Lighting Assessment & Retrofit Project Training Manual V2

Originally Designed to Reduce Light Pollution for
Texas Parks and Wildlife Department

Now Expanded for Use at Most All Facilities

Training Developed by Cindy Luongo Cassidy

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CONTENTS

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Lighting Assessment & Retrofit Project Overview

Our objective is to create a pool of volunteers who can:

- Inventory the existing outdoor lighting around any structure or structures that are part of a facility. This process will work for everything from a single- family home to a large acreage facility such as a school or state park.
- Recommend changes to reduce light pollution
- Follow up and coordinate with the property owner(s).

So that:

- Light Pollution is reduced
- Night skies are protected
- Safety is increased
- Energy usage is reduced
- All living things may have the darkness needed to survive
- The resultant lighting may be an example of good lighting practices
- The updated facility may be part of an International Dark Sky Place.

Contacts for Current Volunteers (2020 and beyond)

In addition to your trainer, you may contact members of the IDA Texas Board of Managers and the IDA Director of Engagement via this email:

IDATexas@darksky.org

To learn more about the IDA Dark Sky Places program or to start an application, go to darksky.org, click on "Our Work" then "International Dark Sky Places. Near the bottom of that page is a link to follow when you are ready to begin.

Original Project Background

The Lighting Assessment and Retrofit Project (LARP) was part of a larger initiative where Texas Parks & Wildlife Department (TPWD) partnered with both McDonald Observatory and the Texas Section of the International Dark-Sky Association (IDA). McDonald Observatory developed a Texas State Park specific program to train their

interpreters to deliver night sky programs. They also taught those interpreters about best practices in night lighting.

The LARP trained volunteers from all over the state to do lighting assessments for the State Parks and to be there to follow up with the parks assisting them in the implementation of those best practices in night lighting. Cindy Luongo Cassidy, of the Texas Section of IDA, developed and delivered the LARP training.

Expectations of Volunteers

The project recruited volunteers for many Texas Park and Wildlife Department locations. This positioned the parks to become International Dark Sky Parks.

Volunteers were expected to:

- Communicate with the park leadership
- Do a site visit
- Inventory the existing outdoor lighting at TPWD facilities
- Review inventory and recommended changes to reduce light pollution
- Create a written assessment of the park's lighting situation
- Follow up and coordinate with the park superintendent
- Document and communicate
- Provide Progress and Evaluations

Outdoor Lighting Challenges

By Cindy Luongo Cassidy
Taken from the author's earlier published work "Effective Outdoor Lighting"

Effective outdoor lighting has many benefits. However, the way that many outdoor lights are designed and installed neither takes into account the nature of the human eye nor current scientific knowledge on outdoor lighting.

Poorly designed or installed outdoor lighting:

- Limits visibility by producing glare which reduces our safety and security
- Creates light trespass
- Wastes money in needless energy costs
- Obscures our view of the stars
- Jeopardizes the health and sustainability of the ecosystem
- Hurts the economy

One might wonder how it can be that bad. Poorly chosen outdoor lighting causes all of these problems but the cure is easy.

First, we will explore the challenges that outdoor lighting may cause then the solutions.

Glare, Safety, and Security

Glare and over lighting are at the core of the problems dealing with safety and security. Glare occurs when bright, direct light hits your eye. If you can see the source of the light or the light reflector, it's producing glare. A good light will shield the bulb so that you see a lit area below the light instead of a dazzling light source.
Discomfort glare causes constant adaptation of your eye to the varying light levels. That in turn causes discomfort and reduces your ability to see. Disability glare may literally blind you, because the human eye adjusts itself to the brightest object in sight, which then limits its ability to see other things. If there's a big difference in light intensity between the lit area and the surroundings you won't be able to see either very well.

Either type of glare severely diminishes our ability to see properly in the nighttime environment. Safety demands that the best visibility possible is provided during the times people will be moving around an area.

If you walk or drive away from a brightly lit area into a darker area or vice versa, it takes your eyes time to adjust. During that adjustment period visibility is hampered. Safety and visibility are improved with minimal lighting combined with reflective signs and road markings. A situation where one's visibility might be impaired could occur

as one exits an overly lit commercial area and enters a highway with just one's headlights for lighting. It takes a few minutes for your eyes to adjust to the darker conditions of the highway. Another example from a different perspective might occur in the transition period from exploring a cave to bright light. A transition area with dim lights just outside the cave would allow one's eyes to adjust before moving into a brighter area.

Glare negatively effects security. Lights can make us feel more secure. The task is to be more secure not to just feel more secure. Two factors are key in using lights to increase the feeling of security and in not actually reducing security. First, shield or position lights to minimize glare. Second, reduce the amount of light to minimize the contrast between the lit and unlit areas.

Keep in mind that criminals need light too. Lighting can facilitate criminal activity by drawing attention to a property and permitting easy access. Criminals can hide when obscured by glare as seen by neighbors or passersby.

People and items are hidden when a floodlight is aimed so that the light from the fixture strikes your eye. People and items are visible when that same fixture is aimed or shielded so that the light source is not visible.

Many people believe that lights prevent crime. The National Institute of Law Enforcement and Criminal Justice that is part of the Unites States Department of Justice completed a large study on the impact of street lighting and crime. It determined that there is no statistically significant evidence that street lighting impacts the level of crime. However, there is a strong indication that increased lighting decreases the fear of crime. Shielded lighting that does not produce glare and is not so bright that it produces dark shadows could promote safety and security. Unfortunately, many individuals, groups and lighting manufacturers have long proliferated the flawed belief that good security demands large unshielded flood lights; most people take it as truth.

Security issues are best addressed with measures other than lighting. More effective and less expensive security measures include using adequate locks and having an effective alarm system. To use lights to improve security, the most effective means is to provide a sudden change to the surrounding environment. Sensor governed security lighting that turns on when someone approaches an area may attract attention and drive away someone with criminal intent. To prevent a reduction in visibility, even these sensor-governed lights should be shielded and installed so that they neither produce glare nor a severe difference between the illuminated area and it's adjacent area.

In summary, unshielded or improperly aimed security lighting can actually reduce security by producing glare and uneven illumination that conceals persons with criminal intent. Any glare created by these so-called security lights will limit the ability for anyone to see the site. A light used for safety or security must keep the bulb or

refractive lens shielded and be of the lowest amount of light possible to do the job. Passersby who see people in over lighted areas usually presume they belong there and the over lighting creates dark shadows at the edges of the light. Keep in mind that if there is no one present to see the criminal all the light will do is attract the criminal and provide light for the criminal activity.

Light Trespass

Light trespass occurs when the light source from one property may be seen from any other property. The illumination may be seen but the light source should be hidden from view. Light trespass infringes on the property rights of the neighbor who has unwanted light intruding onto his or her property. It can lower property values, reduce the quality of the nighttime environment and be a general irritant. Wouldn't you want to have the full enjoyment of your property without being forced to live with unwanted light directed onto it?

To eliminate light trespass, shield and aim all lights on your own property so the illumination stays within your own property lines. If you can see the source of the light, that is the bulb or refractive lens, from a neighboring property, then that light is committing light trespass.

Wastes Money and Energy

In the United States alone, it is estimated that billions of dollars in energy costs are wasted each year in outdoor lighting that shines up into the sky. This excess use of energy also translates into added pollution created by operating the lights and producing the electricity. Water is sometimes wasted in the process of producing the electricity for excess outdoor lighting.

Illustration # 1 depicts the progression in illumination projected or reflected above the horizontal. The picture progression begins in the late 1950s, to the mid 1970s, 1997, and finally an estimate of what it will be like in 2025 unless we change our habits.

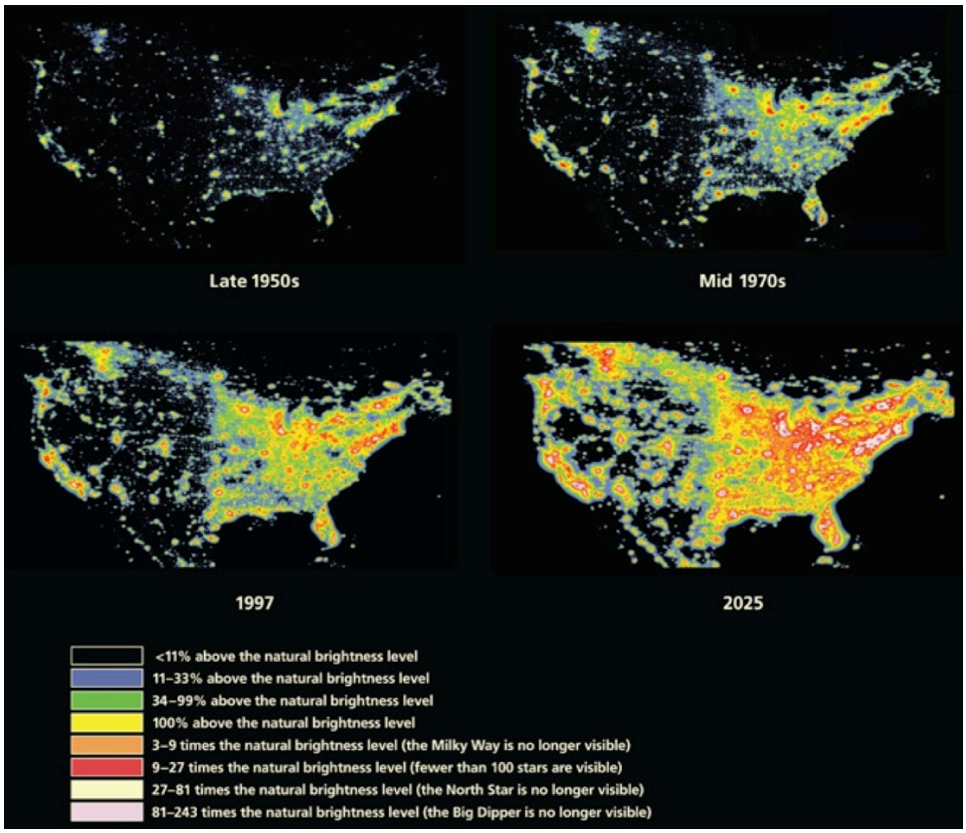

Illustration # 1

Source: Image and data processing by the National Oceanic and Atmospheric Administration (NOAA) National Geophysical Data Center. Data collected by the U. S. Air Force Weather Agency under the Defense Meteorological Satellite Program 1992-2003

Obscures the View of the Stars

Light emitted near and above the horizontal scatters into the atmosphere creating what is known as sky glow. Some light aimed downward is so intense that it reflects back up and also adds to sky glow. This light travels miles in our atmosphere effecting areas far from the origin of the light.

Big Bend National Park in southwest Texas is known for its dark skies. They became even darker after a lighting upgrade in 2010.

Illustration # 2: Note the illumination of the mountains within Chisos Basin before the exterior lighting upgrade.

Illustration # 3: After the exterior lighting upgrade, the illumination is directed where visitors need it and the mountains within the Chisos Basin are not illuminated.

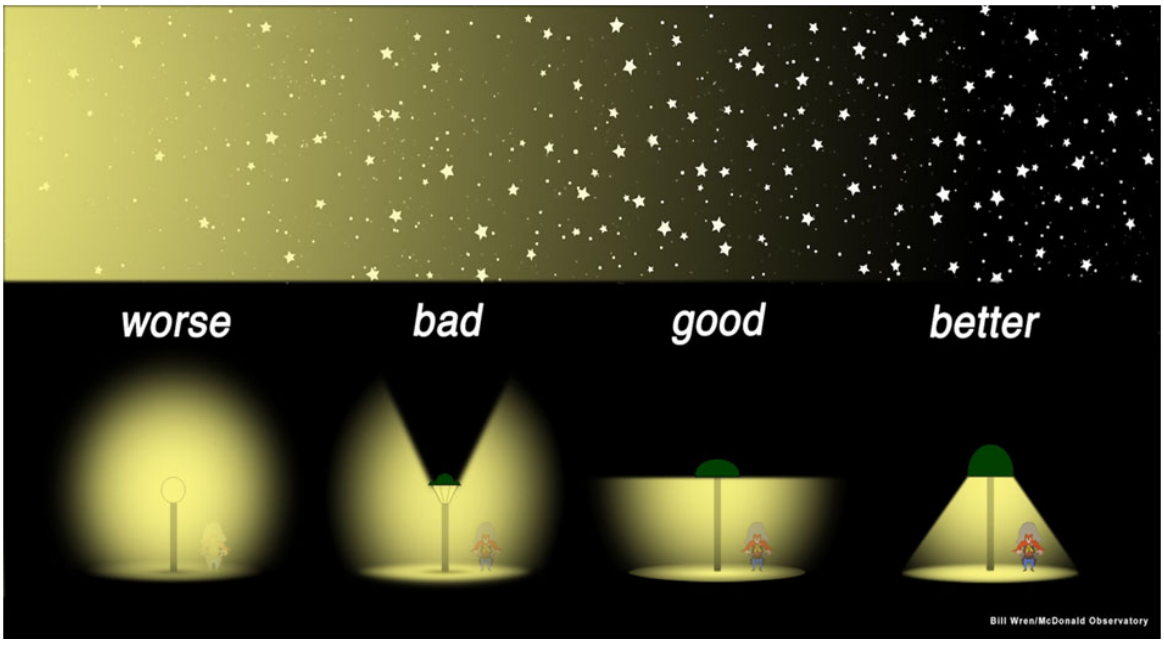

Illustration # 4 Graphic Credit: Bill Wren, McDonald Observatory

Each of our choices of light fixtures in illustration # 4 and the amount of light those fixtures produce determine how much sky glow will be created each night. Look at the number of stars you can see above each fixture type. Think about that. This is the easiest pollution to eliminate. We create it anew every night.

With our current choices in lighting, about 80% of the U.S. population has never seen the Milky Way. We can change that.

Sustainability and Health Issues

In "Degraded Darkness", Ben Harder, the general manager of health and science for U.S. News & World Report, says: "It's tempting to assume that artificial light distresses only a few exquisitely sensitive species. But mounting evidence suggests that disappearing darkness undermines our best conservation efforts."

More and more ecological and health issues are being identified that are caused by artificial light at night. Almost every living thing on this earth has functions dependent on living in an environment with a pattern of light and dark. Dusk causes the beginning of a chemical process that each living things health and existence is dependent upon. Medical studies indicate that exposure to artificial light at night negatively affects our health by tampering with our endocrine system. That process that begins at dusk would normally create a spike in the amount of hormone melatonin in our bodies between midnight and 4 AM. Even very small amounts of light can suppress the production of melatonin enough to affect our sleep patterns and the rebuilding of our immune systems. People who work during the hours from midnight to 4 AM have a much higher incidence of breast and colorectal cancers. Melatonin has been proved to stop the growth of a common type of breast cancer cell during the hours of natural darkness when it peaks. Even nocturnal animals have a normal melatonin spike in the early morning hours that artificial light will suppress. Although the way they produce melatonin differs, all plants and animals are dependent on a normal day-night cycle that should not be disrupted by artificial light at night.

Research shows additional significant negative effects of artificial light during the hours of natural darkness on many animals. Nocturnal frogs suddenly exposed to artificial light stop all activity and sit motionless even hours after the light has been turned off. Birds are drawn to artificially lighted towers and skyscrapers where millions of them die each year from collisions or exhaustion. Their vision and internal magnetic compasses seem to become dysfunctional in the artificial light. Artificial lights lead baby sea turtles off course. Many die before they can get to the ocean. Salamanders and dung beetles lose their ability to navigate. Artificial light seems to interfere with fireflies, which generate light to find mates. The list goes on and on. The consequences of artificial light at night include general disruptions in daily activity cycles, and reductions in dispersal, foraging, and reproductive opportunities.

Plants have a wide range of photoreceptors that perceive and respond to light signals. Almost all living organisms have a dependence on a circadian rhythm. Daily cycles of light and dark and the number of hours of each trigger key occurrences in their lives. We know what habitat destruction by bulldozer looks like. We don't begin to know all the alterations and disruptions that are caused by our modern habit of profusely using artificial light at night.

Economic Issues

In many areas, all of the above challenges are intertwined with the local economy. Businesses may count on visitors who come to the area for activities and events dependent on the natural environment and the attractiveness of the area. Both of those can be protected with better outdoor lighting. Just the reductions in energy expenses alone make using better outdoor lighting a good business decision. Reducing glare makes a business look more inviting and makes it feel safe there. Helping to keep the human and wildlife population healthy is good for individuals and the community.

Putting artificial light where you need it, when a person is there to use it is a win-win for a community and its economic base.

LED Specific Issues

(This section adapted from and used by permission of the International Dark-Sky Association)

Light-emitting diodes (LEDs) are transforming the way we illuminate our cities and towns, offering a once-in-a-lifetime chance to radically change energy use and alter the quality of nighttime outdoor spaces. With this opportunity comes an obligation to manage these changes responsibly and sustainably. The stakes are high and the potential rewards great, but outcomes depend on informed decisions based on evidence and best practices.

The Benefits of LEDs

The improved energy efficiency of LEDs allows for reduced demand on the grid with a corresponding reduction in carbon emissions.

The perceived brightness of LEDs by humans allows for reduced illuminance providing an additional reduction in electric usage without compromising safety. That is, the human eye sees LEDs in a way that allows us to use fewer lumens.

Another LED benefit is better control over the color content of light. Manufacturers now produce LEDs with "warm" color qualities at high energy efficiency. These same LED options also provide accurate color rendition without emitting excessive amounts of potentially harmful blue light.

Relative to other outdoor lamps, LEDs are thought to be extremely long-lived. When switched on, LEDs are instantly at full brightness, unlike HPS lamps that have a significant time delay to begin emitting light. LEDs also have very low minimum electricity thresholds to produce light, meaning they can be dimmed to much lower illumination levels when less light is needed, resulting in further energy savings.

Blue Light

New technology often comes with unanticipated challenges. White LED lighting has significant levels of potentially hazardous blue light.

A June 2016 American Medical Association (AMA) report, "Human and Environmental Effects of Light Emitting Diode Community Lighting," concluded that "white LED street lighting patterns contribute to the risk of chronic disease in the populations of cities in which they have been installed." The AMA recommends "minimizing and controlling blue-rich environmental lighting by using the lowest emission of blue light possible" in order to reduce potential negative effects on human health.

Concerns about blue light reach far beyond our health. Outdoor lighting with strong blue content will worsen skyglow, already affecting 80% of the globe, because it has a significantly larger geographic reach than lighting with less blue. According to the 2016 "World Atlas of Artificial Night Sky Brightness" street lighting and outdoor lighting retrofits using 4000K lamps, the level commonly used by municipalities, could **more than double** outdoor light pollution.

Blue-rich white light sources are also known to increase glare and compromise human vision, especially in the aging eye. These lights create potential road safety problems for motorists and pedestrians alike in. Additionally, blue light at night has been shown to adversely affect wildlife behavior and reproduction. This is particularly true in migration corridors, which are often stopover points for migratory species.

Visibility

Outdoor lighting is intended to enhance safety and security at night, but too much lighting can actually have the opposite effect. Visibility should always be the goal.

Glare from bright, unshielded lights actually decreases safety because it impairs visibility. The effects of glare are cumulative, meaning that every light source in view impacts vision. Glare also makes it more difficult for the human eye to adjust to low-light conditions nearby.

Blue light, like that in many LEDs lights, is more likely than conventional light sources to increase glare and impair vision. Blue light causes a condition called veiling luminance, i.e., that particular type of light illuminates the inside of the eye causing glare and impaired vision. To have better visibility, we need to focus on using LEDs that have as little blue light in them as possible.

The promises of energy and maintenance savings by retrofitting outdoor lighting with LEDs are attractive. Selecting LEDs with low blue light content provides the additional advantages of improved visibility and reduction in negative health issues. Every effort should be made to diminish or eliminate blue light exposure after dark.

Amber lights are a good choice. Warm lights rated at or below 2700 Kelvin are a good choice.

Lighting Solutions

Light Pollution Solutions

Can we solve most of these problems and still have the light we desire outdoors at night? Yes, if we follow the recommendations of the International Dark-Sky Association we can reduce, if not eliminate, most of the problems associated with artificial lights at night. To do that, follow the protocols below for all outdoor lighting fixtures.

Determine the purpose of each light fixture.

Shield and direct lights only where needed.

Reduce the amount of light to only what is needed.

Select warm colored lights.

Dim or turn lights off using adaptive controls such as switches, timers, and motion control.

Determine the Purpose of Each Light Fixture

Every outdoor light fixture should have a purpose. Consider why it is there as you document it for the inventory and make your assessment of it. What is it illuminating? Who needs that space to be lit? Would something else, like reflective markings or the use of reflective paint, fit the purpose?

You will need to talk with the property owner or manager to verify the light's purpose if it's not clear or is questionable. Remove lights that serve no purpose.

Shield and Direct lights Only Where Needed

The Better Lights for Better Nights diagram (illustration # 5) is a great starting point to learn about fixtures that can shield and control light direction versus fixtures that allow light to go upwards or on adjoining properties or anywhere that the light is not needed.

Acceptable light fixtures shield the light source/bulb from normal viewing points and do not allow any light above a horizontal line drawn through the lowest point of the illuminating elements. The best fixtures tuck the bulb up in the fixture and light only the area that needs to be lit, minimizing glare and light trespass.

Better Lights for Better Nights

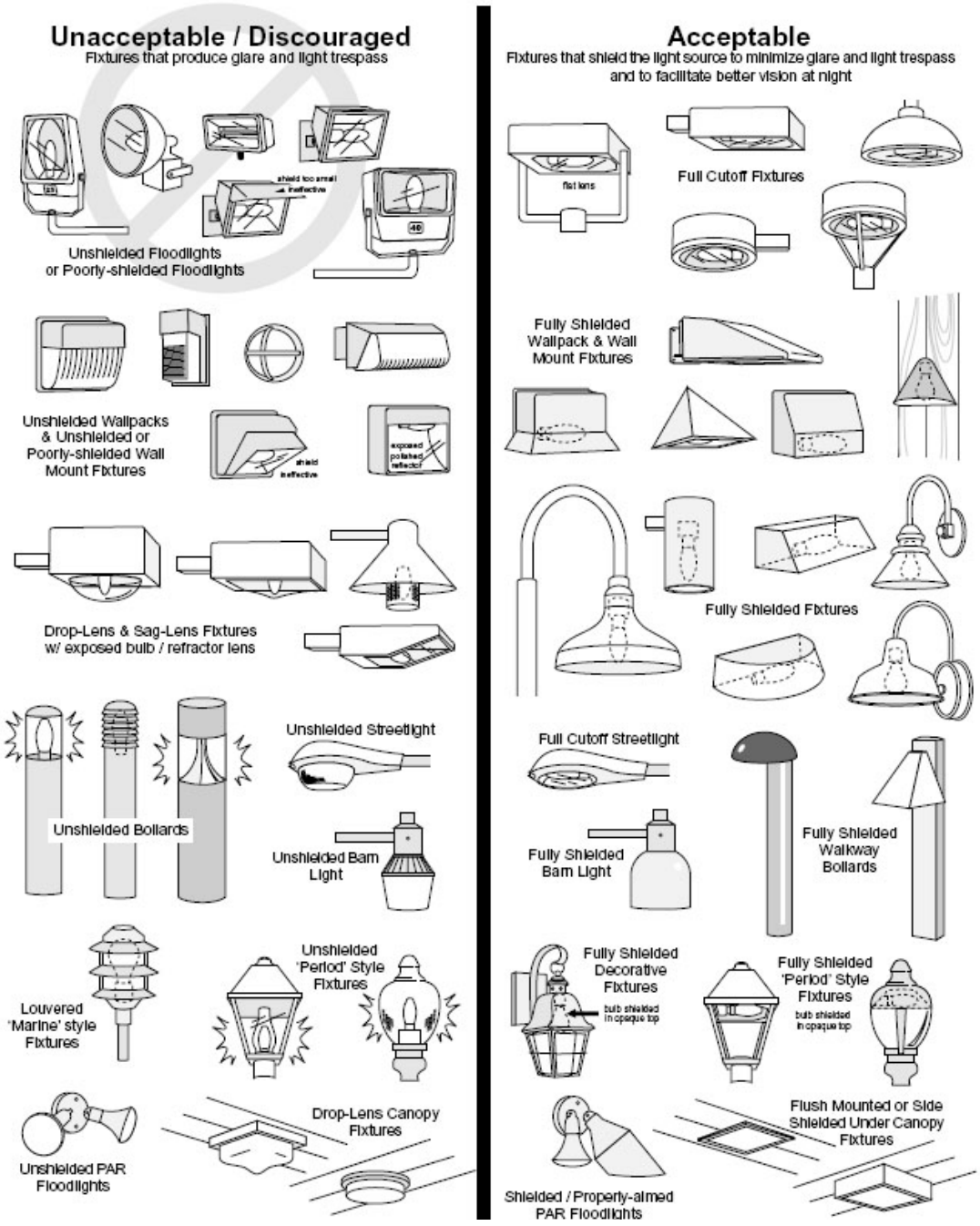

Illustration # 5 Diagram by Bob Crelin

Aiming lights "down" does not mean to just angle the light towards the ground. The fixture must be positioned so it does not allow any light to shine above a horizontal line drawn through its lowest part. In most applications, this requires the light be installed above the area to be illuminated.

The light from a properly installed fixture should project below and out to the sides of the fixture, like a cone with the peaked top of the light at the fixture as in illustration # 6. An acceptable fixture that is mounted at an upward angle would normally change it into an "unacceptable" fixture.

Low output landscape lighting directed upward and shielded so that no one sees the source of the light from any other property is acceptable if the lights are turned off when no one is actively using them. Remember, both plants and animals need natural darkness to be healthy.

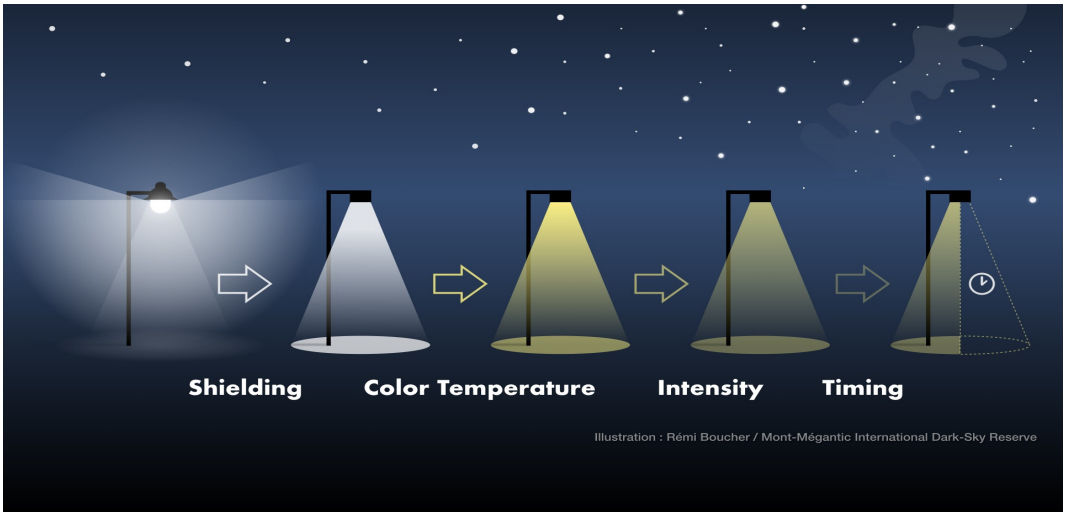

Illustration # 6 Graphic by Remi Boucher / Mont-Megantic International Dark-Sky Reserve

There are situations where an 'acceptable fixture', even one labeled "Dark Sky Friendly", full cutoff, or fully shielded may need additional shielding to actually hide the source of the light from a normal viewing point. A fixture mounted up on a tall pole or on a hill would probably require additional shielding to be installed on all sides of the light source.

The light fixture in illustration # 7 is called a full cutoff fixture where no light is emitted above a horizontal line drawn through the lowest light-emitting part of the fixture.

The light fixture in illustration # 8 is a standard "shoe box" style fixture with additional shielding to stop light from being emitted near the horizontal.

Illustration # 7

Illustration # 8

The light source in illustration # 8 is not seen from any other property because of the use of the shielding and the positioning of the light pole. The pole is installed at least 4 times the height of the pole away from the property line.

Light trespass is normally stopped when every outdoor light is shielded so that the source of the light cannot be seen from any neighboring property. The fixture in illustration # 9 is a well shielded version of the fixture in illustration # 10.

Illustration # 9

Illustration # 10

If the lights look star-like from another property, the owner is paying for light to go onto that other property and the light is trespassing.

Reduce the Amount of Light to Only What is Needed

What you can't tell from the "Better Lights for Better Nights" handout at the beginning of this section is the amount of light that each fixture produces. The amount of light produced is measured in lumens.

Shielding the light concentrates it where it's needed and usually allows you to reduce the lumens to get the same or additional light where you actually need it. In fact, a wattage reduction is usually required to keep that concentrated light from producing reflective glare and an overly lit situation.

Always consider the way the human eye works when selecting the amount of light for a particular outdoor application. Use significantly less light than is the modern habit to enhance night vision and reduce glare. Remember that a very bright light will make the unlit areas seem impossibly dark.

Too many lumens, i.e., too bright a light, will cause light to bounce off of the surfaces it shines upon and reflect up into the sky, into the eyes of people trying to see nearby, into the habitat of nearby wildlife, etc. The light may attract birds and insects that then will not be able to proceed with their natural habits. So, the shape of the fixture isn't everything. Lower the lumens (and wattage) when you switch from an unshielded fixture to a shielded fixture.

Did we just say lower the wattage? You bet. These fixtures not only cut the glare, allowing people to see better, but they reduce the costs of operating the lights. That's a win-win!

Select Warm Colored Lights

Living things need light in the blue wavelength, which looks to humans as white light, during the day, especially through the morning hours, but light in the blue wavelength should be avoided after dusk. With current technology, the best way to tell a light is blue-rich is to look at the color temperature of the light. Warm colored lights usually produce less light in the blue wavelength.

The color temperature of a light may be listed on the package just as 'warm' or 'cool', or the manufacturer may indicate the Kelvin(K) rating for a light. Commercial lights may list the color as the "Correlated Color Temperature" or CCT. Old-fashioned incandescent bulbs are rated around 2700K, which is described as a warm color. Many of the bright white Light Emitting Diodes (LEDs) are rated at 4000K and above. This bright white light creates more glare and suppresses the production of melatonin in living organisms which can, over the long term, damage the health of that organism.

Know when a particular light will be used and take into consideration what the color of the light does to living things. Remember, blue light should be avoided after dusk. You may find it interesting to research the lighting studies led by Dr. George Brainard that focus on the type of lighting used inside the International Space Station and its effects on the astronauts.

Turn Lights Off Using Adaptive Controls such as Switches, Timers, and Motion Control

Lighting an unoccupied area will not keep criminals away and may attract them. It is usually a waste of energy. A big plus for turning off the lights when no one is there to use them is that it allows wildlife and plants to exist in natural darkness. As you know by now, wildlife and plants need natural darkness. Timers and motion detectors can help you achieve the goal of having lights turned off when no one is there to use the light.

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Lighting Fixtures: Those Pesky Details

Preparing to Take Inventory

It is useful to identify details about the fixtures and light sources of what you see on your site in order to create a useful inventory and begin making an assessment of each outdoor light. This section will provide a description of the most prevalent types of light fixtures and light sources you encounter.

Fixture Types and Possible Retrofits

Barn Light: aka Yard Light, Security Light, NEMA head

Illustration #11 Illustration # 12

Illustration # 11 represents your typical barn light. In the recent past, the recommendation was to replace the refractive lens with a metal shield as in illustration # 12. For the last 6 to 8 years it has been almost impossible to locate metal shields for this type of fixture.

The recommendation is to replace the entire fixture with a more efficient shielded fixture like illustration # 13.

Select a warm rated bulb (2700K or below; Amber for parks) and make sure the bulb does not extend below the bottom edge of the fixture.

Illustration # 13

Cobra head: Drop lens or Flat lens

Illustration # 14

The drop lens cobra head (illustration # 14, top) should be replaced with a shielded fixture. The flat lens cobra head (illustration # 14, bottom) was formerly one of our best options if it was repositioned so that the lens is exactly level.

At issue with this "full cutoff" flat lens fixture is the newer knowledge that more skyglow is created from light emitted at or near the horizontal than directly shining upward.

The fixture options shown in illustration # 15 create less light trespass and much less glare and are the up-to-date preferred replacements.

The shielding needs to be a dark color rather than the white option in the photo. The external 360-degree visors are a good option and are offered by several manufacturers. As you know by now, glare kills our vision.

That 360-degree shield may be needed due to proximity to other properties or mounting height.

Illustration # 15

Shoe box style full cutoff area or parking lot fixture

Illustration # 16

This is a typical modern parking lot fixture. Illustration # 16 shows a full cut off fixture, which generally has little glare when the bulb is recessed, and a reflector is used. Glare can be minimized with an additional shield, if needed.

However, if the light source is an LED, the fixture will most likely need 360-degree shielding due to the way LEDs work with the human eye.

Wall Pack

Typical wall packs like both of the ones in illustrations # 16 & # 17 need to be replaced or shielded.

Illustration # 16

Illustration # 17

Illustration # 18 is a sample full cutoff wall pack that is acceptable. Wall packs could, optionally, have a "Shade" installed over them as in illustration # 19. The Shade has a special top with openings for heat to escape but not allow light to escape. The fixture in illustration # 20, with a recessed light source ,is the best selection.

Illustration # 18

Illustration # 19

Illustration # 20

Spot or flood lights

Spot or flood lights may be shielded with a clip-on or built-in shroud. The bulb itself must be pointed downward as in illustration # 21. Spots or floods may also be replaced with a fixture such as the one in illustration # 22 or other similar fully shielded fixture.

Illustration # 21

Illustration # 22

Custom shielding can be used on many light fixtures that would normally produce glare to change them from unacceptable to acceptable. Be creative!

How to Estimate the Lamp Type, Wattage, and Lumens

If you are going to do a cost analysis of the retrofit or if this property will be part of an application to be an International Dark Sky Place, you will need to estimate the wattage used by each light and the lumens produced. The facility may connect you with their maintenance staff who may know the details for many of the light fixtures, but you may have to estimate.

Some commercial lights will be labeled with their type and wattage like the ones below. Some you will need to become familiar with the bulb types.

- The light in illustration # 23 is a 45-watt LED (Light Emitting Diode). It has a great label with big letters but also notice the small diodes that make up each light source area. Those diodes may look a little different in another manufacturer's light fixture, but they will be similar to these if it is an LED.
- The light in illustration # 24 is a 100 W HPS. The "HPS", for High Pressure Sodium, is printed small but if you take a photo and zoom in you can see the label. Look at the shape of the bulb, now you're starting to learn what a Hk,,,,,igh Pressure Sodium (HPS) bulb looks like.

Illustration # 23

Illustration # 24


Illustration # 25

Keep in mind that a High Pressure Sodium (HPS) bulb looks a lot like the Metal Halide bulb in illustration # 25. The primary visual difference between them is that metal halide produces a white light and the light emitted from an HPS bulb is amber orange. HPS is about twice as electrically efficient as metal halide and has much less light in the blue wavelength.

If you are not familiar with residential-sized Compact Fluorescent Light (CFL), incandescent, and LED bulbs, it may be time for a field trip to your local hardware store. If you go, notice relative size and shape of various wattages and their lumen output.

Illustration # 26

For an example of a bulb that at first glance may look like the incandescent bulbs we are all familiar with, look closely at this CFL in illustration # 26 to see the tell-tale spiral inside the bulb's lens. This particular bulb is a 23 W CFL that produces about 700 lumens.

Notice, also, the flat bottom. This type of bulb if pointed straight down and, usually in a smaller wattage (i.e. producing fewer lumens), may be used in some small fixtures to make the fixture produce minimal light pollution and match a location's Lighting Management Plan (LMP).

Illustration # 27

The next bulb, in illustration # 27, is a LED. Note the formed looking surface of the light source. The particular bulb is a 16 W bulb that produces about 900 lumens.

Estimates of Lumens Based on Wattage

This table is built from multiple manufacturers' efficacy figures and therefore provides a range of lumen outputs for the selected types of light source included.

The table was created for the sole purpose of providing an easy method of estimating the lumens produced by existing lighting products when you do not have actual specification for the bulbs in each fixture.

Lumens were determined using an average luminous efficacy. Energy saving lamps may generate more lumens per watt.

Light Output in Lumens	Incandescent Watts	CFL Watts	LED Watts (Lumen efficacy varies greatly with color)	High Efficiency LEDs
200 to 375	25	6 to 8	2 to 3	2 or less
450 to 700	40	9 to 13	4 to 5	3 to 4
800 to 900	60	13 to 15	6 to 8	4 to 5
1100 to 1200	75	18 to 25	9 to 13	6 to 7
1500 to 1800	100	23 to 30	16 to 20	7 to 9
2000 to 2600	150	30 to 35	25 to 28	10 to 13
2800 to 3000	200	45 to 50	35 to 40	14 to 15
5000 to 10,000		100	65 to 133	25 to 50

How to Estimate the Color Temperature

You will need to estimate the color temperature for each light. The facility may connect you with their maintenance staff who will know the details for many of the light fixtures, but you may have to estimate.

Most incandescent bulbs are rated at 2700 Kelvin. High Pressure Sodium (HPS) bulbs are rated at 2200 Kelvin. Look at these and other sample bulbs for which you know the rating assigned by the manufacturer.

For light sources that you have to estimate the Kelvin rating, have at least two of you compare what color you see when the light is illuminated at night to this chart. In addition, compare what you see to bulbs for which you know the Kelvin rating. Unless you are determining compliance with an outdoor lighting ordinance or Light Management Plan (LMP), this comparison will provide a sufficient determination of the Kelvin rating for the light.

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Inventory, Assessment & Follow Up

Initial Communication

Clear communication and the relationship you establish with the facility being assessed is essential to the success of the project. Hopefully, you have been invited to do the assessment or you are working with a group associated with the property. In your initial communication you should:

- Outline the assessment process
- Introduce the team that will work on the assessment
- Request a name and contact information for follow up if different from your initial contact person
- Let them know when you plan to visit

Before You Go

It's a good idea to get to know the property somewhat before you go there. Explore the area via Google Maps or a similar program. To be prepared to take inventory you should have:

- Blank data collection forms available electronically, along with other files for this project, at https://tinyurl.com/LARP-CLC
- A flashlight or head lamp
- Pencil or pen
- Clip board or another surface to write on
- An aerial view or map of the property
- Camera - preferably one capable of manual exposure. Familiarize yourself with your camera's settings at home so that you can play with them as you shoot photographs after dark.
- Determine whether you want to take the photos in low resolution or edit them afterwards to keep the final size of your photo small. Then, set your camera accordingly. Remember you'll need to insert the photos in a document and still have the document small enough to email. (I personally like to take my photos in high resolution then edit them in Photoshop Elements afterwards to reduce the image size below 2 inches on the longest side. This keeps a sharp image yet gets the photo to a manageable size for insertion in a document.)
- Consider taking a tripod for your photographs taken after dark.

The Property Visit & Inventory

Initial Property Visit

- Meet with your property contact if possible.
- Pick up any access documentation required to show that you are allowed on the property.
- Make sure you have a map or aerial view printout of the property.

Daylight Inventory of Lighting Fixtures

- Start early enough to do a complete inventory in daylight.
- Bring that map or aerial view.
- Document all lighting fixtures in daylight on the data collection forms. Keep a detailed record of the number of each type of fixture at a location.
- Photo document each type of light fixture.
    - No need to have a photo of every fixture. One of each type is sufficient.
    - Make sure your camera is set to the proper resolution. (See the notes under "Before you go".)
    - Keep a record matching photographs with location descriptions.
- Note the apparent purpose of the light, if determined.
- Be sure to note on your inventory any lights that are on during daylight hours.

Inventory of Lighting Fixtures After Dark

- Start when it gets dark enough for lights to come on and do another complete inventory.
- Photo document each type of light fixture.
    - Try to have the photo depict what you see with your eye. Many automatic cameras will try to "fix" the image.
    - If you have a tripod it can help you get a clearer image. If you don't have a tripod look for fence posts, buildings or some other stable object for you to lean against as you take the photo. Don't lean against a running car, as the vibration will extend to your hand.
    - If your camera has a "night scenes" selection, try it.
    - Experiment with your manual settings if your camera offers them.
    - Do the best you can with the camera you have. If it doesn't turn out the way your eye saw it then describe what you saw in words.
    - Use photos to document evidence of light wasted into trees, onto a roof, above the light, or elsewhere that is not useful.
- Keep a record matching photographs with location descriptions. You may find light fixtures that were missed during the daylight inventory.
- All outdoor lighting should be inventoried. This includes lights that are not currently operational; lights that don't appear to be adding to sky glow; lights

located indoors that are overly bright (if you can see the source of the light from outside); lights with colored shielding; and lights that appear to be temporary.

- Things to ask yourself about any lights visible from outdoors
    - What's the purpose of that specific light?
    - Does it comply with the Lighting Management Plan (LMP) for the property? (Creating a LMP is another project.)
    - Is it really needed? Is it needed all night or could it be on a timer or motion detector? Your property contact can help answer these first two questions.
    - Could reflective paint or reflectors serve the purpose? Maybe not, but always think outside of the box.
    - Where does the illumination from that light fixture spread? Maybe the aim needs to be adjusted or a fixture producing less light installed.
    - Can you see the luminous elements (lamp or light bulb, any diffusing elements, and surfaces intended to reflect or refract light)? Can it be shielded? If not then, consider replacing the fixture.

- Note problems and initial retrofit recommendations on the data collection form. Recommendations may include such suggestions as:
    - Repositioning a fixture
    - Shielding the fixture
    - Replacing the fixture
    - Turning the light off during certain hours
    - Using lower wattage or a different type of bulbs
    - Changing flood lights to spotlights
    - Adding manual control switches to replace dusk-to-dawn photocells
    - Implementing timers
    - Adding motion detectors

Review Inventory & Recommended Changes

Before you prepare you assessment:

- Review your data collection sheets and verify which photographs match with each light fixture. You should have a photo record of each type of light fixture in daylight and again after dark. Remember to reduce the resolution before it is inserted into your assessment document.
- Create a summary table or spreadsheet with a count of each type of light in each location and whether or not you recommend that they be left as it, retrofitted, adjusted, or replaced.
- Create detailed recommendations and options from your initial recommendation notes for each fixture that should be improved.
- Use your trainer as a resource when you need help with recommendations.
- Keep your complete inventory records for later use during follow up and retrofitting.

The Assessment Letter

Communication is key to the success of this project. The letter assessment is an overview of your observations and recommendations. It is based on the data you collected during the inventory process.

There is a sample assessment letter in the appendix of this training manual. Your assessment letter should include:

- Overview of the property and the overall rationale behind the assessment.
- An overview of the lighting on the property and high-level recommendations. You may include specific reference to good lighting in place, lack of shielding, excessive glare, and a general description of the current state of the lighting.
- Always thank the facility contact for the opportunity to be involved. We are there to work with them and to be of service.
- Request a meeting to follow up in regard to the retrofits (shielding, replacements, or repositioning), if any are required.
- For your first few assessments, ask your trainer to review your assessment prior to sending it.

The Inventory

The inventory is a compilation of the details about each outdoor light fixture on the property. This is a key deliverable for the project.

There is a sample inventory in this training manual after the Data Collection Sheets. It includes:

- The location where the fixture is located and an assigned number for that location. Some properties may only have one area to inventory in which case you will not need to note the location.
- A photo of the fixture. You only need one photo when there are multiple instances of the same type of light fixture on a property.
- The function and fixture type. What function does this light provide? What type of fixture is it – a wall pack, a shoe-box area light, a ceiling fixture, etc?
- The number of this type of fixture at this location.
- The total wattage used by this fixture. If the fixture has two or more bulbs, provide the total wattage for the fixture.
- The bulb type (incandescent, CFL, LED, etc.)
- The color temperature. The maintenance staff may be able to help you with the Kelvin rating of the light. If not, estimate it based on a visual inspection.
- Observations about the current shielding
- Observations about any controls used to power the fixture
- A notation if the light produces less than 500 lumens

- Retrofit Actions – your notes about whether this fixture needs to be shielded, replaced, removed from service, etc.
- A judgement about whether this fixture complies with the Lighting Management Plan (LMP) or, in the absence of an LMP, if it is properly shielded, produces a reasonable number of lumens, and is an appropriate color temperature.

Follow Up and Coordinate

Your assessment letter will ask for a follow up meeting to discuss the recommended changes. Take the initiative to schedule that meeting. A face-to-face meeting is preferred, perhaps one in which you go look at some of the lighting in question. **This is a time to listen and be of service to the property on their terms.**

In the follow up meeting you'll want to make sure they understand the recommendations and the reasoning. You may want to offer your help in reviewing any selected replacement fixtures before they're installed

Document and Communicate

Each volunteer team should keep copies of all communications, assessments, recommendations, and status of retrofits.

Electronic copies of those documents, as well as any status updates for significant events, should be shared with everyone on your team, the person who requested the assessment and your contact at the property.

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Data Collection Sheet

Retrofit/Replacement Considerations: Is the light fixture & placement good or does it need a shield, motion detector, timer, reduction in lumens, replacement, or to be removed?

Location/Purpose ____
Photo order ______Type of fixture_______________# at this location _______
Est Wattage __________ Est Color Temp _________ Need(s) attention? Y/N
Retrofit / Replacement notes ____
____
____

Location/Purpose ____
Photo order ______Type of fixture_______________# at this location _______
Est Wattage __________ Est Color Temp _________ Need(s) attention? Y/N
Retrofit / Replacement notes ____
____
____

Location/Purpose ____
Photo order ______Type of fixture_______________# at this location _______
Est Wattage __________ Est Color Temp _________ Need(s) attention? Y/N
Retrofit / Replacement notes ____
____
____

Location/Purpose ____
Photo order ______Type of fixture_______________# at this location _______
Est Wattage __________ Est Color Temp _________ Need(s) attention? Y/N
Retrofit / Replacement notes ____
____
____

Location/Purpose ____
Photo order ______Type of fixture_______________# at this location _______
Est Wattage __________ Est Color Temp _________ Need(s) attention? Y/N
Retrofit / Replacement notes ____
____
____

Available electronically at https://tinyurl.com/LARP-CLC

Sample Inventory (available in electronic format)

Sample Lighting Inventory - CLC Training Grid

Light Ref # & Location	Photo	Function / Fixture Type	Quantity	Watts	Lamp Type	Color Temp	Lumens	Fixture Shielding	Controls	Special Purpose / < 500 lumens	Retrofit Action	Complies with LMP?
Homestead 1		Historical fixture by walkway / Pole light	1	N/A	N/A	N/A	N/A	Unshielded	No Power, The electrical cables were removed years ago.	N	None needed	Yes
Homestead 2		Porch lighting / Wall Sconce	4	75	Incan	2700K	450	Unshielded	Used nightly, turned off by 9:00 pm	Y	None	Yes
Homestead 3		Lighting around perimeter of the home / RAB FFLED	12	230	LED	5100K	2,429	Unshielded	Dusk to Dawn	N	Replace with fully shielded fixtures with warm light source.	No
Homestead 4		Illumination of flags / Spot	2	84	LED	5000K	2,748	Unshielded - mostly straight up to flag.	Dusk to Dawn	N	We will replace with 3000 K, reduced lumens, solar powered down lighting to just illuminate the flags.	No
Homestead 5		Porch lighting / Recessed ceiling fixtures	4	60	Incan	2700K	950	Shielded (flush with ceiling)	Manual switch used a couple of hours per day	N		Yes
Homestead 6		Safety lighting for the crew / spot light	2	100	Incan	2700K	1100	Unshielded spot	Manual switch	N	Replacing fixtures & using warm CFLs	No
Homestead 7		Safety under driveway canopy / ceiling mount	5	13	CFL	2700K	950	Shielded fully under canopy	Manual switch used for the crew each morning.	N		Yes
Pool House 1		Illuminate outdoor porch area / Moroccan Lantern	2	5	CFL	2700K	280	Bulb is Shielded (encased fully in the fixture) but the fixture glows gently.	Manual switch	Y	Leave historical fixtures in place. Continue to document specs for low output warm bulb.	Yes

Cost Analysis

Money, money, money! The cost repercussions can make or break a replacement project.

The inventory just completed is essential to document what is onsite and what needs to be replaced. Taking it one step further to analyze costs associated with those replacements, and any savings that may be realized, can be the impetus that moves the project to completion.

First Steps for Cost Analysis Spreadsheet

It's time to create a Cost Analysis spreadsheet. The spreadsheet created here does not include maintenance costs associated with the existing fixtures nor installation and maintenance costs associated with the new fixtures. Your situation may call for these additional costs to be evaluated.

Use the Sample Cost Analysis V2 spreadsheet offered electronically at https://tinyurl.com/LARP-CLC and printed at the end of this section. It is suggested that you leave the headings, first row, and totals line at the bottom as an example to be able to copy and paste formulas from that first row. Always check the formulas to verify they properly updated the row number as well as checking to make sure it matches the description of the math to be done as described in the detailed explanations of the calculations below. You will delete that example row before you finalize your spreadsheet. The simple formulas will be explained fully here.

The spreadsheets were created to allow you to copy the first 5 columns (Light Reference # & Location, Photo, Function / Fixture Type, Quantity, and Watts) from the inventory spreadsheet for each fixture that is marked for replacement. Copy just those first 5 columns, one row at a time, and paste those 5 columns into the first 5 columns of a single row of the Cost Analysis spreadsheet you are creating. Do that for each fixture to be replaced.

Current Fixture Hours per Day

Coordinate with those who operate the property to estimate as closely as possible the number of hours per day that each type of light is illuminated. You may be able to do this based on the information you gathered compiling the inventory. Enter it.

Current Fixture Calculations

We can now calculate Watts used per day. You may copy the formula for this column from the sample row or enter the results from a manual calculation, as illustrated below, into the Watts per Day column.

Quantity of Fixtures X Watts X Hours per Day = **Watts per Day**

Some months have more than 30 days and some less, but this is a reasonable approximation for Watts per Month. This formula may also be copied and pasted from the sample row.

Watts per Day X 30 = **Watts per Month**

Electrical usage in watts are billed in KilloWatt Hours (KwH), so we convert watts used in a month to KwH per Month by dividing by 1000.

Watts per Month / 1000 = **KiloWatt Hours (KwH) per Month**

How much does it cost to run all of that type of light fixture at this location each month? We need to multiply the KwH per month by the current electric rate. You may want to substitute the local rate here. The formula in the Sample Cost Analysis uses $0.12 per KwH.

KiloWatt Hours (KwH) per Month X $0.12 = Cost for all (of this type of) Fixtures per Month at $0.12 per KwH

Enter the Replacement Fixture Numbers

Enter the following for each replacement fixture:

- Cost of each selected replacement fixture (RF) and any new wiring or electrical connections required,
- The number of that type of replacement fixtures (RFs), and
- The hours per day the RFs will be illuminated.

Calculate the extended cost for all of this type of replacement fixtures. You may copy the formula from the example row or enter this simple multiplication:

Cost of RF X RF Quantity = Cost for all of this type of RFs

In the sample, the lighting used to illuminate the exterior of the home from a distance is being replaced with flush-mounted under-eave fixtures. There will be fewer needed to adequately illuminate the home.

Replacement Fixture (RF) Data Calculations

Calculate the extended cost for all of each type of replacement fixture. You may copy the formula from the example row or enter this simple multiplication:

Cost of each RF X RF Quantity = Cost for all of this type of RFs

Now calculate Watts expected to be used per day for the replacement fixtures. You may copy the formula for this column from the sample row or enter the results from a manual calculation into the Watts per Day column.

RF Quantity X RF Watts X RF Hours per Day = **RF Watts per Day**

Some months have more than 30 days and some less, but this is a reasonable approximation for Watts per Month. This formula may also be copied and pasted from the sample row.

RF Watts per Day X 30 = **RF Watts per Month**

Electrical usage in watts are billed in KilloWatt Hours (KwH), so we convert watts used in a month to KwH per Month by dividing by 1000.

RF Watts per Month / 1000 = **RF KiloWatt Hours (KwH) per Month**

How much does it cost to run all of that particular type of light fixture at this location each month? We just need to multiply the KwH per month by the current electric rate. You may want to substitute the local rate here. The formula in the Sample Cost Analysis uses $0.12 per KwH.

RF KiloWatt Hours (KwH) per Month X $0.12 = Cost for all (of this type of) RFs per Month at $0.12 per KwH.

Time to determine how many months it will take to break even financially for replacement fixtures whose cost per month is less than the cost per month of the fixtures they replaced. In the Sample Cost Analysis V2, this formula is in column T. For row 4, the excel formula is =L3/(J3-S3). It is recommended that you copy this formula.

Cost for all of this type of RFs / (Original Fixture Cost per Month – RF Cost per Month)

Cost Analysis

Make sure the sums on the Totals row include all the rows for all of the replacement fixtures. Click on each cell with a formula to verify it is pulling data from the correct place and contains the correct formula. Calculations were designed to be as simple as possible so that formulas embedded in the spreadsheet are easy to verify.

You will now have calculations that indicate how many months it will take to break even for each specific replacement fixture. Some fixtures will pay for themselves faster than others.

Sample Lighting Cost Analysis on Replacement Fixtures - CLC Training Grid

Light Ref # & Location	Current Fixture Photo	Function / Fixture Type	Quantity	Watts	Hrs per Day	Watts per Day (Quantity X Watts X Hours per Day)	Watts per Month (Watts per Day X 30 Days)	KiloWatts Hours (KwH) per Month (Watts per Month / 1000)	Cost for all Fixtures per Month at $0.12 per KwH (KwH per Month X 0.12)	Cost per Replacement Fixture (RF) & new wire / J-box, etc.	Cost for all of this type of Replacement Fixtures	RF Quantity	RF Watts	Hrs per Day	RF Watts per Day (Quantity X Watts X Hours per Day)	RF Watts per Month (Watts per Day X 30 Days)	RF KwHs per Month (Watts per Month / 1000)	Cost for all RFs per Month at $0.12 per KwH (KwH per Month X 0.12)	Months to Break Even	Details of Replacements	Photo of Replacement Fixture
Homestead 3		Lighting around perimeter of the home / RAB FFLED	12	230	12	33120	993600	993.6	$119.23	$127.00	$1,016.00	8	11	12	1056	31680	31.68	$3.80	8.80	Changed to warm, flush mounted under-eave fixture needed fewer fixtures. Lumen reduction to 700 per fixture for an even	
Homestead 4		Illumination of flags / Spot	2	84	12	2016	60480	60.48	$7.26	$36.00	$36.00	1	0	12	0	0	0	$0.00	4.96	Solar flagpole downlight.	
Homestead 6		Safety lighting for the crew / spot light	2	100	6	1200	36000	36	$4.32	$40.00	$80.00	2	13	3	78	2340	2.34	$0.28	19.81	Bronze Outdoor Wall Sconce using CFL bulb and a timer to reduce usage.	
TOTAL Monthly Cost - existing fixtures									**$126.49**	**TOTAL RF Costs**	**$1,132.00**	**TOTAL Monthly Cost - RFs**						**$3.80**	9.23		

In our example, the simple fixture on the last row of examples, replacing a spotlight, takes almost 20 months to pay for itself. Do not let this dissuade the purchase. The value of eliminating glare, excessive lighting, and light trespass is not part of the numeric calculation yet it should be a priority too.

Look at the totals for the three types of light fixtures. The overall hardware cost is $1,132.00. With the reduction in electrical costs per month from $126.49 to $3.80 it only takes a little over nine months to recoup the hardware costs and pay for the whole project.

Appendix

Included in this section:

- Lighting Standards for Texas State Parks
- Sample assessment letter to accompany inventory and cost analysis
- Preparations to identify a potential Dark-Sky Park

Electronic Files Available at https://tinyurl.com/LARP-CLC

- Sample Data Collection Sheets
- Sample Inventory Excel Spreadsheet
- Sample Cost Analysis Excel Spreadsheet

Lighting Standards for Texas State Parks (as of 2012)

In General:

- All outdoor lighting shall be shielded so that the luminous elements of the fixture are not visible from any other property.
- Outdoor lighting fixtures, except those covered in "exceptions", are to be fully shielded. That is, they are not allowed to have light escape above a horizontal plane running through the lowest point of the luminous elements.
- The standard lamp, when less than 2000 lumens is required, shall be a cold-start compact fluorescent lamp (CFL). For lighting requiring more than 2000 lumens it is preferred to use High Pressure Sodium (HPS) as the source. If LEDs are used, they should be rated below 3500K with a minimum CRI of 70.
- A preference should be given to reflective guidance markers such as glow-dots and white paint wherever possible in the place of actual lighting.
- Lumen is the unit of measure used to quantify the amount of light produced by a lamp. The government requires all new light bulbs to express their output in lumens. Add up your lumens and divide the total by the number of square feet you intend to illuminate. Compare this number to the lumens caps as defined here. The lumens per square foot limits are as follows:
    a. Lighting Zone 0: Lumens cap per square foot is 0.5. These are areas where the natural environment will be seriously and adversely affected by lighting. Impacts include disturbing the biological cycles of flora and fauna and/or detracting from human enjoyment and appreciation of the natural environment. Human activity is subordinate in importance to nature. The vision of human residents and users is adapted to the darkness, and they expect to see little or no lighting. When not needed, lighting should be extinguished.

b. Lighting Zone 1: Lumens cap per square foot is 1.25. These are areas where lighting might adversely affect flora and fauna or disturb the character of the area. The vision of human residents and users is adapted to low light levels. Lighting may be used for safety and convenience but is not necessarily uniform or continuous. After the park set curfew, most lighting should be extinguished or reduced as activity levels decline.
c. Lighting Zone 2: Lumens cap per square foot is 2.5. These are areas of human activity where the vision of human residents and users is adapted to moderate light levels. Lighting may typically be used for safety and convenience but it is not necessarily uniform or continuous. After curfew set by each specific park, lighting may be extinguished or reduced as activity levels decline.
d. Lighting Zone 3: Lumens cap per square foot is 5.0. These are areas of human activity where the vision of human residents and users is adapted to moderately high light levels. Lighting is generally desired for safety, security and/or convenience and it is often uniform and/or continuous. After the park set curfew, lighting may be extinguished or reduced in most areas as activity levels decline.

Exceptions:

- The preferred practice is to raise and lower governmental flags daily. If there is a reason to not raise and lower the flag daily then flagpoles with governmental flags whose height is 25 feet tall or less may be illuminated from below. The preferred option is to illuminate from above using one of the top-down lighting options available on the market. They may, however, be illuminated with a single spot type fixture whose maximum initial output is 75 lumens per foot of flagpole height above ground. The fixture is to be mounted so that the lens is perpendicular to the flagpole so that the light points straight up at the flag. It is recommended that the lens have a grill to reduce glare.
- Outdoor light fixtures with a maximum output of 320 lumens per fixture, regardless of the number of bulbs, (equals approximately one 25 watt incandescent light), may be left unshielded provided the fixture has a diffuser installed, and the source of the light is not visible from any other property. The output from these fixtures shall not exceed 10% of the lumens per square foot allowed for that lighting zone.
- Code required lighting for steps, stairs, walkways, and building entrances are excluded from the lumens caps. However, this lighting must be shielded per the general requirements and must attempt to fit within the lumens cap.
- Holiday lighting with either low-output bulbs, limited to small individual bulbs on a string with a maximum output of 25 lumens within any square foot, or individual bulbs of less than 50 lumens each from November 15th to January 12th is excluded.

Please note that any parks desiring to apply for Dark Sky designation by the International Dark-Sky Association will need to define what lighting zones apply where. They can overlay the park map with specific lighting zones. Set curfews will also have to be documented for such parks.

Sample Assessment Letter to Accompany Inventory and Cost Analysis

Name and Title of Property Contact(s)
Lighting Assessment & Retrofit Project
Date *today's date*
By *your name(s)*

Dear *Property Contact(s)*,

Thank you for allowing us to assess the lighting at Big Boulder State Park. This assessment was undertaken as part of a project to assist TPWD to protect the night skies, reduce glare, reduce operating expenses, allow TPWD to be an example of good lighting practices, reduce the intrusion of artificial lighting in the habitat of wildlife, and identify parks that have the potential to be designated as International Dark-Sky Association (IDA) Dark Sky Parks.

Following best practices of night-time lighting, as reflected in the TPWD Lighting Management Plan (LMP), will provide a true dark sky experience for the public and help educate the public about lighting practices that control the spread of light pollution. Big Boulder State Park could, once retrofitted, be an ideal venue for ranger-led nighttime interpretive programs and a good candidate to apply to be designated as an International Dark-Sky Park. Amateur astronomers would be eager volunteers to share their knowledge of the night sky, knowing that lighting in the park would not interfere with observations.

Attached is the Outdoor Lighting Inventory. The majority of the current light fixtures match the TPWD LMP. The recommendation is to replace the three types of fixtures that do not adhere to the TPWD LMP. The second attachment is the Cost Analysis. The recommended replacements more than pay for themselves in less than ten months. The cost savings are due to significant gains in lighting efficiency as well as directing light only where it is needed.

Our team is available to provide a detailed presentation about the findings for you or others on your staff as you desire. It has been a pleasure to work with your organization.

With Best Regards,
Your name(s)

Preparations to identify a potential Dark-Sky Park
Could this location be recognized as a Dark Sky Park?

If, after studying the current requirements online at the darksky.org website for an International Dark Sky Place, you believe the park or property you assessed might be a candidate then, coordinate with an IDA Texas Board of Managers member who will help guide you in this quest.

Reach out to the Board of Managers at IDATexas@darksky.org.

Parks may have a variety of situations, including being in a light polluted area, and qualify for one of the Dark Sky Place designations, as long as they adopt good lighting practices and conduct education about those lighting practices.

Volunteers like you are the best!

Thank You!