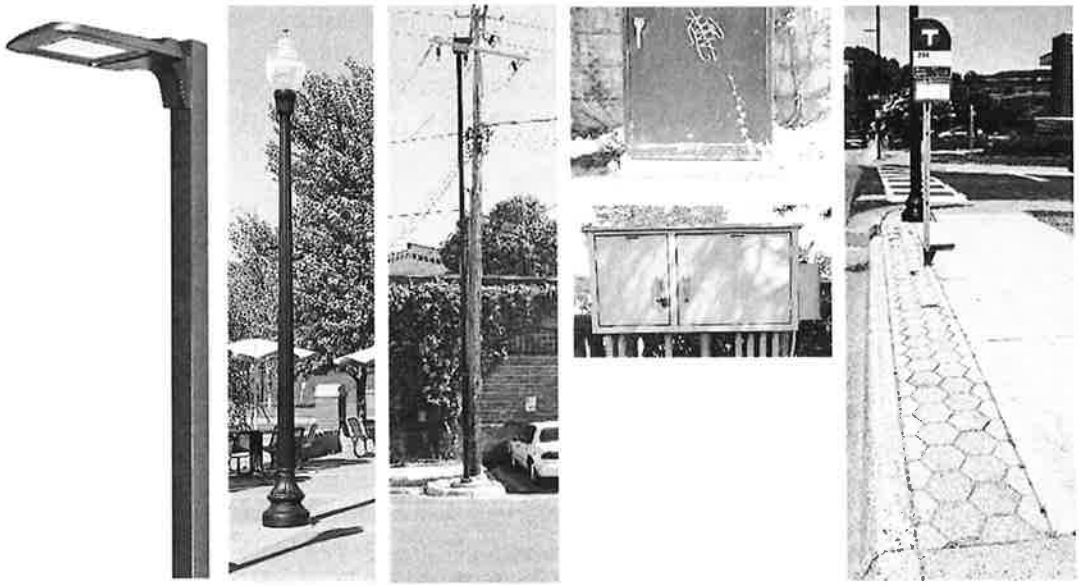
Findings:

- Approximately 12 existing poles are close to overhead primary and secondary conductors, some dangerously. Xcel does not allow any components of privately owned poles to be placed within 10' of overhead conductors
- Some poles have disconnected grounding conductors
- The majority of the underground conductors are Type THWN equipped with nylon insulation that meets code minimum requirements

Recommendation:

- Move conflicting tall poles to new locations, usually to opposite side of street or a different corner at intersections
- Install shorter or decorative poles on existing concrete bases under overhead conductors – poles can be under overhead conductors if required clearance is maintained
- Replace internal pole wiring if new LED luminaires are retrofitted to existing poles
- As underground conductors and circuits fail, replace with Type XHHW or USE which is equipped with cross-linked polyethylene insulation (waterproof). Considering LED equipment would be used for luminaires and seasonal displays, smaller conductors can be installed within existing conduits.

2.10 Considerations for Future Ownership of Existing System



The following concepts are for the City to consider as they decide whether to assume ownership and maintenance of the existing Xcel lighting systems after contracts expire.

Considerations:

- Most of the badly deteriorated steel poles have been removed. Periodic review and paint touch up can keep the remaining poles in operation for an extended time. New side-mount LED luminaires can be mounted to the existing poles and then transferred to new poles when budget permits.
- The decorative fiberglass poles have many years of usable life remaining. New post top LED luminaires can be mounted to the existing poles and then transferred to new poles when budget permits.
- The same LED luminaires that could be installed on existing steel poles can be easily installed on top of the signal luminaire extensions to maintain continuity though the area.
- All of the existing service cabinet footings are in serviceable condition. New service cabinets can be fabricated to fit the existing footings. All existing cabinets can be easily configured to meter both receptacle and lighting circuits.
- A new service cabinet was placed to serve the lift bridge concourse lighting. I specified it to be equipped numerous extra circuits. This cabinet could easily serve the roadway and parking lot lighting currently served by cabinets C and D. A maintenance strip is in place a short distance away, located on both sides of Chestnut starting at the west side of the pedestrian trail crossing.
- Existing newer aluminum roadway poles could be removed from Main Street and placed in locations where steel poles have failed and been cut. The new style poles the City chooses as the Main Street standard can be installed in their place.
- Approximately 12 existing poles can be shortened due to overhead utility conflicts
- Consistently, where roadway lighting exists, a maintenance strip is in place directly behind the curb. This will enable spot repairs of underground circuiting and conduit to be less disruptive to area use and timelier to complete.

3.0 LED Luminaire Options For the Downtown Area

Both HPS luminaire styles within the Downtown Area have an LED equipped replacement that is similar to, and possibly indistinguishable from the existing luminaires. The primary difficulty in selecting an LED luminaire is sorting through the numerous products and sometimes outlandish claims one finds when trying to obtain a high quality replacement that is appropriately priced, maintains well, and performs well photometrically.

3.1 Equipment Selection

The first step in adopting LED lighting is to determine if you are satisfied with the maintainability, maintenance history and photometrics associated with your existing luminaires. If this is the case and the luminaire has at least 15 years of serviceable life left, ask the manufacturer's representative if they have a factory LED retrofit kit that can equip your existing luminaire housing with a UL Listed driver, LED array and surge suppressor. Require that the entire luminaire, complete with its retrofitted equipment, retains the manufacturer's UL listing. Many small companies offer UL Listed retrofit kits that when installed in your luminaire housing will not retain the UL listing.

Not all luminaires, especially decorative ones, have factory retrofit kits available due to the physical limitations of the existing luminaire housing. The LED array that would equal the performance of the HPS lamp you are hoping to replace, typically occupies more luminaire surface area than the resident HPS lamp. In addition, the typical LED array and driver are very sensitive to heat, and the existing HPS housing may not have been designed to take this into consideration.

When evaluating new LED luminaires, we recommend looking at the offerings from large manufacturers that have been in the luminaire business for a long time and have a good reputation with the lighting maintenance departments of other government agencies. Most reputable manufacturers that have invested in high quality luminaires will have LED replacement luminaires for your typical performance based shoebox and cobrahead luminaires. The good performers may not look quite like the luminaires you are trying to replace due to their contemporary shapes, and sometimes prominent cooling fins designed keep the luminaire's internal components at the proper operating temperature.

3.2 Existing Luminaires

The City of Stillwater has four luminaire styles wattages within the Central Area. They are the following:

- Holophane LED and King Acorn HPS luminaires
- Lumec HPS L61 Vernon Lantern luminaires
- Sterner HPS Shoebox luminaires
- GE LED Utility style luminaires

See Appendix B for Existing Luminaire Cut Sheets

3.2.1 Acorn Luminaires

Early roadway lighting within the Downtown Area consisted of fluted poles, very similar to those currently in place, equipped with high-wattage incandescent glass post top acorns. They would have provided illumination of the building facades, general delineation of travel, but may not have provided the level of lighting on the roadway required for current pedestrian and vehicle safety. There were six poles per block arranged in a staggered pattern.

Today the acorn luminaires are not currently located along any main roadways in the downtown area. They can be found on the historic Lift Bridge and Concourse, Lowell Park Plaza and Sam Bloomer trail. The Lift Bridge, Concourse and Plaza luminaires are equipped with LED optics. The Sam Bloomer Trail luminaires are equipped with HPS lamps. All acorn luminaires have fully exposed globes. This luminaire can be purchased in its current HPS configuration.

3.2.2 Lumec L61 Vernon Lantern Luminaire

The HPS hexagonal lantern luminaires are located along Main Street. They are equipped with 70 and 100 watt lamps. These are part of an Xcel system that is still under contract for maintenance. These luminaires may have a factory LED retrofit kit available, and may be available as a new LED luminaire. At this time though, information regarding these LED configurations has not been published. The original HPS version is no longer an offering from Xcel Energy. Currently, it can be purchased in the HPS configuration.

3.2.3 Sterner Executive Shoebox Luminaire

The HPS shoebox luminaires are located throughout the Downtown Area along roadways and in parking lots. They are equipped with 200 and 250 watt lamps. These are part of an Xcel system that is no longer under contract for maintenance. These luminaires do not have a factory LED retrofit kit available. LED replacements for these luminaires can have a more contemporary appearance, but are typically located at higher mounting heights and can easily blend in to any style of adjacent architecture. The original HPS version is no longer an offering from Xcel Energy. It cannot be purchased in the HPS configuration. Xcel does not offer anything that resembles the shoebox luminaire.

3.2.4 GE Utility Luminaire (Cobrahead)

The LED cobrahead luminaires and their accompanying round aluminum poles are minimally scattered throughout the Downtown Area along roadways, and have been used as replacements for shoebox poles in critical locations that have been removed due to structural issues. These are part of an Xcel system that is no longer under contract for maintenance. These luminaires are not typically installed in areas where aesthetics are of concern.

3.3 Existing Lighting Levels

Existing lighting levels were calculated for the style of pole, pole spacing, and roadway width along one block of Main Street between Olive and Chestnut. All subsequent calculations used this same block spacing to provide consistent comparisons.

See Appendix C for Existing Photometrics and Layouts

3.3.1 Existing 250W Shoebox and 70W Lantern Photometric Evaluation

The following light levels were calculated for the existing combination system along Main Street: **See Figure 1**

Roadway – 2.5fc average @ 1.64:1 uniformity

Sidewalk – 2.0fc average @ 2.28:1 uniformity

This pole layout is very similar to other blocks along Main Street, though some of those blocks have even tighter spacings along with the same quantity of poles and subsequently higher lighting levels.

3.3.2 Existing 250W Shoebox Photometric Evaluation

The following light levels were calculated using only the 250W shoebox luminaire at the same spacing as the combination system outlined above: **See Figure 2**

Roadway – 1.8fc average @ 2.61:1 uniformity

Sidewalk – 1.5fc average @ 3.73:1 uniformity

This pole layout is very similar to that of the side streets outside of the Main Street right-of-way.

The calculations for the existing lighting systems indicate that there may be an overabundance of light in the downtown area.

3.4 Recommended Lighting Levels

There are no absolute rules for establishing roadway lighting levels. We have documents provided by AASHTO and the IES (Illuminating Engineering Society) that serve as guidelines. Ultimately, the preferred lighting levels are determined by City managers and recommendations from experienced lighting professionals. MnDOT will only inforce the minimums outlined in the AASHTO guide for the designated roadway and area use.

The AASHTO guide indicates that TH 95 would be considered a Minor Arterial with a Commercial area use and specifies a minimum of **1.4fc average** with a **uniformity of 4:1**. The guide also indicates the roadways outside of Main Street would be considered Collectors with an Intermediate area use and specifies a minimum of **0.8fc average** with a **uniformity of 4:1**.

You're current light levels exceed the recommended levels.

3.5 Proposed Lighting Equipment, Light Levels and Layouts

There are countless lighting scenarios that could be explored for the replacement of the City's Downtown Area lighting systems. Meetings with the City identified the following two primary approaches for the replacement of these lighting systems:

1. A complete removal and replacement of the existing system in-kind in its current configuration
2. A complete removal and replacement of the existing system with historic style acorn poles consistent with those in-place throughout the downtown between the 1930's and 1950's. This configuration is consistent with an option outlined in the Downtown Redevelopment Plan.

Proposed lighting levels were calculated for the style of poles and layouts that were discussed with the City. Once again, we used the pole spacing and roadway width respective of one block of Main Street between Olive and Chestnut. All subsequent calculations used this same block spacing to provide consistent comparisons.

See Appendix D for Proposed Photometrics and Layouts

3.5.1 LED 72W Arieta and 23W Full Cutoff Acorn Photometric Evaluation

The following light levels were calculated for the existing combination system: **See Figure 3**

Roadway – 1.7fc average @ 1.48:1 uniformity

Sidewalk – 1.28fc average @ 2.13:1 uniformity

This pole layout is very similar to other blocks along Main Street, though some of those blocks have even tighter spacings along with the same quantity of poles and subsequently higher lighting levels. We selected the Leotek Arieta luminaire as an appropriate replacement for the existing 250W HPS Shoebox luminaire. It has a very good operational history and is

known for minimizing glare. The Full cutoff acorn also will minimize glare and reduce uplight. An LED version of the existing lantern can be used if it becomes available. These lighting levels are slightly above those recommended by AASHTO.

3.5.2 LED 72W Arieta Photometric Evaluation

The following light levels were calculated using only the 72W Arieta luminaire at the same spacing as the combination system outlined above: **See Figure 4**

Roadway – 1.1fc average @ 1.87:1 uniformity

Sidewalk – 0.83fc average @ 2.08:1 uniformity

This pole layout is also very similar to that of side streets outside of the Main Street right-of-way. These lighting levels are slightly above those recommended by AASHTO.

3.5.3 LED 66W Non-Cutoff Historic Acorn Photometric Evaluation – Main St.

The following light levels were calculated for a complete replacement of the existing combination system along Main Street: **See Figure 5**

Roadway – 1.5fc average @ 1.56:1 uniformity

Sidewalk – 1.2fc average @ 2.05:1 uniformity

This pole layout is very similar to the original historic lighting system. These lighting levels are slightly above those recommended by AASHTO.

3.5.4 LED 66W Non-Cutoff Historic Acorn Photometric Evaluation – Side St.

The following light levels were calculated using only the same 66W acorn as the system outlined above: **See Figure 6**

Roadway – 1.1fc average @ 2.17:1 uniformity

Sidewalk – 0.8fc average @ 2.93:1 uniformity

This pole layout is very similar to the original historic lighting system. These lighting levels are slightly above those recommended by AASHTO.

3.6 Proposed Lighting Estimates

Estimates were prepared for the following two project scenarios identified by the City.

See Appendix E for Scenario Estimates

3.6.1 Full Replacement In-Kind – One for One

The first scenario involves the complete removal and replacement of the existing combination system in-kind with similar light poles and LED equipped luminaires. All concrete light bases are to be removed and replaced in the same locations. **See Figure 7**

3.6.2 Full Replacement with Historic Acorn Lighting Units

The second involves the complete removal and replacement of the existing combination system with LED equipped historic acorn poles. All concrete light bases are to be removed and replaced in new locations that are respective historic pole layout. **See Figure 8**

3.6.3 Luminaire Replacement – One for One

I addition to the two estimates detailed above, we prepared an estimate for the replacement of only the existing luminaires with LED equivalents. No underground infrastructure was considered other than replacement of the service cabinets and conductors within the poles. **See Figure 9**

3.7 Return-on-Investment

The Return-on-Investment (ROI) calculations compare the energy savings associated with the installation of new LED luminaires instead of new HPS luminaires. The replacement of supporting infrastructure consisting of underground conduit and circuiting, concrete bases, service cabinets and light poles would be the same in either case. The ROI calculations detail separate luminaires associated with two different scenarios:

1. A duplicate system consisting of LED equipped tall and short poles in similar locations as existing (one-for one replacement) **See Figure 10 and 11**
2. A new system consisting of historic LED acorn style luminaires and poles in place of the existing combination system. All luminaires for the system (acorns and shoeboxes) are combined together into the "Fixture Count" as 1. **See Figure 12**

See Appendix F for Luminaire ROI Breakouts

3.8 Lighting Controls

The introduction of LED luminaires has provided many new methods in which we can operate roadway lighting systems. We now have almost infinite control over on and off times, lighting levels, system monitoring and asset management.

In addition to their primary purpose of shining light onto dark roadways and public areas, LED lighting systems are increasingly evaluated for how well they reduce energy consumption and maintenance and improve safety for both pedestrians and motorists.

At a minimum, we recommend that the City install LED luminaires that are equipped with dimmable drivers. In most cases dimmable drivers are provided as a standard with new luminaires. This will enable the luminaire to accommodate a lighting control system in the future.

3.8.1 Benefits

The following are some of the benefits to employing lighting controls into LED roadway lighting systems:

- Additional energy savings
- Maintenance savings
- Reduction in light pollution
- Extended luminaire life
- Real-time Asset Management

3.8.2 Types of Control

The following types of control systems can be easily employed with LED roadway lighting systems:

3.8.2.1 Onboard Automatic

This type of control is considered to be of the "Set and Forget" style. The luminaire's LED driver can be programmed (flashed) with a particular dimming schedule or curfew that will adjust light levels to account for changes in traffic and pedestrian use within the area. The drivers are typically programmed to reduce lighting levels after hours of peak area use. One example is to allow the lights to come on at sunset to 100% light output, then dim to 50% light output at 1:30 AM. The controls would maintain this reduced level until 5:00 AM, at which time the levels would be adjusted back to 100% until the sunrise turns the lights off. The LED driver can be reprogrammed at any time, but would require the use of a bucket truck once the luminaire has been installed on a pole. Any light level can be set within the onboard controls, even a 0% or off light level.

3.8.2.2 Real-time Asset Management

These controls enable the user to monitor and maintain system operations, energy consumption, equipment outages and lighting curfews. These systems allow monitoring and control 24 hours a day. They can alert maintenance crews and staff of important operating conditions and parameters by email or text message. They can also be connected to devices that will allow the system to dynamically change light levels or operating characteristics through pedestrian detection, and changes in weather conditions and traffic flow. Access to the system is web-based.

The typical method of communication associated with real-time asset management system is wireless. Some manufactures offer a powerline carrier option as well. Both systems provide the same levels of control, monitoring and interface for the user.

3.8.2.3 Wireless

The Wireless system uses a control device that look very much like a photocell. This controller is mounted to each luminaire. Luminaires without a photocell receptacle would need to be modified to accommodate a special controller that would protrude from the side or top of the luminaire or luminaire arm.

3.8.2.4 Powerline Carrier

The Powerline Carrier system uses the existing underground electrical distribution wires currently in place to communicate with a controller in the base of each light pole. This is very convenient for existing lighting systems and does not require the installation of any additional circuiting to the poles, nor does it use a photocell socket on top of the luminaire. This is especially helpful when employed into a decorative lighting system.

4.0 Lighting Maintenance Guide

The Lighting Maintenance Guide is intended to aid the City in maintaining the expected useful life of new roadway lighting systems.

See Appendix G for Lighting Maintenance Guide

kst

Appendix A

Existing Pole Location Map

Project Number: STILL 152259
Print Date: 8/16/2020
GIS Data Furnished By
City of Stillwater

SEH

Downtown Street Lights
Stillwater, Minnesota

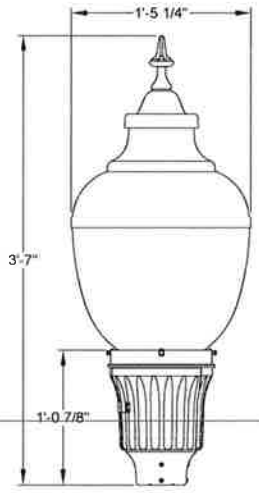
FIGURE 1
Existing Pole Location Map

Appendix B

Existing Luminaire Cut Sheets

HOLOPHANE®
LEADER IN LIGHTING SOLUTIONS

Catalog Number	
Notes	Type



LOWELL PARK

Maximum weight - 37 lbs
Maximum effective projected area - 2.19 sq. ft.

AWDE3

Acrylic Washington Postlite Utility LED3

SPECIFICATIONS

General Description

The Acrylic Washington Postlite Utility LED3 is designed for ease of maintenance with the plug-in electrical module common to each of the luminaires in Holophane's Utility Luminaire Series. The large acorn-shaped luminaire, while reminiscent of the 1920's, contains a powerful, stalk-mounted Chip-On-Board, LED platform with a precision optical system that maximizes post spacings while maintaining uniform illumination

Mechanical Specifications

The luminaire housing shall:

- Be heavy grade A360 cast aluminum (aluminum with <1% copper)
- IP55 rated housing provides tool-less access with a spring-loaded latch
- Incorporate a hidden hinge door allowing the door to swing open and remain open
- Offer units with an EEI- NEMA twist lock photocontrol receptacle, the housing contains a tempered glass window to allow light to reach the cell
- Mount to slip-fitter that will accept 3" high by 2-7/8" to 3-1/8" O.D. pole tenon
- Provide four uniquely designed stainless steel spring clips, enclosed in a clear polyvinyl chloride sleeve and adjusted by 1/4-20 hex-head bolts that securely cradle the prismatic acrylic refractor. The same ¼-20 bolts also support the decorative rib and banding assembly

The finish shall:

- Utilize a polyester power coat paint to ensure maximum durability
- Meet 5000-hour salt spray
- Offer Tiger Drylac finishes that are applied by a Tiger Drylac certified facility.

Electrical Specifications

The driver shall meet the following requirements:

- Certified by UL or CSA for wet locations
- A factory programmable electronic driver with 0-10V dimming control leads
- LEDs shall have a minimum of 70 CRI and available in 2700K, 3000K, 4000K, and 5000K CCT
- The electrical system shall be designed to meet ANSI/IEEE C62.41.2 and shall offer a 10kV/5kA surge protection, fail off, as standard with an upgradable 20kV/10kA surge protection, fail off with indicator light, option
- Lumen output can be customized prior to manufacturing by way of FPDxx Options
- The electrical components are mounted on an aluminum plate that is removeable with minimum use of tools. A matching five conductor plug connectsto the receptacle in the luminaire housing to complete the wiring. For photoelectric operation, the electrical module is provided with an EEI-NEMA twist-lock photocell receptacle.

Optical Specifications

The optical system is IP66 rated and consists of a precisely molded thermal resistant acrylic refractor and top reflector mounted within the decorative acrylic optic. The top reflector redirects over 50% of the upward light into the controlling refractor while allowing a soft up-light component to define the traditional acorn shape of the luminaire. The lower refractor uses precisely molded prisms to maximize the pole spacings while maintaining uniform illuminance. Two refractors are available, designed for IES type III and V distributions. Lunar Optics shielding is available for asymmetric and symmetric distributions.

Control Options

The control options shall include, but not limited to, the following:

- Field adjustable output to adjust output to luminaire - AO
- Long life photocontrol, 20 years – PCLL, P34 and P48 with DTL
- 3 and 7 pin receptacles internally in housing (PR3, PR7) or inside acrylic lens mounted (PR7E)
- nLight Air rSBOR6 outdoor fixture-mounted motion and photo-sensor, features a dual radio to communicate wirelessly to other nLight Air devices for group response to motion, on/off control in response to daylight and by switch – RSBOR6
- Fixture embedded nLight Air network interface for individual fixture control and dimming - NLTAIR2.

Certification and Standards

- Luminaire shall be UL or CSA listed.
- Suitable for operation in an ambient temperature up to 40°C / 105°F per UL or CSA certification
- LM79 compliant
- DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check with the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

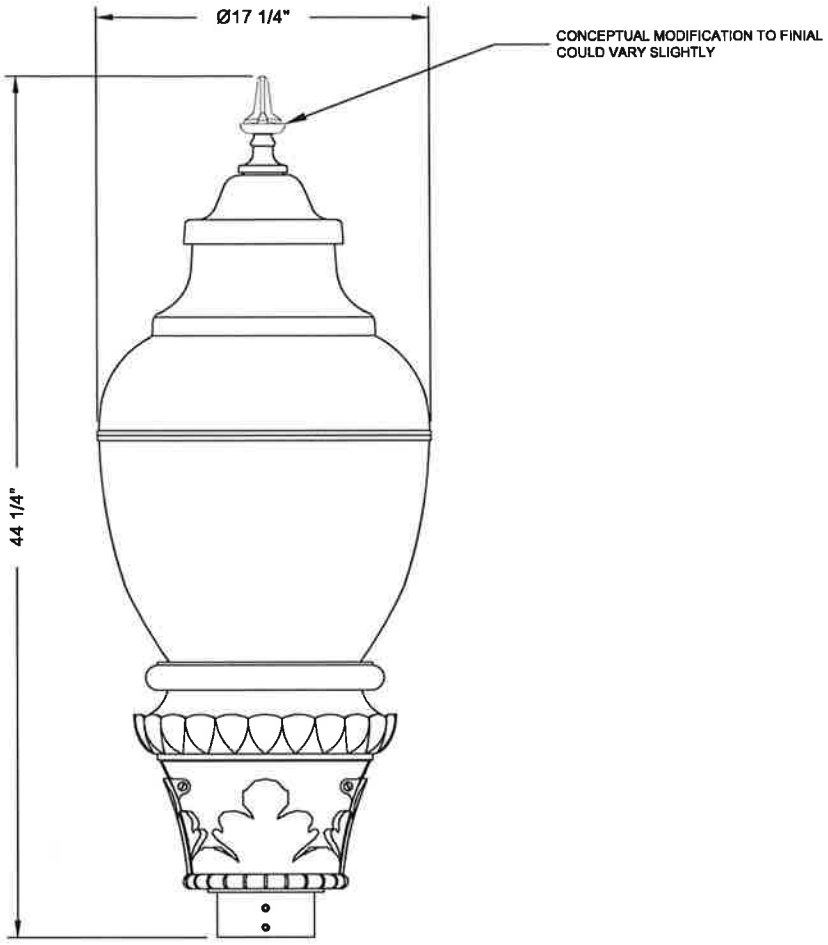
Warranty – 5 Years Limited

Complete warranty terms located at:
www.acuitybrands.com/support/customer-support/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C.

LIFT BRIDGE CONCOURSE
State Street LED 2

Special: Modified optical system, Custom spike finial, Internally treated for frosted look



ORDERING INFORMATION

State Street LED Series

- LED Performance Package 30
- 3000 Series CCT
- Auto-Sensing Voltage (120-277)
- Custom Matched Color, Federal Green #34097
- Symmetric Type V optics
- SPECIAL: Internally Frosted Optics
- SPECIAL: Custom cross finial, Custom Matched Color
- 20ft Prewired Leads
- House Side Shield, Perforated 180

Catalog #'s:

Fixture: STLE2P3030KASCMC45(MOD)(FROST)(R)CMCL20WLED
HSS18PERF **RFD267607**

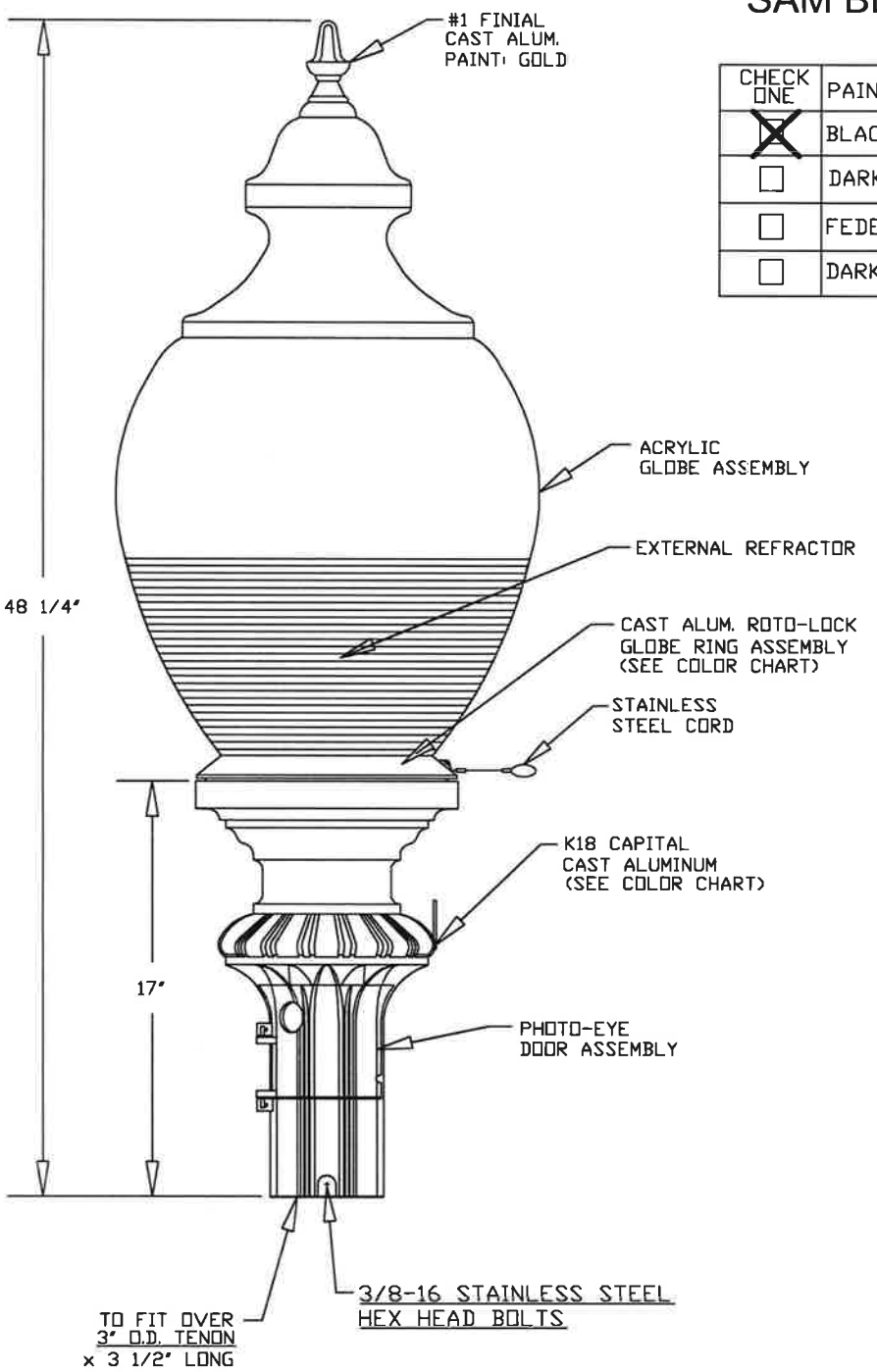
Customer Signature **Date**

HOLOPHANE®
LEADER IN LIGHTING SOLUTIONS
An AcuityBrandsCompany

St. Croix River Bridge Concourse

ORDER #: 2043-17-13802-2	TYPE: Special	DRAWING #: TSG01035
REVISION: 3	REVISION DATE:	
DRAWN: MAB	ORIGIN DATE:	PAGE: 1

SAM BLOOMER TRAIL



CHECK ONE	PAINT ** SMOOTH **	XCEL CODE
☒	BLACK (RAL 9017)	BK
☐	DARK BRONZE (RAL 8019)	DB
☐	FEDERAL GREEN (RAL 6012)	FG
☐	DARK GREEN (RAL 6005)	DG

REV.	ALTERATION	DATE	BY
A	REVISED SCREW SIZE	051001	TB
B	WIRE SUSPENSION LOOP REPLACED BY TAB.	05/18/04	M.M.
C	HANGER TAB REPLACED BY SUSPENSION LOOP.	08/24/04	M.M.
D	PAINT WAS TEXT. BZ RAL 8019	04/10/18	A.A.
E	ADDED COLOR CHART, SCREWS WERE SETSCREWS	05/06/20	G.R.

SPECIFICATIONS

CATALOGUE NO.: K118R-EAR-II-100(MOG)
-HPS-120(MT)-K18
QUANTITY: 2
GLOBE MAT'L: ACRYLIC
IES CLASSIFIC.: TYPE II
WATTAGE: 100W
LIGHT SOURCE: HIGH PRESSURE SODIUM
LINE VOLTAGE: 120V (MULTI-TAP)
POLE ADAPTOR: K18
LAMP BY OTHERS

BALLAST INFORMATION:

BALLAST TYPE: HX-HPF
BALLAST MANU.: MAGNETEK / ADVANCE
CATALOG NUMBER: S100MLTLC3M / 71A8091

OPTIONS:

QUICK DISCONNECT ☒
TERMINAL BLOCK ☐

OTHER:

NOTE; LUMINAIRE SHALL BE PREWIRED WITH ONE BLACK, ONE WHITE AND ONE GREEN, #12 GAUGE, STRANDED COPPER, 600 VOLT, INSULATED CONDUCTOR TYPE THHN OR THWN, EACH CONDUCTOR 20 FOOT LONG.
HARNESS TO BE COMPLETE WITH QUICK DIS-CONNECT.

NOTE: FIXTURE TO BE PACKED IN ONE CARTON, HEIGHT NOT TO EXCEED 48 INCHES.

CUSTOMER ORDER No:
4504562216
KING U.S. ORDER No:
S-KUS-2006219
BSE ITEM#
2669238
KING U.S STOCK CODE:

CUSTOMER APPROVAL: _____

KING LUMINAIRE
COMPANY INC.
840 WALKER'S LINE, P.O. BOX 7, BURLINGTON, ONTARIO, CANADA L7R 3X9
P.O. BOX 266 JEFFERSON, OHIO 1153 STATE ROUTE 46N U.S.A. 44047

DRAWING NAME:	DWG NUMBER	DATE:	DWG BY:	REV.
APPROVAL DWG	XCEL-K118-HID-2	04/24/01	A.A.	E

PROJECT/CUSTOMER: XCEL - K118-EAR
CHK.BY
\SPECIFICATIONS\XCEL\XCEL-K118-HID

LUMEC
by signify

Urban

Hexagonal Lantern

L24-L28-L60-L61-L60S
Post Top

Project
Location
Cat. No.
Type
Lamp Qty
Notes

Exemplifies Lumec's ability to blend engineering know-how and old-time charm. Nothing has been left to chance in the design of the Lumec **Hexagonal Lantern**. These luminaires are able to fill a space with a warm and reassuring light. Behind the antique-inspired look, the **Hexagonal Lantern** luminaire reminds us that the past and the present are eternally linked and when combined together in a luminaire, they offer exceptional style.

MAIN STREET

Ordering guide sample

Luminaire	Lamp	Optical System	Voltage	Options	Mounting & Configuration	Pole*	Finish**
L61-SE	100 HPS	SE3	120	CPTC			BKTX

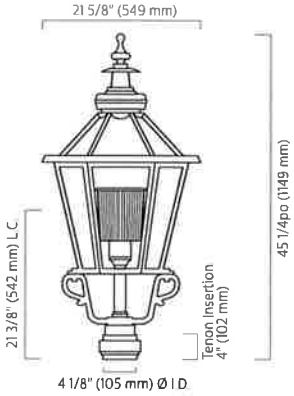
* Consult the eCatalog for details and the complete line of poles

The specially formulated Lumital powder coat finish is available in a range of many standard colors.
** Consult Lumec's Color Chart for complete specifications

Luminaires

Conform to the UL 1598 and CSA C22.2 No. 250.0-08 standards

L24-RR



Weight: 37 lbs (16.8 kg)

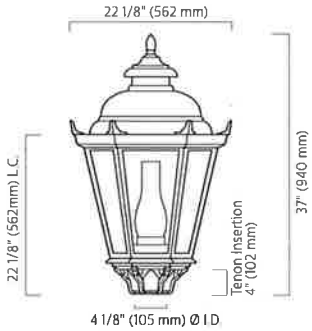
EPA: 3.17 sq.ft

L28-SE-SF28

Weight: 54 lbs (24.5 kg)

EPA: 2.90 sq.ft

L60-SG-SF60



Weight: 40 lbs (18.1 kg)

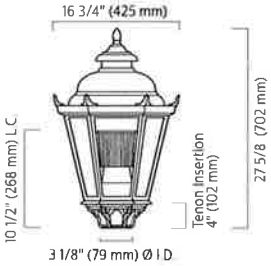
EPA: 2.95 sq.ft

L61-RR-SF61

Weight: 49 lbs (22.2 kg)

EPA: 2.95 sq.ft

L60S-SR-SF60S



Weight: 34 lbs (15.4 kg)

EPA: 2.30 sq.ft

These lanterns are available with the following lens finishes

PC-C	Clear polycarbonate
PC-O	Opal polycarbonate
PC-FC	Frosted clear polycarbonate
GL-C	Clear tempered glass
GLBG-C	Clear beveled tempered glass

Executive

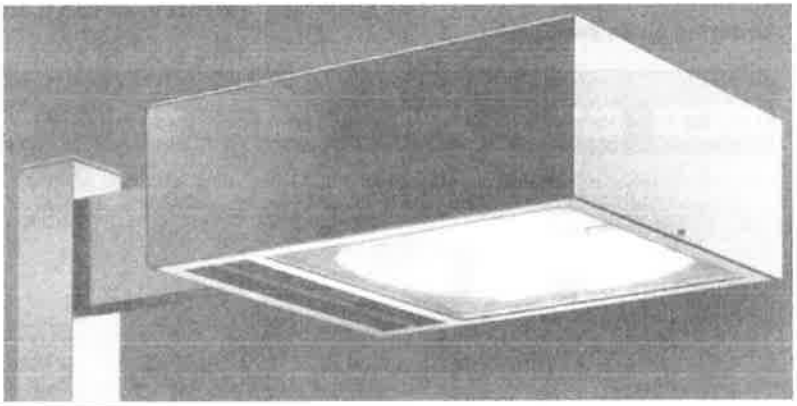
Dimensions

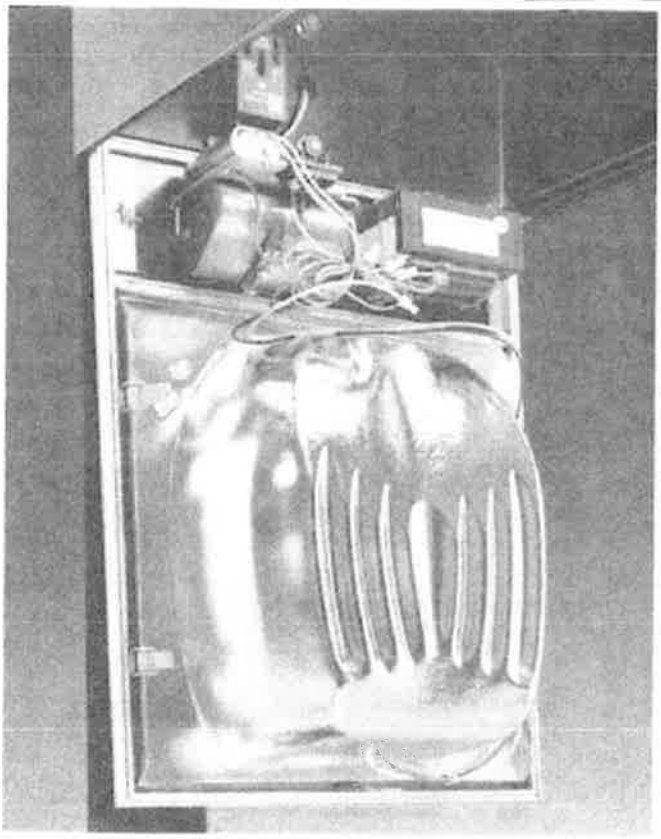
	Wattage	Luminaire Size	Standard Arm Dimensions	Recommended Mounting Height
EXECUTIVE 20	up to 200 watts	16" x 20" x 6"	2" x 4" — 8"	7'6" to 20'
EXECUTIVE 25	up to 400 watts	20" x 25" x 8"	2¼" x 6" — 12"	15' to 40'
EXECUTIVE 32	up to 1000 watts	24" x 32" x 10"	2¼" x 6" — 12"	25' to 40'

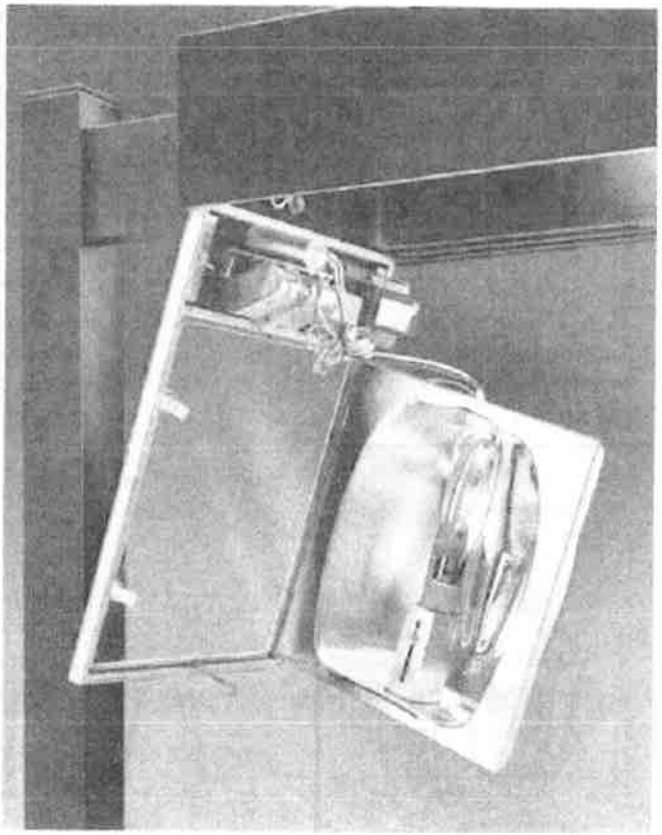
Mechanical Features • Unitized ballast/reflector system, hinged and removable as a unit. Easy access for installation and maintenance. • Reflector is hinged and sealed against a one piece E.P.D.M. gasket. • Thermal and impact tempered glass lens. • Extruded aluminum arm with galvanized steel threaded tie rods. • Extruded aluminum lens frame with accurately mitered corners, secured with internal corner keys.

Photometric Flexibility • Wattages from 70 to 400 • Die-formed, semi-specular reflector system in standard IES patterns II, III and V. A Forward Distribution Reflector is also available. 1000 WATT EXECUTIVE 32, identical in appearance and construction, forward distribution reflector or with bilateral field-adjustable reflector. Designed and manufactured to meet or exceed UL and NEC requirements. All fixtures bear the IBEW and UL label.

Options • Photoelectric control receptacle • Single or duplex weatherproof receptacle • Luminaires can be wall mounted • Baked enamel or anodic hard coat finishes available in a wide range of colors.







REPLACEMENTS THROUGHOUT STUDY AREA

GE Evolve®

LED Roadway Lighting

ERL1-ERLH-ERL2

Project name ____________
Date ____________
Type ____________

Typical Specifications: ERL1-ERLH-ERL2

LED & Optical

- **Output Range:** 1900 – 30000 lm
- **Photometric Options:** Type II Narrow, Type II Wide, Type III, Type IV
- **System Efficacy:** 100 - 145 LPW
- **CCT:** 2700K, 3000K, 4000K; LEDs @ 70 CRI

Lumen Maintenance Tables

Projected Lxx per IES TM-21 at 25°C for reference:

02,03,04,05,06	L96	L95	L94
07,08,09	L95	L91	L89
10	L89	L80	L76

10, 11	L97	L96	L96
13, 14	L95	L93	L92
15, 16	L94	L91	L91

16, 18, 19, 21, 23	L96	L94	L95
25, 27, 28	L95	L93	L92
30	L94	L91	L90

Note: Projected Lxx based on LM80 (10,000 hour testing). Accepted industry tolerances apply to initial luminous flux and lumen maintenance measurements.

Electrical

- **Input Voltage:** 120-277 volt and 347-480 volt
- **Input Frequency:** 50/60Hz
- **Power Factor (PF)*:** >90%
- **Total Harmonic Distortion (THD)*:** <20%

**Power factor and THD tolerance exceptions: ERL1 "02" Lumen output: PF and THD within tolerances above only at 120 volt. ERL1 "03" Lumen output: @120 volt PF~0.89; @ 480 volt THD~26% ERL1 "04" Lumen output: @480 volt THD~22%*

Ratings

- **Surge Protection:** per ANSI C136.2-2015:
  (Driver Internal):
  - 6kV/3kA "Basic: (120 Strikes)" - Standard on ERL1 (02-06)
  - 10kV/5kA "Enhanced: (40 Strikes)" - Standard on ERL1 (07 - 10), ERLH, ERL2

  (Additional Separate Secondary SPD)
  - 10kV/5kA "Enhanced: (40 Strikes) - Option "R"
  - 20kV/10kA "Elevated" (40 Strikes) - Option "T"
- **Safety:** UL/cUL Listed. UL 1598 listed, suitable for wet locations Ⓤ/cⓊ
- **Environmental:** Compliant with the materials restrictions of RoHS
- **EMI:** Title 47 CFR Part 15 Class A
- **Vibration:** 3G per ANSI C136.31-2010
  LM-79 testing in accordance with IESNA Standards
- Std. Optical enclosure rated per ANSI C136.25-2009:
  - ERL1/ERLH/ERL2 = IP65, Optional: IP66

International Dark Sky Association listed. 2700K or 3000K must be selected to meet IDA certification and approval.

- **Operating Temperature:**

ERL1	02-10	-40°C to 50°C
ERLH	10-11, 13	-40°C to 50°C
ERLH	14-16	-40°C to 45°C
ERL2	16-28	-40°C to 50°C
ERL2	30	-40°C to 45°C

Delayed start may be experienced < -35°C

Construction & Finish

- **Housing:**
  - Die Cast Enclosure
  - Casting-integral heat sink for maximum heat transfer
- **Lensing:** Impact resistant tempered glass, standard
- **Paint:** Corrosion resistant polyester powder painted, minimum 2.0 mil. thickness.
  - Standard Colors: Dark Bronze, Black, & Gray
  - RAL & custom colors available
  - Optional coastal finish available.
- **Weight:** 12.4lbs (5.6kg) – 24lbs (10.9kg)

Warranty

- **System Warranty:** 5 Year Standard, 10 Year Optional

Controls

- **Dimming:**
  - Standard: 0-10V; Optional: DALI (120-277V Only)
- **Sensors:**
  - Photo electric sensors (PE) available.
- LightGrid™ compatible

Mounting

- Slipfitter with +/- 5 degree of adjustment for leveling.
- Integral die cast mounting pipe stop.
- Adjustable for 1.25 in. or 2 in. mounting pipe.

Suggested HID Replacement Lumen Levels

- ~4,000–5,000 lumens to replace 100W HPS Cobra-head
- ~7,000–8,800 lumens to replace 150W HPS Cobra-head
- ~8,500–11,500 lumens to replace 200W HPS Cobra-head
- ~11,500–14,000 lumens to replace 250W HPS Cobra-head
- ~21,000–30,000 lumens to replace 400W HPS Cobra-head

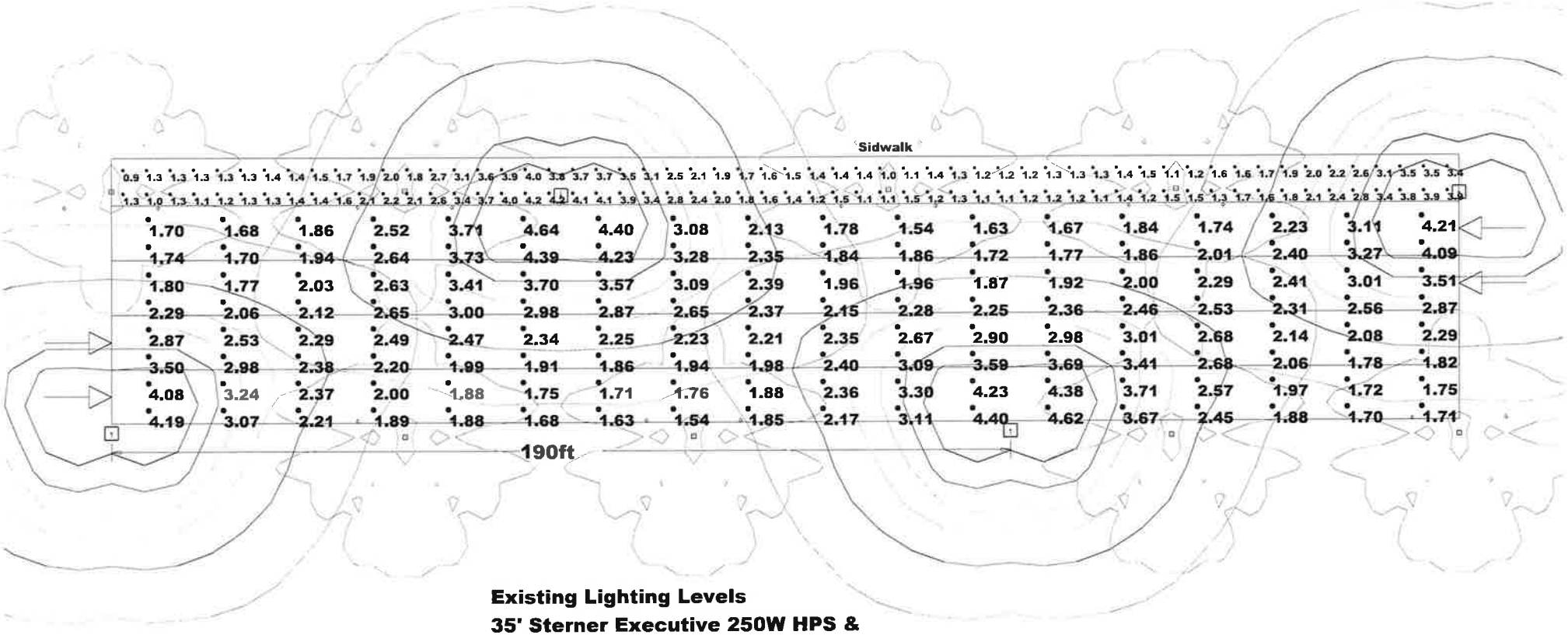
Note: Actual replacement lumens may vary based upon mounting height, pole spacing, design criteria, etc.

A1, B1	Extra Narrow/Narrow Asymmetric	A3	Type II Narrow
C1, E1	Asymmetric Short/Medium	B3	Type II Wide
D1, G1	Asymmetric Forward/Extra Wide	C3	Type III
F1	Asymmetric Wide	D3	Type IV
		E3	Type II Enhanced Back Light

**The information above is designed to provide a guideline to select the correct luminaire for a roadway application. The best and most accurate way to ensure the proper design is do a lighting layout Utilizing AGI.

Appendix C

Existing Photometrics and Layouts



Existing Lighting Levels
35' Sterner Executive 250W HPS &
15' Lumec L61 (Vernon) 70W HPS

Calculation Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Roadway_Illum	Illuminance	Fc	2.53	4.64	1.54	1.64	3.01
Sidewalk	Illuminance	Fc	2.05	4.2	0.9	2.28	4.67

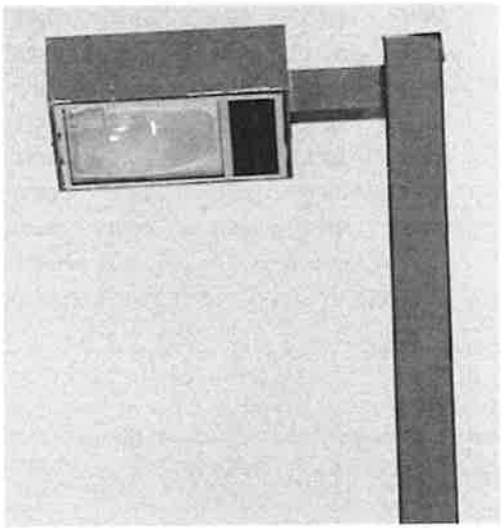
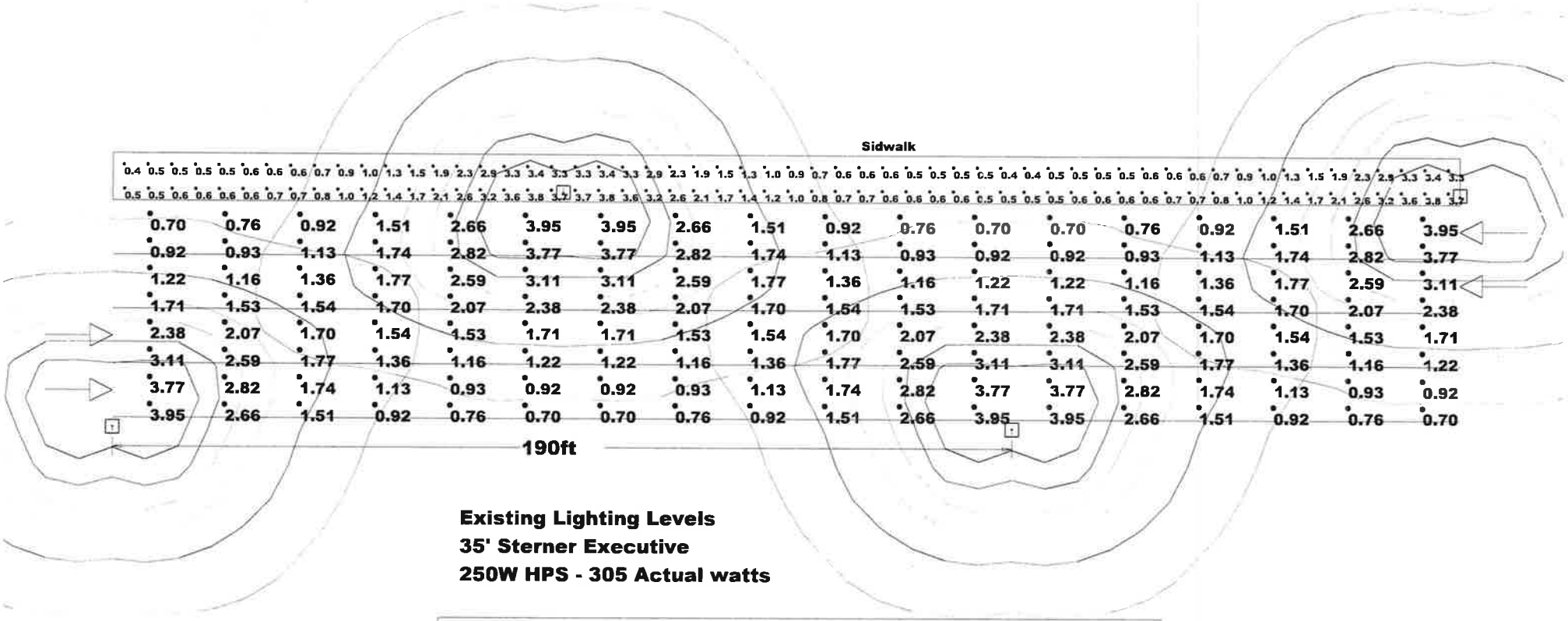


FIGURE 1



Existing Lighting Levels
35' Sterner Executive
250W HPS - 305 Actual watts

Calculation Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Roadway_Illum	Illuminance	Fc	1.83	3.95	0.70	2.61	5.64
Sidewalk	Illuminance	Fc	1.49	3.8	0.4	3.73	9.50

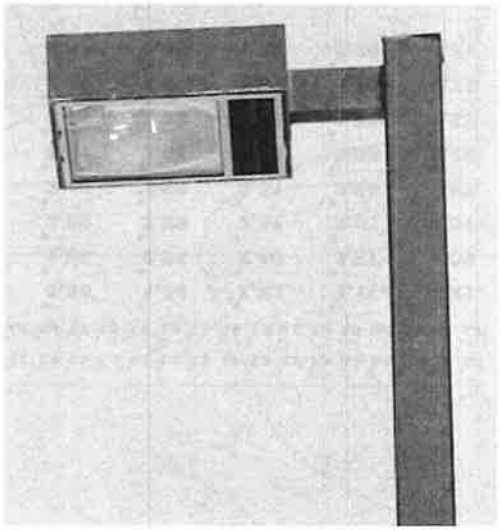
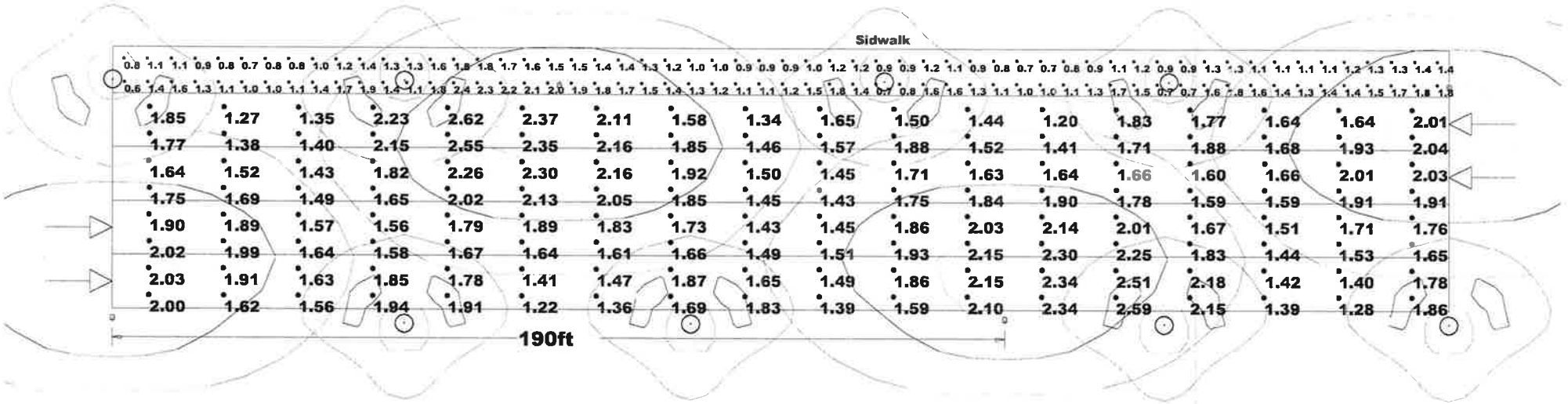


FIGURE 2

Appendix D

Proposed Photometrics and Layouts



Proposed Lighting Levels
35' Leotek Arieta AR-13 72W LED &
15' Holophane Full-cutoff Acorn 23W LED

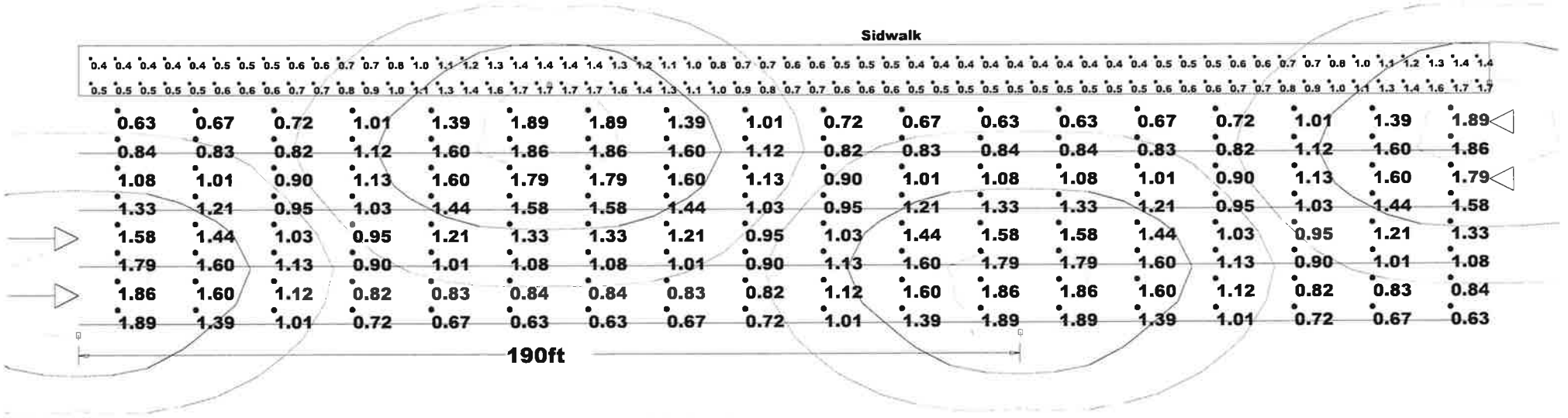
Contemporary Shoebox
LED Full-cutoff

Calculation Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Roadway_Illum	Illuminance	Fc	1.78	2.62	1.20	1.48	2.18
Sidewalk	Illuminance	Fc	1.28	2.4	0.6	2.13	4.00

Proposed for Downtown Main street

Acorn
Full-cutoff

FIGURE 3



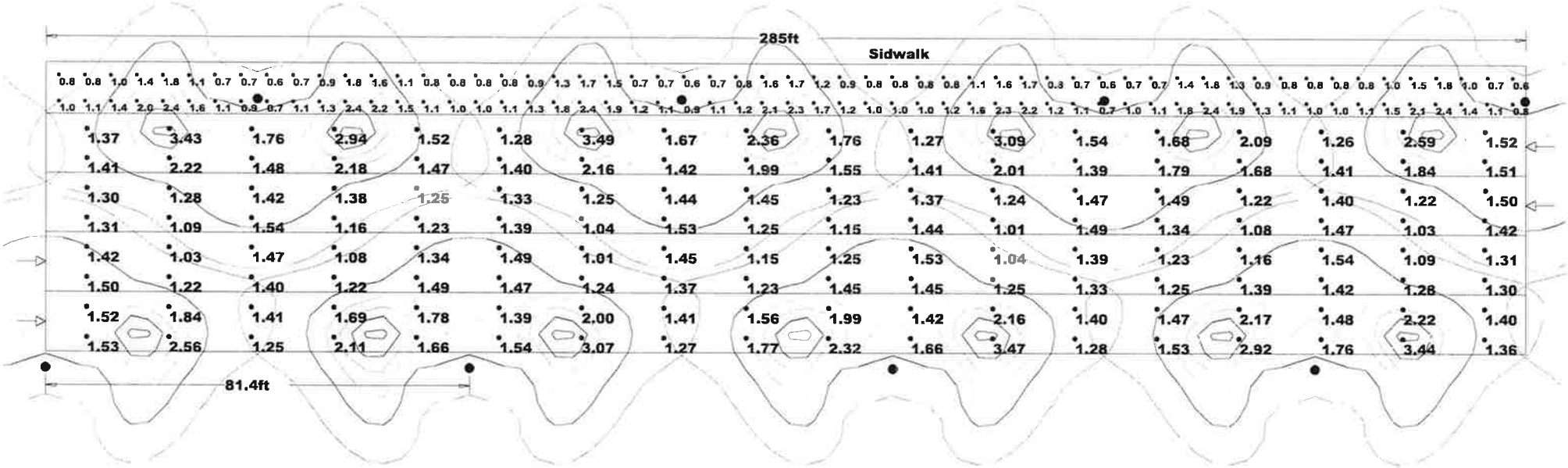
Proposed Lighting Levels
35' Leotek Arieata AR-13
72W LED

Contemporary Shoebox
LED Full-cutoff

Calculation Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Roadway_Illum	Illuminance	Fc	1.18	1.89	0.63	1.87	3.00
Sidewalk	Illuminance	Fc	0.83	1.7	0.4	2.08	4.25

Proposed For Side Streets

FIGURE 4



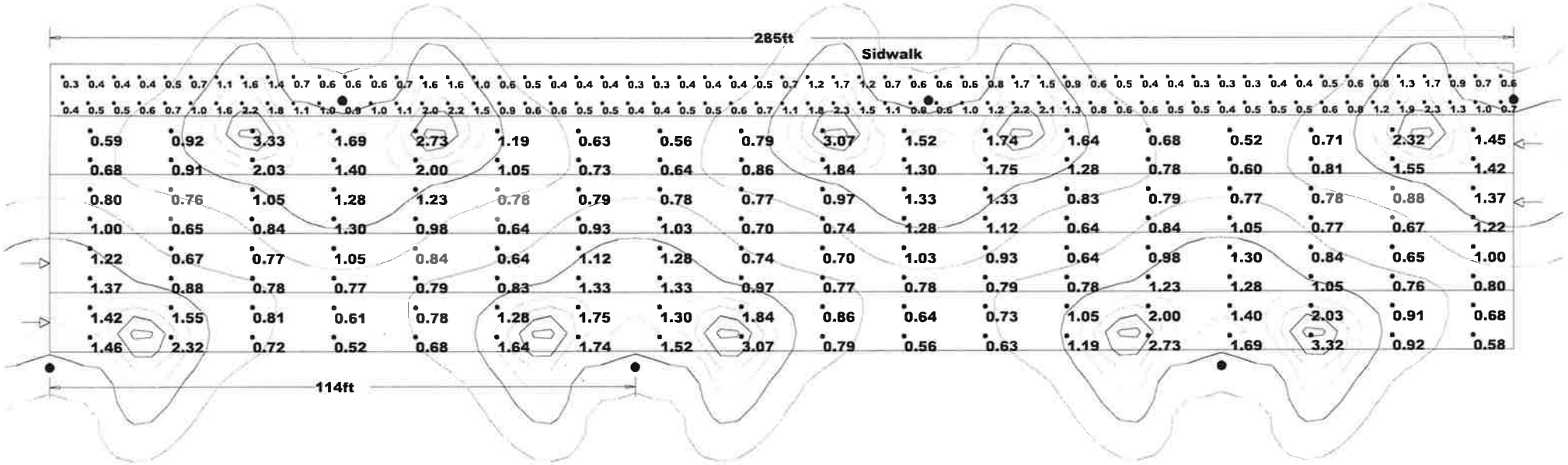
Proposed Lighting Levels - 8 Poles

15' Holophane Washington 66W LED

Calculation Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
RoadOpt_1_Illum	Illuminance	Fc	1.58	3.49	1.01	1.56	3.46
Sidewalk	Illuminance	Fc	1.23	2.4	0.6	2.05	4.00

Proposed For Downtown Main Street And Key Areas

FIGURE 5



Proposed Lighting Levels - 6 Poles

15' Holophane Washington 66W LED

Calculation Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
RoadOpt_1_Illum	Illuminance	Fc	1.13	3.33	0.52	2.17	6.40
Sidewalk	Illuminance	Fc	0.88	2.3	0.3	2.93	7.67

Proposed For Sidestreets And North End

FIGURE 6

Appendix E

Scenario Estimates

9/27/2020

City of Stillwater
Downtown Lighting

CITY OWNED - FULL REPLACEMENT IN-KIND

WITH RECEPTACLES (ON 20 POLES)
STATEMENT OF ESTIMATED QUANTITIES

Item No.	DESCRIPTION	Unit	QTY.	Cost	Estimated unit cost
2021.501	MOBILIZATION	LS	1	$4,000.00	$4,000.00
2563.601	TRAFFIC CONTROL	LS	1	$10,000.00	$10,000.00
2104.502	REMOVE LIGHTING UNIT	EACH	173	$69,200.00	$400.00
2104.502	REMOVE LIGHT FOUNDATION	EACH	173	$86,500.00	$500.00
2104.502	REMOVE SERVICE CABINET	EACH	5	$2,000.00	$400.00
2104.502	REMOVE LUMINAIRE	EACH	31	$4,650.00	$150.00
2104.503	REMOVE CABLES	LIN FT	18,500	$46,250.00	$2.50
2104.518	REMOVE CONCRETE WALK	SY	500	$5,000.00	$10.00
2521.518	4" CONCRETE WALK	SF	4,500	$54,000.00	$12.00
2545.502	LIGHTING UNIT TYPE SPECIAL - 35'	EACH	110	$660,000.00	$6,000.00
2545.502	LIGHTING UNIT TYPE SPECIAL 1 - 15'	EACH	63	$270,900.00	$4,300.00
2545.502	LUMINAIRE TYPE SPECIAL - 35'	EACH	0	$0.00	$1,300.00
2545.502	LUMINAIRE TYPE SPECIAL 1 - 15	EACH	0	$0.00	$1,300.00
2545.502	LUMINAIRE TYPE SPECIAL 2 - PARKING	EACH	31	$40,300.00	$1,300.00
2545.502	LIGHT FOUNDATION DESIGN E MODIFIED	EACH	173	$190,300.00	$1,100.00
2545.502	SERVICE CABINET	EACH	5	$30,500.00	$6,100.00
2545.502	SERVICE EQUIPMENT	EACH	5	$7,500.00	$1,500.00
2545.502	EQUIPMENT PAD	EACH	5	$6,750.00	$1,350.00
2545.502	HANDHOLE	EACH	24	$28,800.00	$1,200.00
2545.503	2" NON-METALLIC CONDUIT	LIN FT	0	$0.00	$6.00
2545.503	2" NON-METALLIC CONDUIT (DIRECTIONAL BORE)	LIN FT	18430	$368,600.00	$20.00
2545.503	3" NON-METALLIC CONDUIT (DIRECTIONAL BORE)	LIN FT	0	$0.00	$25.00
2545.503	UNDERGROUND WIRE 1/C 6 AWG	LIN FT	92000	$156,400.00	$1.70
2545.503	UNDERGROUND WIRE 1 COND 12 AWG	LIN FT	22360	$17,888.00	$0.80
	TOTAL			**$2,059,538**	
	plus 10% contingency			$205,953.80	
	Adjusted total			**$2,265,491.80**	

FIGURE 7

9/27/2020

City of Stillwater
Downtown Lighting

CITY OWNED - FULL REPLACEMENT WITH HISTORIC ACORN POLE

NO RECEPTACLES, 35' POLES ON 3RD STREET
STATEMENT OF ESTIMATED QUANTITIES

Item No.	DESCRIPTION	Unit	QTY.	Cost	Estimated unit cost
2021.501	MOBILIZATION	LS	1	$4,000.00	$4,000.00
2563.601	TRAFFIC CONTROL	LS	1	$10,000.00	$10,000.00
2104.502	REMOVE LIGHTING UNIT	EACH	173	$69,200.00	$400.00
2104.502	REMOVE LIGHT FOUNDATION	EACH	173	$86,500.00	$500.00
2104.502	REMOVE SERVICE CABINET	EACH	5	$2,000.00	$400.00
2104.502	REMOVE LUMINAIRE	EACH	31	$4,650.00	$150.00
2104.503	REMOVE CABLES	LIN FT	18,500	$46,250.00	$2.50
2104.518	REMOVE CONCRETE WALK	SY	900	$9,000.00	$10.00
2521.518	4" CONCRETE WALK	SF	8,000	$96,000.00	$12.00
2545.502	LIGHTING UNIT TYPE SPECIAL - 35'	EACH	3	$18,000.00	$6,000.00
2545.502	LIGHTING UNIT TYPE SPECIAL 1 - 15'	EACH	227	$976,100.00	$4,300.00
2545.502	LUMINAIRE TYPE SPECIAL - 35'	EACH	0	$0.00	$1,300.00
2545.502	LUMINAIRE TYPE SPECIAL 1 - 15	EACH	0	$0.00	$1,300.00
2545.502	LUMINAIRE TYPE SPECIAL 2 - PARKING	EACH	31	$40,300.00	$1,300.00
2545.502	LIGHT FOUNDATION DESIGN E MODIFIED	EACH	230	$253,000.00	$1,100.00
2545.502	SERVICE CABINET	EACH	5	$30,500.00	$6,100.00
2545.502	SERVICE EQUIPMENT	EACH	5	$7,500.00	$1,500.00
2545.502	EQUIPMENT PAD	EACH	5	$6,750.00	$1,350.00
2545.502	HANDHOLE	EACH	24	$28,800.00	$1,200.00
2545.503	2" NON-METALLIC CONDUIT	LIN FT	0	$0.00	$6.00
2545.503	2" NON-METALLIC CONDUIT (DIRECTIONAL BORE)	LIN FT	18430	$368,600.00	$20.00
2545.503	3" NON-METALLIC CONDUIT (DIRECTIONAL BORE)	LIN FT	0	$0.00	$25.00
2545.503	UNDERGROUND WIRE 1/C 6 AWG	LIN FT	58000	$98,600.00	$1.70
2545.503	UNDERGROUND WIRE 1 COND 12 AWG	LIN FT	17700	$14,160.00	$0.80
	TOTAL			**$2,169,910**	
	plus 10% contingency			$216,991.00	
	Adjusted total			**$2,386,901.00**	

FIGURE 8

9/27/2020

City of Stillwater
Downtown Lighting

CITY OWNED - REPLACE LUMINAIRES ONLY - LED - IN-KIND

STATEMENT OF ESTIMATED QUANTITIES

Item No.	DESCRIPTION	Unit	QTY.	Cost	Estimated unit cost
2021.501	MOBILIZATION	LS	1	$4,000.00	$4,000.00
2563.601	TRAFFIC CONTROL	LS	1	$6,000.00	$6,000.00
2104.502	REMOVE LIGHTING UNIT	EACH	0	$0.00	$400.00
2104.502	REMOVE LIGHT FOUNDATION	EACH	0	$0.00	$500.00
2104.502	REMOVE SERVICE CABINET	EACH	5	$2,000.00	$400.00
2104.502	REMOVE LUMINAIRE	EACH	204	$30,600.00	$150.00
2104.503	REMOVE CABLES	LIN FT	0	$0.00	$2.50
2104.518	REMOVE CONCRETE WALK	SY	0	$0.00	$10.00
2521.518	4" CONCRETE WALK	SF	0	$0.00	$12.00
2545.502	LIGHTING UNIT TYPE SPECIAL - 35'	EACH	0	$0.00	$6,000.00
2545.502	LIGHTING UNIT TYPE SPECIAL 1 - 15'	EACH	0	$0.00	$4,300.00
2545.502	LUMINAIRE TYPE SPECIAL - 35'	EACH	110	$143,000.00	$1,300.00
2545.502	LUMINAIRE TYPE SPECIAL 1 - 15	EACH	63	$81,900.00	$1,300.00
2545.502	LUMINAIRE TYPE SPECIAL 2 - PARKING	EACH	31	$40,300.00	$1,300.00
2545.502	LIGHT FOUNDATION DESIGN E MODIFIED	EACH	0	$0.00	$1,100.00
2545.502	SERVICE CABINET	EACH	5	$30,500.00	$6,100.00
2545.502	SERVICE EQUIPMENT	EACH	5	$7,500.00	$1,500.00
2545.502	EQUIPMENT PAD	EACH	0	$0.00	$1,350.00
2545.502	HANDHOLE	EACH	0	$0.00	$1,200.00
2545.503	2" NON-METALLIC CONDUIT	LIN FT	0	$0.00	$6.00
2545.503	2" NON-METALLIC CONDUIT (DIRECTIONAL BORE)	LIN FT	0	$0.00	$20.00
2545.503	3" NON-METALLIC CONDUIT (DIRECTIONAL BORE)	LIN FT	0	$0.00	$25.00
2545.503	UNDERGROUND WIRE 1/C 6 AWG	LIN FT	0	$0.00	$1.70
2545.503	UNDERGROUND WIRE 1 COND 12 AWG	LIN FT	22360	$17,888.00	$0.80

TOTAL	**$363,688**
plus 10% contingency	$36,368.80
Adjusted total	**$400,056.80**

FIGURE 9

Appendix F

Luminaire ROI Breakouts

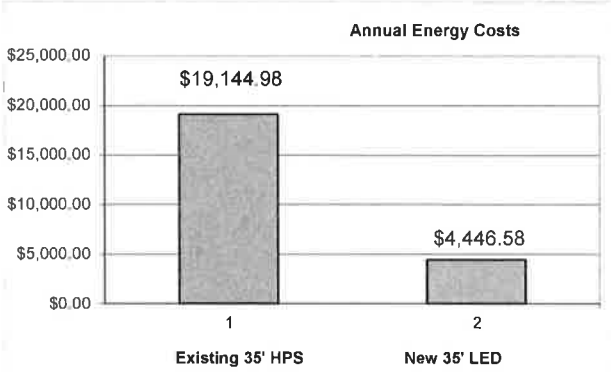
Return On Invesment - LED Replacement for 250W Shoebox Downtown Area - Roadways and Parking Lots One-for-One

Existing Luminaire: **Sterner Executive 250W HPS Shoebox**

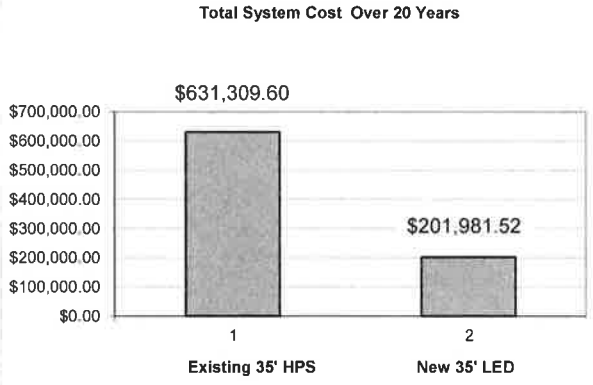
Proposed Luminaire: **Leotek Arieta 72W LED**

Cost Per kWh	$0.10
Operating Hours per Day	12
Operating Days per Year	365

	Existing Luminaire	Proposed Luminaire	
Luminaire Description	HPS	LED	Energy Use
Fixture Count	141	141	
Actual Operating Watts/Fixture	310	72	
Hours Burned Per Year	4380	4380	
Cost Per Luminaire	$600.00	$800.00	
Per Luminaire Rebate	$0.00	$0.00	
Percent of Time Fixtures are Turned off by the Sensor	0%	0%	
Luminaire Watts	43,710	10,152	
Luminaire kW	43.71	10.15	
Monthly kWh	15,954.15	3,705.48	
Annual Energy Costs	$19,144.98	$4,446.58	
Monthly Energy Costs	$1,595.42	$370.55	



Average Rated Lamp Life (hrs.)	20,000	200,000	Energy and Maintenance Costs
Cost of Lamp	$40.00	$100.00	
Number of Lamps Per Fixture	1	1	
Approximate Labor and Disposal per Fixture for Relamp	$250.00	$250.00	
Maintenance Cost over 20 years	$141,000.00	$0.00	
Lamp Cost over 20 years	$22,560.00	$0.00	
Annual Maintenance Cost (based on 20 year system operation)	$8,178.00	$0.00	
Approximate Labor, Disposal, Etc. to install new Luminaire	$250.00	$250.00	
Total Fixture Cost	$84,600.00	$112,800.00	
Total System Rebate	$0.00	$0.00	
Total Initial Install Cost	$84,850.00	$113,050.00	



Annual System Operating Cost	$27,322.98	$4,446.58
Annual System Savings	NA	**$22,876.40**
Payback (in years)	NA	**1.2**
Total System Cost Over 20 Years	$631,309.60	$201,981.52
20 Year System Savings	NA	**$429,328.08**

FIGURE 10

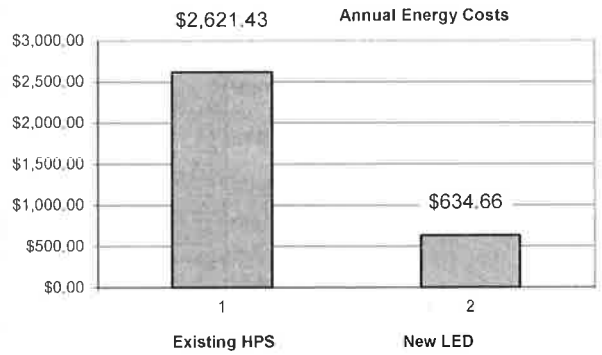
Return On Invesment - LED Replacement for 70W Lantern Downtown Area Roadways - One-for-One

Existing Luminaire: **Lumec 70W HPS Lantern**

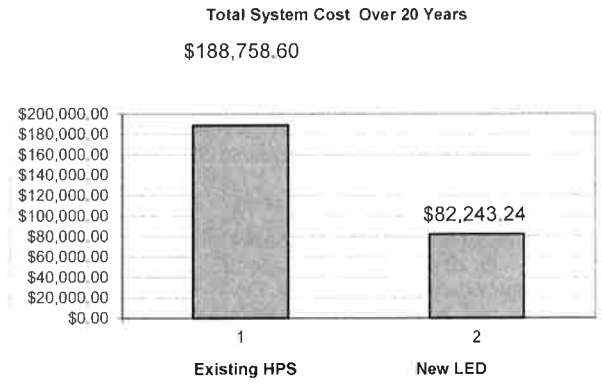
Proposed Luminaire: **Holophane Full Cutoff Washington 23W LED**

Cost Per kWh	$0.10
Operating Hours per Day	12
Operating Days per Year	365

	Existing Luminaire	Proposed Luminaire	
Luminaire Description	HPS	LED	Energy Use
Fixture Count	63	63	
Actual Operating Watts/Fixture	95	23	
Hours Burned Per Year	4380	4380	
Cost Per Luminaire	$1,000.00	$1,100.00	
Per Luminaire Rebate	$0.00	$0.00	
Percent of Time Fixtures are Turned off by the Sensor	0%	0%	
Luminaire Watts	5,985	1,449	
Luminaire kW	5.99	1.45	
Monthly kWh	2,184.53	528.89	
Annual Energy Costs	$2,621.43	$634.66	
Monthly Energy Costs	$218.45	$52.89	



Average Rated Lamp Life (hrs.)	20,000	200,000	Energy and Maintenance Costs
Cost of Lamp	$40.00	$100.00	
Number of Lamps Per Fixture	1	1	
Approximate Labor and Disposal per Fixture for Relamp	$250.00	$250.00	
Maintenance Cost over 20 years	$63,000.00	$0.00	
Lamp Cost over 20 years	$10,080.00	$0.00	
Annual Maintenance Cost (based on 20 year system operation)	$3,654.00	$0.00	
Approximate Labor, Disposal, Etc. to install new Luminaire	$250.00	$250.00	
Total Fixture Cost	$63,000.00	$69,300.00	
Total System Rebate	$0.00	$0.00	
Total Initial Install Cost	$63,250.00	$69,550.00	



Annual System Operating Cost	$6,275.43	$634.66
Annual System Savings	NA	**$5,640.77**
Payback (in years)	NA	**1.1**
Total System Cost Over 20 Years	$188,758.60	$82,243.24
20 Year System Savings	NA	**$106,515.36**

FIGURE 11

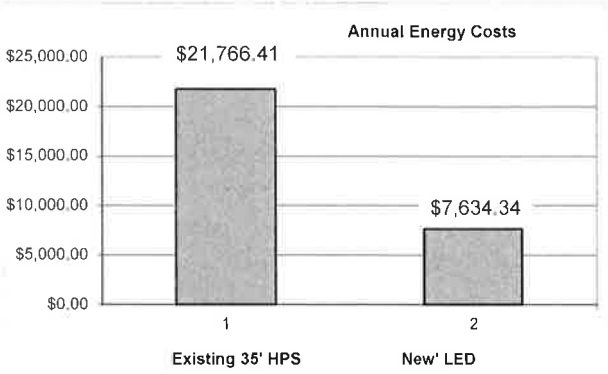
Return On Invesment - LED Replacement for Complete Downtown Area System with Historic Acorn

Existing Luminaire: **250W HPS Shoebox & 70W Lantern - 204 Luminaires**

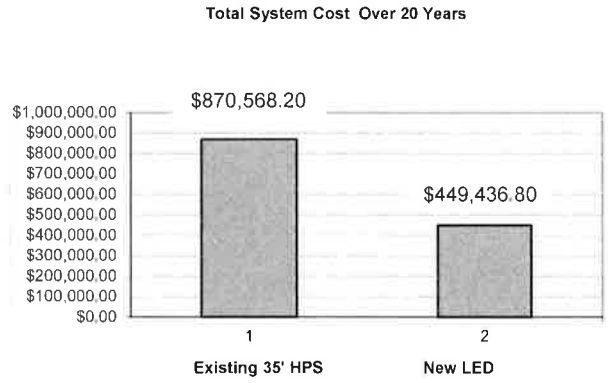
Proposed Luminaire: **66W Historic Acorn & Parking Lot 72W LED - 261 Luminaires**

Cost Per kWh	$0.10
Operating Hours per Day	12
Operating Days per Year	365

	Existing Luminaire	Proposed Luminaire	
Luminaire Description	HPS	LED	Energy Use
Fixture Count	1	1	
Actual Operating Watts/Fixture	49695	17430	
Hours Burned Per Year	4380	4380	
Cost Per Luminaire	$147,600.00	$231,500.00	
Per Luminaire Rebate	$0.00	$0.00	
Percent of Time Fixtures are Turned off by the Sensor	0%	0%	
Luminaire Watts	49,695	17,430	
Luminaire kW	49.70	17.43	
Monthly kWh	18,138.68	6,361.95	
Annual Energy Costs	$21,766.41	$7,634.34	
Monthly Energy Costs	$1,813.87	$636.20	



Average Rated Lamp Life (hrs.)	20,000	200,000	Energy and Maintenance Costs
Cost of Lamp	$8,160.00	$26,100.00	
Number of Lamps Per Fixture	1	1	
Approximate Labor and Disposal per Fixture for Relamp	$51,000.00	$65,250.00	
Maintenance Cost over 20 years	$204,000.00	$0.00	
Lamp Cost over 20 years	$32,640.00	$0.00	
Annual Maintenance Cost (based on 20 year system operation)	$11,832.00	$0.00	
Approximate Labor, Disposal, Etc. to install new Luminaire	$51,000.00	$65,250.00	
Total Fixture Cost	$147,600.00	$231,500.00	
Total System Rebate	$0.00	$0.00	
Total Initial Install Cost	$198,600.00	$296,750.00	



Annual System Operating Cost	$33,598.41	$7,634.34
Annual System Savings	NA	**$25,964.07**
Payback (in years)	NA	**3.8**
Total System Cost Over 20 Years	$870,568.20	$449,436.80
20 Year System Savings	NA	**$421,131.40**

FIGURE 12

Appendix G

Lighting Maintenance Guide

Lighting Maintenance Guide

Maintenance Recommendations for Lighting Systems

City of Stillwater, Minnesota

SEH No. STILL 152259

September 27, 2020

SEH

Building a Better World for All of Us®

Engineers | Architects | Planners | Scientists

Table of Contents

Lighting Maintenance Guide

Maintenance Recommendations for Lighting Systems

Prepared for City of Stillwater, Minnesota

1.0 Lighting Maintenance Guidelines

This Lighting Maintenance Guide is intended to aid the City in maintaining the expected useful life of new roadway lighting systems and possibly extend the life of existing systems.

Lighting systems, by nature, are highly visible both day and night. Proper maintenance of these lighting systems is important for several reasons.

1. Good maintenance techniques will ensure the system is performing as designed.
2. The overall condition and appearance of the lighting system can reflect upon the City's civic commitment.
3. Good system performance improves public safety and minimizes hazards to the public.
4. An effective and properly executed maintenance plan can minimize the required number of luminaires needed for a roadway lighting system and subsequent installation, operation and energy costs.

2.0 Types of Lighting Maintenance

Demand

Demand responsive maintenance is related to random occurrences such as pole knockdowns, lamp or circuit outages and other equipment failures.

Routine

Routine maintenance refers to scheduled activities such as luminaire washing, pole paint touch-up, etc. These activities are intended to retain the expected level of system performance, while eliminating the need for certain demand responsive maintenance.

The main difference is the time at which these activities are conducted. The activities required for both demand and routine maintenance are discussed below.

2.1 Demand

Demand responsive maintenance includes all of the various activities necessary to keep the system operational.

Emergency maintenance activities such as attending to service cabinet and pole knockdowns, exposed wires and other public safety threats must be attended to within minutes or hours after

notice has been received. Failure to respond to emergency maintenance in a timely manner can be hazardous to the public. To address these immediate concerns, the City must have at its disposal the crews and equipment necessary to perform these activities, or the ability to contract the work with a private agency. In either case, spare lighting system components should be stocked to facilitate urgent repairs.

Non-emergency demand responsive maintenance items do not require the response time dictated by emergency maintenance activities and include the repair of individual luminaire outages and underground circuit faults, and other random events. While the correction of these deficiencies is not as time critical as emergency items, they should be corrected as soon as economically feasible. Most agencies do not address an individual non-emergency issue until multiple issues occur within the same area. In a similar manner, single or multiple luminaire issues may never be corrected if the luminaire is soon to be serviced as part of a routine maintenance schedule, or scheduled for replacement as part of a larger project or upgrade program.

2.2 Routine

Routine maintenance, also referred to as "scheduled" or "preventive maintenance," is performed on a regular basis in order to maintain the light output of the system and reduce long term maintenance expectations. The requirement of this type of maintenance stems from two primary factors, each of which reduces the output of a lighting system over a period of time. These are lamp lumen depreciation and luminaire dirt depreciation.

2.2.1 Lamp Lumen Depreciation

Lamp lumen depreciation is an irreversible process where the lumen output of the LED lamp steadily decreases over time. Only replacement of the lamp will result in regaining the original lumen output.

The typical LED luminaire has a published rated life of over 100,000 hours of operation. Depending upon how hard the luminaire is driven, that rated life could be doubled. This is not when the luminaire fails, but is defined as the time at which it degrades in light output to a given percent of its initial value. A common measure of this value is, 70% of initial light output, or "L70". With lighting systems operating at an average of 12 hours of per day, we can expect to start evaluating the rendered light levels in about 23 years.

2.2.2 Luminaire Dirt Depreciation

The second major factor causing a reduction in lumen output by the luminaire is dirt accumulated on the interior and exterior of the luminaire optics and on the LED lamp itself. This reduction in light output is referred to as luminaire dirt depreciation and is usually related to the amount of time between washings and the type of area in which the luminaires are located. This practice will ensure the luminaire operates with almost original lumen output.

3.0 Reducing Lighting Maintenance

Ongoing lighting maintenance is a necessary and expensive factor to consider when owning municipal lighting systems. Reducing these expenses should be one of the City's main objectives, especially for the construction of new lighting systems.

We can never eliminate maintenance associated with unexpected events such as pole knockdowns, but we can minimize the primary expenditures associated with luminaire repair, and underground faults, by correctly specifying any new lighting system. The reduction in lighting system maintenance originates with the City's commitment to not compromise in the quality of the lighting equipment and installation methods that are specified in construction documents.

The introduction and rapid evolution of LED equipped luminaires has now eliminated the costs associated with typical lamp changes. Installing the appropriate conductors in conduit

for underground circuiting can greatly reduce the chances of underground electrical faults. The same can be accomplished by eliminating the use of steel screw-in anchor bases.

There are numerous additional methods of installation and specific equipment to specify that can assist the City in producing a "bullet proof" lighting system. A strong lighting specification can ensure that this is accomplished.

4.0 Maintenance Recommendations

Routine maintenance practices, when neglected, result in the greatest reduction in roadway light levels primarily due to system outages attributed to equipment failure.

The following recommendations are typical for existing and new lighting systems. To minimize mobilization costs, it is recommended to combine as many of these practices as possible when visiting each lighting unit or system.

4.1 Luminaires

4.1.1 Luminaire Assembly

Apply, or reapply anti-seize compound to the threads of all dissimilar metal set crews and hardware necessary to access optical compartments on luminaires and any mounting hardware on the luminaires.

4.1.2 Optics

LED luminaire optics will need to be cleaned periodically. Depending upon the style, LED luminaires may not have an optical chamber to clean. If this case, a simple hose-down or light pressure wash will suffice unless they attract an inordinate amount of road spray and insects. Lighting systems in the proximity of rivers or lakes may attract more insects than other locations Decorative luminaires may have an optical chamber which should be cleaned in the regular manner. After a few years of operation, an inspection will enable the City to determine the appropriate interval to perform the cleaning operation.

4.1.3 Luminaires Gaskets

When washing or repairing the luminaires, glassware and lens gaskets should be checked for cuts and gaps that permit dust, insects and moisture to enter the interior of the luminaire. Replace as necessary.

4.2 Light Poles

All anchor base poles should be checked for loose anchor nuts and luminaire mounting hardware. A simple shove will let you know if this problem is present. Loose mounting hardware can cause pole flanges to crack and luminaires to fall off the poles.

Gaskets on light pole handhole doors, if present, should be inspected periodically and repaired as necessary to minimize the ingress of dust and water.

Apply, or reapply anti-seize compound to the threads of all dissimilar metal set crews and hardware associated with the handhole doors necessary to access the circuit splicing and fusing.

Poles with missing handhole doors should be repaired as soon as possible. This is a hazard to the public. Exposed circuit conductors are susceptible to theft.

Chips and damage to the finish should be touched up periodically on painted or powder coated aluminum poles to prevent corrosion and further finish loss.

The interval for repainting light poles is typically 5 to 7 years after the first repainting. That schedule is dependent upon the poles proximity to the curb line and the amount and speed of automobile and plow traffic along the roadway. It is also dependent upon the City's tolerance

for an unsightly pole. Once the repainting starts, the painting interval is fairly consistent due to the expected life of the new finish. It will never be as good as the original finish unless the pole is removed from its foundation and completely stripped and shop painted.

4.3 Lighting Service Cabinets

Gaskets on older lighting service cabinet doors should be inspected periodically and repaired as necessary to minimize the ingress of dust and water.

Hinges should be inspected for damage and replaced as required.

Replace door locks that are inoperable. This condition is a hazard to the public. Lubricate locking mechanisms periodically to prevent premature failure.

Watch for corrosion on circuit breaker buses. Corroded buses can cause arcing and heat buildup on the bus and circuit breakers. Internal components can be replaced as needed.

Extend conduits entering the bottom of the concrete base so they terminate above grade.

Ensure that an approved duct seal is applied over the conduit and conductor entries into the service cabinets. This minimizes the humidity emitted from the conduit system from condensing on the components inside the cabinet.

Check for tightness of cabinet anchor bolts. Cabinet should not move on its concrete base.

These items can be inspected and action taken each time a visit is made to repair items associated with the lighting system. Every 4 years the condition of the cabinets should be reviewed.

4.4 Pull Boxes

Ensure that the pull box rim and lids are at or slightly above or at finished grade .Make sure all stainless steel bolts remain in the cover and are tightened in place.

Ensure that an approved duct seal is applied over the conduit and conductor entries into the pull boxes.

Replace damaged pull box covers as soon as feasible.

4.5 Obstructions

Keep trees trimmed on a regular basis as they can shield the luminaire and greatly affect the uniformity of roadway light levels.

4.6 Spare Equipment

Keep at least one complete lighting unit of each type in stock to provide for quick replacement of damaged equipment in the event of a knockdown or other equipment problem such as luminaire failure or vandalism.

Lighting service cabinets can be replaced in short order. There are a number of cabinet fabricators in the metro area that can quickly furnish a new cabinet, though the lighting system may be out of commission for a week or longer.

Interconnecting lighting conduit between adjacent lighting systems will enable the City to easily back-feed a lighting system disabled by a cabinet knockdown.

4.7 Maintenance Records

Maintain accurate records of maintenance activities for each pole and luminaire in the lighting system. Maintenance data can help identify trends and issues associated with specific equipment in the system.

Provide a pole numbering system (small numbers applied to the street side of poles) to help staff and citizens identify the location of problems.

5.0 Contracting for Maintenance

Contract the services of a reliable local electrical contractor to provide both on-call demand and routine maintenance services. The contractor will not keep an inventory of lighting equipment used by the City. It is imperative that the City keep an inventory of spare equipment for timely replacement.