# CANYON CREEK PARKING LOT LIGHT REWORK PROJECT

Printed 2020-09-05 (v1)


## Abstract

Overview of the rework of the Canyon Creek Parking Lot Light project completed August 15th, 2020.



Mark Weaver

JMarkWeaver@gmail.com

## Document Objective

This purpose of this document is to communicate a defined set of problems, the opportunity / project goals, and methods to address those problems with the Canyon Creek parking lighting.

## The Challenge

From a short-term perspective, one light of the three lights had gone out. From a strategic perspective the lighting technology had become obsolete. While it is possible to simply replace the burned-out bulb with a new one, this was a poor strategic financial decision.

## Opportunity / Project Goals

1. Restore lighting (illumination) to full capacity.
2. Consider opportunities to improve lighting (illumination). See Table 1 – Efficiency Comparison of Illumination Technologies.
3. Reduce on-going maintenance costs. See Table 2 - Operating Cost Comparison
4. Reduce on-going power costs. See Table 2 - Operating Cost Comparison
5. Consider additional conversion opportunities.

## Background and History

The existing lighting is three "shoebox" fixtures on two poles.

- One shoebox fixture is placed on 25' pole (on top of a 2' base) is placed at the north end of the parking lot.
- Two shoebox fixtures are placed on 25' pole (on top of a 2' base) is placed at the south end of the parking lot.

The shoebox fixtures originally housed HID bulbs which are an old technology and is being phased out. See Table 1 – Efficiency Comparison of Illumination Technologies.

As a temporary measure, the association had installed "LED corn cob" style bulbs as a cost-effective transition. This decision was made at a time when Integrated LED fixture costs were still high, but we wanted to consider an alternative to HID bulbs.

*Figure 1 - Older HID Shoebox Fixture*

## Moving Forward

While the catalyst for the project was initially a failed LED corn cob bulb, it was an obvious poor business decision to replace the bulb with another obsolete, inefficient bulb with a short life span. The opportunity was taken to upgrade to new more efficient lighting fixtures.

*Figure 2 - New Integrated LED Fixture*

The most significant cost portion associated with replacing a bulb or fixture is the boom lift rental. With bulbs or fixtures that have a greater life span, the requirement for boom lift rental is greatly reduced on average over time.

### Getting More Light for Less Power

Although there are many factors involved in getting more lumens (light) per watt (power) two will be highlighted:

1. Efficiency – This is the amount of light versus heat when power is applied. See the "Estimated Wattage" row in Table 1 below. To allow for an approximate amount of illumination (lumens), less efficient bulbs or fixtures must be designed to consume more power.
   - A HID bulb consumes most of its power as it gives off heat (and less light).
   - An LED bulb or a LED fixture consumes most of its power as it gives off light (and less heat).
2. Directional Efficiency – This is the amount of light lost as it is trapped inside the fixture.
   - A HID and LED corn cob bulb lose as much as 30 to 40% of their generated light as it is shines against the back insides of the fixture.
   - Newer Integrated LED fixtures shine an array of LED diodes without the need for light to be reflected against another surface. LED fixtures have virtually no directional efficiency loss.

Moving to a more efficient device involved completely replacing the obsolete "shoebox" style fixture.

| Lamp type[1] | HID (installed in fixture) | LED Corn Cob (installed in fixture) | LED Integrated |
|---|---|---|---|
| Estimated Wattage | 400 watts | 300 watts | 150 watts |
| Directional Efficiency | 40% loss | 35% loss | 0% loss |
| Efficiency (Lumens/Watt) | < 30 lumens / watt typical | ~ 35 lumens / watt | > 50 lumens / watt typical |

*Table 1 – Efficiency Comparison of Illumination Technologies*

### Another Reason to Eliminate the Fixture

In addition, older fixtures have protective "lens" over the bulb which may be flat (or sometimes curved to focus the light). Simply passing light though this additional lens reduces the amount of available light (and generates heat as a byproduct) as much as 5%. If the fixture or lens is not perfectly sealed, contaminants (such as water, dust, dirt, insects, pollen) will make the lens even further less efficient. Depending on the maintenance level of the lens, light losses could add another 10% and shorten the life of the bulb within the fixture. Newer Integrated LED fixtures do not have a protective lens to trap light or contaminants.

[1] Source: http://www.innovativelight.com/hid-vs-led-lighting/

## What Lamp / Fixture Efficiency Looks Like

An easy and obvious indicator of the efficiency any device is usually its designed size.

*Figure 3 - Comparison of Fixture Sizes*

As you can see in the large "shoebox" fixture on the right[2], these fixtures are about three times size both the in both weight (approximately 45 pounds) and 5 times the surface area. This additional "size" is used by the fixture dissipate unusable yielded heat and unusable light (converted to heat).

More efficient fixtures are typically much smaller. The Integrated LED fixture on the left (approximately 15 pounds) need less surface area to dissipate heat because most of its electrical energy is directly converted to light with less heat byproduct.

## Operating Cost Comparison

While every circumstance is a little different, operating cost include:

- Nominal power consumption
  - each fixture multiplied by
  - the amount of time used
- Nominal life of each fixture to include
  - Replacement cost of each of fixture plus
  - Periodic Labor and equipment rental

| Lamp type | HID (installed in fixture) | LED Corn Cob (installed in fixture) | LED Integrated |
|---|---|---|---|
| Estimated Wattage | 400 watts | 300 watts | 150 watts |
| PEC KWHs[3] * 12 hrs / day * 3 fixtures * 365 days / yr | 0.000040297 * 400 * 12 * 3 * 365 = $211 / yr | 0.000040297 * 300 * 12 * 3 * 365 = $159 / yr | 0.000040297 * 150 * 12 * 3 * 365 = $79 / yr |
| Replacement Cost[4] | $ 50 for HID bulb<br>$350 for lift<br>$100 - $500 labor ($300 avg)<br>$700 Total | $100 for LED bulb<br>$350 for lift<br>$100 - $500 labor ($300 avg)<br>$750 Total | $150 for LED fixture[5]<br>$350 for lift<br>$100 - $500 labor ($300 avg)<br>$800 |
| Nominal Life Span | 2 to 5 years (4-year avg)[6] | 2 to 5 years (4-year avg) | 5 to 8 years (6-year avg) |
| ROM 10-year Replacement Cost | $700 / 0.4 = #1750 | $ 750 / 0.4 = $1875 | $800 / 0.6 = $1,333 |
| ROM 10-year Power Consumption Cost | $211 * 10 = $2,110 | $159 * 10 = $1,590 | $79 * 10 = $790 |
| ROM 10-year Total Costs | $3,860 (100%) | $3,465 (~90%) | $2,123 (~55%) |
| Industry Operating Cost[7] | 100% | ~ 80 % | Up to 40% |

[2] Although this fixture in this picture has a LED corncob bulb installed, it was originally designed for HID bulb. Although the corncob bulb is an LED bulb, its inefficient design has many of the same heat dissipation and light loss issues of HID bulbs.

[3] PEC pricing varies by time of day. As the normal lighting period crosses from "super economy" through "peek" the "normal" rate of $0.040297/kwh will be used.

[4] Source: Amounts are estimates and will vary over time. While the cost of an LED Integrated fixtures is higher at this time, this cost is expected to continue to go down as LED fixtures continue to be more pervasive. Fixture cost is still less than half of equipment and labor of single fixture repair.

[5] While the current price of the Integrated LED fixture was $228, prices continue to fall. For the purpose of calculations, $150 can be used.

[6] While the nominal life expectancy of HID bulbs is typically 22,000 hours (/365 days/yr * 12 hrs/day = 5 years), actual life expectancy is typically less as ballast life expectancy must be included. At "end of life" HID bulbs output only 70% of their original light level. In addition, "lamp starts" (such as when lights are cycled off and back on at tennis courts), reduces the life expectancy.

[7] Source: https://www.superbrightleds.com/blog/making-switch-led-parking-lot-lights/1948/

*Table 2 - Operating Cost Comparison*

## Risks, Unknowns and Expected Changes

Infrared LEDs were invented in 1962, white LED in 1993. While Integrated LED lighting technology has become pervasive in the industry over the last five to ten years, it is still evolving. Integrated LED that are being sold today will be replaced with different models within a year or two.

### Risks

Since manufactures are striving to come out with new and more efficient models every couple of years, there is a limited long-term test history. Manufacturers use mathematical modeling to project a 5 to 8 (or longer) year life expectancy, not actual historical model data. Occasionally, manufactures experience low-yield models or models with poor design margins that may not be discovered right away. When this happens, this may cause some or all units to be replaced prematurely. The manufacture will usually pay for replacement of the fixture, but not for the labor. Conversely, some Integrated LED light fixtures may last much longer than predicted in modeling.

### What will Stay the Same

Although the Integrated LED fixture model numbers will change to reflect changes in specifications a few things are likely to remain the same:

- 2-3/8” Slide on mounting base post adapter. See Figure 4.
- 115v AC to 227v AC nominal operating voltage - Lamps do not need to be rewired but will adjust automatically to the provided voltage
- 5000 Kelvin (daylight) color

*Figure 4 - 4" Square to 2-3/8" post adapter*

### What is Likely to Change

Future Integrated LED fixtures will likely have:

- minor changes to fixture appearance
- further improvements in efficiency
- illumination patterns

# Implementation Choices

As the north end of the parking lot was significantly less illuminated than the south end, and since there was only one light fixture instead of two, the opportunity was taken add a second lighting fixture on the north parking lot pole. To do this, a “bullhorn” fixture bracket (https://www.lightmart.com/low-profile-bullhorn-with-2-tenons/) was installed on the north parking lot pole. The bottom part of this bracket mounts on a square post adapter as shown in Figure 4. The top part of this bracket simply receives two light

*Figure 5 - Bullhorn*

fixtures without the need for post adapter. Holes in this bullhorn bracket allow for wiring to be run through to each fixture, but bushing must be installed to prevent wire damage over time.

## Impact on Consumed Power

As the number of fixtures has now increased overall from 3 to 4, the consumed wattage would now be about 600 watts, but still significantly less than what was being consumed before. See the last column of Table 3.

| Lamp type | HID (installed in fixture) | LED Corn Cob (installed in fixture) | Integrated LED | |
|---|---|---|---|---|
| Estimated Wattage | 400 watts | 300 watts | 150 watts | |
| Installed Fixtures | 3 | 3 | 3 | 4 |
| Consumed Power (watts) | 1,200 watts | 900 watts | 450 watts | 600 watts |

*Table 3 – Lamp Technology Choices, Number of Installed Fixtures and impact on Consumed Power (Wattage).*

## What was Discarded and / or Replaced

All wiring starting from the base of the pole was removed. Some of the 14 AWG existing wiring had damaged insulation, damaged core wire or damaged connections (i.e. wire-nut connections). In addition, previous repairs and maintenance had added sections of wires patched in at each fixture and at the base. While it was currently working, it was due for failure. The 12 AWG stranded replacement wiring is heaver and more reliable.

As wire nuts deteriorate from corrosion over time, all were discarded and replaced with new.

## What was set aside for future consideration

### *Shoebox Fixtures*

While it is likely that we simply choose to discard the old Shoebox fixtures, we will hold on to these fixtures until our immediate lighting needs are fully evaluated.

### *Corn Cob LED bulbs*

The corn cob style LED bulbs have served their purpose as a transition device. Of the 3 devices, 1 has failed. We may choose to use the remaining two to illuminate the pool area. It may not be worth the effort, but instead to use the two remaining corn cob bulbs as replacement to a couple of the remaining HID bulbs.

## What Lighting Equipment Was Reused

Fortunately, Integrated LED fixtures are designed to be highly compatible with existing industry lighting equipment. Specifically,

- (2) 4” Square Light Poles with their bases
- (1) 4” Bullhorn (from the south parking lot pole)
- (1) 4” Post Adapter (from the south parking lot pole)
- (2) Photocell adapter (from each light pole).
- All wiring leading up to the base of the pole.[8]

[8] At some point, the cabling from service panel to the base of pole needs to be pulled out replaced as it is likely suffering service damage as seen with the other wiring. At this same time, the service voltage lights can be changed from 120v to 208v which will improve power distribution efficiency by about 2%.

## What Was Newly Installed

The total bill for new equipment was $1043.

- $912 (4 Integrated LED fixtures @ $228) ➔ (2) on S. pole, (2) on N. pole.
- $131 (1 Low profile Bullhorn with 2 Tenons) ➔ (1) on N. pole
- ~$20 (~75' * 4 * stranded 12 AWG – stock, no invoice)
- (~30 Wire nuts – stock, no invoice)

## What Equipment Was Used

For the most part standard electrical tools were for the job. The only exceptional tool required was a boom lift for $384.67 for a T350 JLG which is readily available from HomeDepot stores.

- $309.00 Equipment rental (24 hours)
- $ 46.35 Equipment insurance
- $ 29.32 Sales Tax

*Figure 6 - T350 JLG - 35' Boom Lift*

### T350 JLG – 35' Boom Lift

Although the lift is light weight and easily transportable to a job site, its advanced computer controls ensure that the lift can be safely operated.

- The boom cannot be extended until the unit disconnected from the tow vehicle and automatically anchored.
- The boom can not be extended past its center of gravity causing it to tip over.
- The boom can be operated from "the bucket" or in "a safety ground" mode.
- The bucket controls are smooth and allow you to make small adjustments in the working position.
- The lift has working reach of 35 feet and easily reaches most parking lot lights. As the Canyon Creek parking lot lights have a nominal height of 28 feet, this lift easily accomplishes the task.

## Rework and Retrofit[9]

The light poles are reworked in a series of relatively simple steps.

1. Power was removed at the breaker panel. The breaker is marked with an "out of service" red tagged. A voltage safety check is done at the base of the pole to ensure that the pole is de-energized.
2. Service wiring is disconnected at the base of the pole. As photocells were wired, they were disconnected and removed.

[9] Electrical work must be performed by licensed electrician and someone skilled in the work.

3. The service wiring that runs to the top of the pole is used to pull new wiring. A length of wire is taped to the old pole wire. The service wiring was cut and secured at the top of the pole.
4. The old light fixture was removed and lowered.
5. The bullhorn was temporarily removed to allowed for the new service wiring to be installed. As the old bullhorn was removed, new wiring was pulled from base up through the pole. An additional wiring was pulled to allow for both sides of bullhorn to be wired.
6. New wiring was temporarily tied off at the top of the pole to allowed longhorn to lowered to serviced.
7. As the bullhorns may have very sharp through-holes which may cause a physical wire damage, grommets were installed at each. (There is one through-hole are at the pole mount and one at one each light fixture. A grommet for this application can be made from a ½" NM PVC threaded pipe fitting, ½" locknut and ½" bushing.)

*Figure 7 - Installing of Bullhorn*

8. The bullhorn was reinstalled at the top of the pole first by threading the new wiring the grommet at the base of the bullhorn, then out through access cap one side. Again, the wiring was temporarily secured to prevent it from falling down through the pole.
9. A corresponding section of wiring was run out through the access cap and secured to the opposite side of the bullhorn for the other light.
10. Lighting adapters were installed on their 2-3/8" slip posts.
11. Lights fixtures were installed on their lighting adapters threading their fixture wires down through their corresponding adapters into the bullhorn.
12. Fixture ground, neutral and line service wires were connected.
13. Fixture angles were adjusted[10].
14. Adapter adjustment covers were replaced as shown in Figure 9.
15. Longhorn end cap covers were replaced.
16. Wiring, angle adjustments, and cover replacements for opposite side were performed.

*Figure 8 - Threading Wire through Fixture Mounting Brackets*

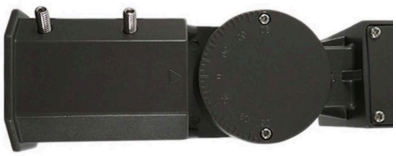


*Figure 9 - Post Slip & Adjustment Adapter*

17. A quick electrical test was performed by:
    a. temporarily not connecting photocells or other control devices,
    b. temporarily connecting ground, neutral and line at the base of the pole,

[10] Typically, fixtures angles are set between 15° and 30° above horizontal. While using angles up to 30° extends the distance in which light is cast away from the pole, care should be used not to let direct fixture light shine into traffic, surveillance cameras, etc.

c. energizing the circuit by switching the breaker on,
d. verifying the light operation,
e. de-energize the circuit and lock-out the breaker.
f. remove and temporary connections of ground, neutral, and line.

18. Final wiring was performed. Once the fixture lights were verified, final wiring was completed including photocells.
19. Final testing was performed.[11]

[11] When testing photocells during full daylight environments, it may take up to 3 to 5 minutes to "blacking out" the photocell to activate the light circuit. Several layers of black tape or hand completely placed over the photocell is required to black out a photocell.

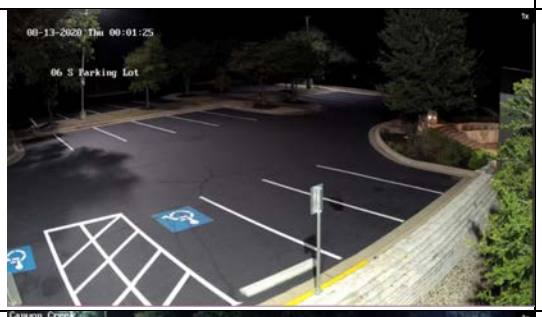
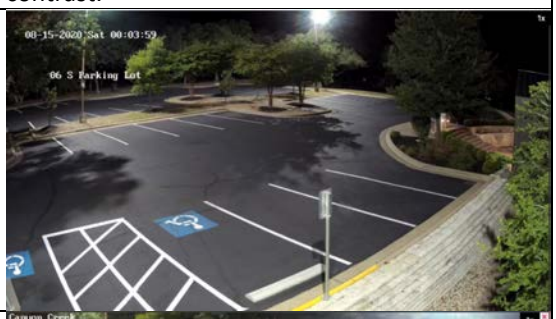
| | Before new lights were installed | After new lights were installed.<br>Note light at the far ends of views and notice contrast. |
|---|---|---|
| Camera #6: Looking from south |  |  |
| Camera #7: Looking from CC building. |  |  |
| Camera #8: Looking at the north east parking lot. |  |  |
| Camera #4: West Parking Lot. Also note sidewalk. |  |  |

*Table 4 - Before and After Comparison*

## Additional Conversion Opportunities

Canyon Creek still has numerous HID (and some LED corn cob) bulbs that may be replaced for an additional savings:

- Pool Lights:
  - 3 of 3 HID bulbs → Integrated LED fixtures (2 at pool deck area, 1 at pool pump driveway)
- Tennis Court Lights:

- 10 of 16 HID bulbs → Integrated LED fixtures – more savings
- 3 of 16 LED corn cob → Integrated LED fixtures – some savings
- 3 of 16 Integrated LED fixtures (Inside of Shoebox) → The Integrated LED fixtures need to be removed from inside from inside shoebox fixture and mounted directly onto pole for best heat dissipation. If this can not be done, the fixtures need to be replaced with the proper unmodified Integrated LED fixtures.

There are two factors that likely contribute to a greater cost savings to replacing the lights at the pool first:

- As the pool lights operate for approximate 12 hours / night (as compared to approximate 1 to 4 hours on average / night for the tennis courts.
- There are only 3 fixtures at the pool (as compared to 16 fixtures at the tennis courts) that would need to be replaced.

The actual cost comparison and cost savings has not been estimated.

## Conclusions

### *Nighttime Image Comparisons*

While the image comparison may be a little subtle, I will highlight a few points in Table 4:

- Camera #6: Parking lot beyond island is now visible.
- Camera #7: Substantially more light across parking lot. Foreground now appears to be yellow by comparison as more light in background is available.
- Camera #8: Improved image contrast – less of image is illuminate through ambient and camera infrared technology.
- Camera #4: Improved image contrast – less of image is illuminate through ambient and camera infrared technology. View of sidewalk down toward basketball court is more visible. Direct view on west side of parking lot.

### *Technology*

Integrated LED lighting fixtures are here to stay. They yield a 5000 Kelvin (daylight or white) light that comes on instantly without the need for a warm-up cycle. It is possible that the cost of Integrated LED fixtures (currently $225) may become as inexpensive as HID bulbs ($50) within the next 5 to 10 years.

### *Efficiency*

Integrated LED lighting fixtures allow for a sufficient cost savings in both on-going energy savings and maintenance costs.

### *Return on Investment*

Integrated LED lighting fixtures are cheaper to operate, last longer and are expected to require less maintenance. If the board considers additional light conversion, additional cost savings will be realized over time.

### *Installation*

Integrated LED fixtures are physically and electrically compatible and weigh substantially less allowing them to be more easily installed.

~ end ~