

BEAR VALLEY VISITOR CENTER FINAL REPORT



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ABOUT CLTC

California Lighting Technology Center's mission is to stimulate the development and application of energy-efficient lighting by conducting technology development and demonstrations, outreach and educational activities, in partnership with lighting manufacturers, lighting professionals, the electric utility community, and governmental agencies. CLTC was established as a collaborative effort between the California Energy Commission and UC Davis, with support by the U.S. Department of Energy and the National Electrical Manufacturers Association (NEMA).

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1.0 INTRODUCTION

The California Lighting Technology Center (CLTC) partnered with the Point Reyes Seashore National Park (PORE) to make energy-efficient lighting and lighting control recommendations for the Bear Valley Visitor Center (BVVC). These recommendations also address suggested light quality for visitor centers required by the U.S. National Park Service (NPS).

PORE is taking steps to join other parks in the Pacific West Region in becoming carbon neutral by 2016, the centennial of the NPS. A carbon neutral park would generate no greenhouse gas emissions from its own operations, those of its partners and concessionaires, and eventually its visitors. Achieving this goal requires major rethinking of park operations, as well as the advancement of new technologies.

A complete audit of interior and exterior lighting was conducted at BVVC to establish an energy consumption baseline. Following the audit, a matrix separating light sources and applications was developed and used to make an initial set of recommendations. These recommendations represent energy-efficient lighting technologies that can be used as retrofits on three implementation levels: lamp, fixture, and system. The lamp and fixture level recommendations served to address more cost-effective, less invasive retrofits, such as one-to-one replacements of lamps or fixtures with more efficient, effective technologies. The system level recommendations are applied in several spaces and serve to light the spaces in a more efficient manner following a task-ambient approach. This report summarizes the recommended technologies, as well as the systems level recommendations for lighting the various spaces of the BVVC.

CLTC also is providing outreach and communication opportunities for the BVVC. A sign was designed to be installed in the center's entrance that educates visitors on the center's energy generation and use and provides tips for cutting visitors' energy use at home. CLTC also is developing a guide to showcase the BVVC's proposed lighting design and serve as a practical workbook for all NPS visitor centers and museums.

2.0 EXISTING CONDITIONS

The BVVC is a large post-and-beam structure a few miles from the coast in northern California. It faces northeast and receives a large amount of natural light via its north- and south-facing windows, as well as from the gable that runs the length of the ridge of the building. The interior lights operate weekdays from 9 a.m. to 5 p.m. and weekends and holidays from 8 a.m. to 5 p.m. Between July 2 and September 4, the visitor center is open Fridays and Saturdays until 6 p.m., adding an additional hour. Exterior lighting is controlled by a photocell and operates about 12 hours each evening, depending on the season. The BVVC is open year-round except on Dec. 25.



Figure 1: The interior ceiling of the BVVC and BVVC gable.

The building's interior surfaces are predominantly wood, with the notable exception being the office and kitchen, both of which are plastered sheetrock painted white. The floor is concrete with a clear glaze. The staff office is lit by 2-foot-by-4-foot T12 surface-mounted wooden parabolic fixtures. The main display areas primarily are lit by sunlight, but these areas also contain gooseneck fixtures and spotlights intended to light the various display dioramas. The dioramas, which illustrate the various types of wildlife common at the Point Reyes seashore, are susceptible to damage from ultraviolet (UV) radiation. Individual historic exhibits have their own lighting, which is not dimmable. All interior fixtures are controlled by manual switches.

Exterior lighting is sparse and consists of similar, unshielded gooseneck fixtures. The exterior message board is lit by unshielded fluorescent strip fixtures and an occupancy-triggered spotlight. Exterior fixtures are connected to photocells.



Figure 2: BVVC spotlights (left) and historical exhibit track lights (right).

Existing lamping consists of 13-watt (W) to 26W compact fluorescent lamps (CFLs) of various color temperatures installed in many applications where CFLs are not ideal. An example of this fixture-and-source mismatch is the lighting in the hallway between the audio/visual (A/V) room and the main exhibit space. The lighting in the hallway is a combination of track lights and recessed lighting. The recessed lighting consists of a large can with no lens. As a result, the amount of light trapped and lost within the fixture is quite large. The fixture as a whole provides less light than it otherwise could, considering the CFL source. The source-fixture mismatch also is evident in track lights meant to light dioramas and historical exhibits. The use of CFLs in track light applications contributes to the unnecessary lighting of areas adjoining the dioramas and kiosks.¹ This light trespass results in increased ambient light levels. In most cases, light trespass of this sort is not a problem, but in a museum environment, such as the exhibit space, the increased ambient light levels require further lighting of the dioramas and kiosks to set them apart as points of interest. This additional illumination results in increased energy costs and radiation exposure.

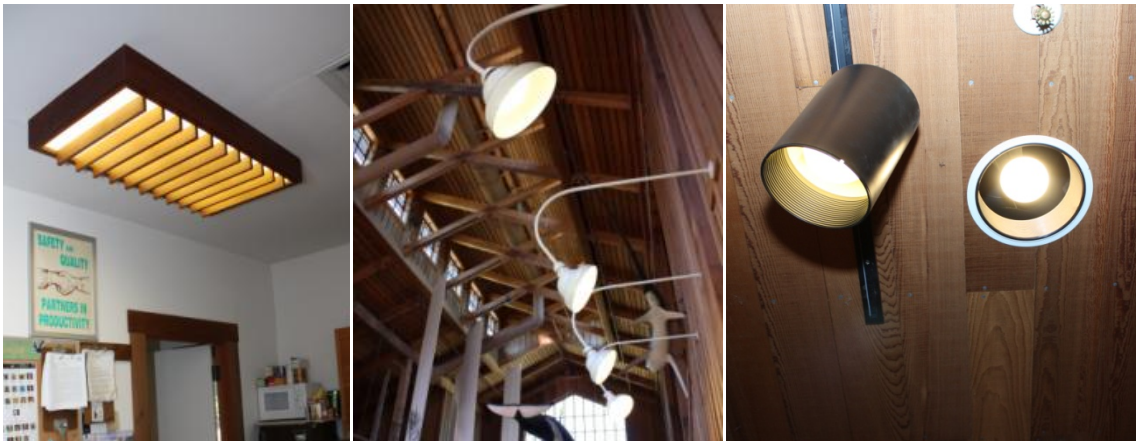


Figure 2: Surface-mounted T12 wooden parabolic troffer (left), gooseneck RLM fixtures (center), and can spotlight and downlight (right).

¹ The CFLs installed at BVVC lack reflectors to focus the omnidirectional light emitted by the CFLs. As a result, much of the light is not directed toward its target and spills on the areas around it.

3.0 LAMP AND FIXTURE RECOMMENDATIONS

CLTC recommends the following technologies to achieve both energy savings and an improved visual environment in the various lighting applications found in the BVVC. In some cases, a recommendation an area that is not presently illuminated was requested by BVVC personnel. Those technologies have no comparable baseline.

3.1 LAMP REPLACEMENTS

Lamp replacements address the most basic level of retrofit investigated for this project. All lamp replacements assume a one-to-one retrofit ratio and are recommended because they will provide an improved visual environment and energy savings.

3.1.1 CERAMIC METAL HALIDE



Figure 3: Osram Sylvania CMH lamp

Ceramic metal halide (CMH) lamps are a relatively new advancement in light sources. They have a lamp life of 12,000 to 15,000 hours, work in both enclosed and open fixtures, and provide a high quality light (3000K, 80+ CRI). The recommended product also has the benefit of ballast thermal protection and UV control. They are available in many bases, including the medium Edison base. CMH lamps are ideal replacements for halogen and incandescent² spot and track lights because of their longer lamp life and incorporated reflectors. As a result, CMH lamps will be best suited for the spot and track light applications within the A/V room, main exhibit space, and gift shop.

3.1.2 LED REPLACEMENT LAMPS



Figure 5: Philips Endura LED

LED replacement lamps are a new technology that couples a long-life, dimmable source with conventional lighting socket types. The EnduraLED line by Philips Lighting provides an LED replacement lamp with a 25,000-hour lamp life, a warm, white light (2700K), and virtually no UV light. LED replacement lamps contain no mercury and are easy to dispose of. They are available with a medium Edison base and provide large energy savings when compared to incandescent and CFL lamps. Depending on the specific lamp type, omnidirectional or directional, LED lamp replacements are effective for either general illumination or illumination in spotlights. Most LED lamp replacements have the limitation of being used only in non-enclosed fixtures. As a result, LED lamp replacements are ideal for open spotlighting like those at the BVVC gift shop, pendant luminaires in the A/V room, and any open-air spotlights in the main exhibit space.

² Halogen PAR38 lamps have a 2,500-hour lamp life. Incandescent PAR 38 lamps have a 1,750-hour lamp life. Values found in Osram Sylvania Lamp and Ballast catalogue.

3.1.3 T8 LAMP AND BALLAST RETROFIT



Figure 4: Sylvania T8 lamps and ballast

Existing T12 fluorescent light fixtures with magnetic ballasts can be retrofitted with new T8 lamps, electronic ballasts, and tombstones to produce large energy savings. The retrofit costs less than purchasing a new fixture and allows the occupant to keep the fixture that is installed. Additionally, different types of fluorescent ballast retrofits (dimming, step-dimming, bi-level, and individually addressable) are available, which facilitates more advanced controls and controls strategies. T8 lamps provide increased light output and decreased power consumption and cost. T8 lamps have a 24,000 to 36,000 lifespan and come in a wide variety of wattages, lengths, color temperatures, and CRIs. Lamp and ballast retrofits are recommended for the BVVC office and mechanical room because of the increased light output and energy and maintenance savings produced by the retrofit,³ as well as the energy saved from switching from a magnetic to an electronic ballast.

3.2 LED DOWNLIGHT



Figure 5: Cooper Halo LED downlight module

LED downlights come in a wide array of color temperatures (2700-5000K) and high CRIs (80+). Depending on the manufacturer, fixture wattages, light output, and trim can vary. The LED modules themselves generally have a lifetime of at least 50,000 hours. Wattages vary between manufacturers and models, but energy consumption per downlight generally is 10-20W. Some LED downlights have the added benefit of being dimmable. LED downlights are recommended for both the A/V hallway and the projector room. The use of LED technologies in these spaces will provide energy savings and higher light levels because of the high fixture efficiency of LED downlight products. Additionally, the long lamp life, when compared with the 8,000- to 12,000-hour lamp life of CFLs, provides maintenance savings. The use of LED sources also eliminates the need for mercury disposal because LEDs do not contain mercury as CFLs do.

³ Four-foot T12 lamps consume 34W, produce an average of 2,600 lumens, and have a 20,000-hour lamp life. Four-foot T8 lamps consume 32W, produce an average of 2,850 lumens, and have a 36,000-hour lamp life.

3.3 LED SPOT AND TRACK LIGHTS



Figure 6: Cooper Stasis LED spot light

Existing spotlights at BVVC initially were designed to use high-powered incandescent sources to provide light for the dioramas. These fixtures have been relamped with CFLs, which are energy efficient but do not produce the focused beam of light required for this application. Because LEDs are point sources, LED spotlights produce a tight beam of light necessary for the dioramas, without the high energy consumption associated with incandescent sources or unfocused light distribution currently experienced with CFLs. Energy consumption is between 10W and 20W, with light output that is similar to a 26W CFL. However, because of the tight beam of light, the LED spotlight provides more light where it is intended, which may allow for much smaller wattage replacements. Additionally, the LEDs are dimmable and available in 3000K or 4000K color temperatures with a CRI of 80. LED spot and track lights are recommended for the A/V room, A/V hallway, and main exhibit space and gift shop. Energy savings from one-to-one retrofits may be surpassed by removing some fixtures outright because of the increased fixture efficiency and tight beam angles of the LED products.

3.4 LED COVE LIGHT



Figure 7: Philips eW Cove Powercore LED cove light

The eW Cove Powercore is a dimmable linear LED fixture designed to provide cove lighting. It has a 50,000-hour lifespan and provides energy-efficient lighting in niche applications. This fixture can provide lighting to the kiosks and is dimmable. As a result, the maximum amount of energy savings can be achieved by avoiding over-illumination of the kiosks and surrounding areas. The 12" model consumes 4.5W of power and produces a high-quality, cool, white light (4200K, 79 CRI). The existing kiosk lighting uses a number of downward-oriented CFLs on a track. Energy savings are dependent on the number of Powercore fixtures used for each kiosk. Replacing CLF light sources with LED products reduces the BVVC's mercury footprint.

3.5 GOOSENECK LIGHTING



Figure 8: Day-Brite LED RLM fixture

Gooseneck fixtures are available in a wide array of styles, colors, and light sources. Existing gooseneck fixtures at BVVC use CFLs; however, changing to an LED light source will provide energy savings and decreased maintenance costs. Depending on the manufacturer, LED gooseneck fixtures consume either 10W or 18W of power and have about a 50,000- to 60,000-hour lifespan. The fixtures can be ordered with lenses; however, none of the gooseneck fixtures at BVVC have lenses. As a result, the existing light sources lack protection from the elements, which increased cleaning to maintain maximum light output. LED gooseneck fixtures are recommended because of the decorative nature of the existing fixtures. Maximum energy savings should be pursued while still preserving the architectural elements or the preexisting lighting. The reduction in maintenance costs from improved lamp lifetimes for exterior lighting will be an added benefit, as will the reduction of another mercury source.

3.6 BI-LEVEL EXTERIOR FLUORESCENT LUMINAIRES



Figure 9: Lithonia Archway bi-level exterior luminaire

The bi-level exterior fluorescent luminaire is available in both 2' and 4' sizes. It is rated for exterior conditions and contains an occupancy sensor that allows for energy savings in areas with low occupancy. This particular fixture, produced by Lithonia, could be used on the exterior bulletin board to provide energy-efficient lighting. Depending on ballast choices and size, the fixture can be set to consume as little as 10% of its total energy use while the area is unoccupied. Further energy savings are dependent on lamp choice and occupancy levels.

3.7 LIGHTING CONTROLS

Lighting controls allow for energy savings from environmental factors or usage patterns. Some controls systems can be installed and produce energy savings without any modification to the lamps and ballasts themselves. Others require systemwide retrofits but produce deep energy savings.

3.7.1 OCCUPANCY CONTROLS



Figure12: WattStopper wall switch sensor

Wall switches with integrated occupancy and daylight sensors provide the ability to gain the energy savings that might otherwise be lost because of user error. Wall switch sensors use either passive infrared (PIR) or ultrasonic sensors to determine when a space is vacant. Depending on the space, dual-technology wall switches may be necessary.

Occupancy-controlled wall switches generally make use of a manual-on and automatic-off feature. Occupancy sensors also come in centralized ceiling-mounted modules. These modules may require additional wiring but allow for a centralized location and/or use with other occupancy sensors to cover large areas. Occupancy controls are recommended for the areas of the BVVC that are not continually in use, such as the projector room, the A/V room and hallway, the kitchen, and public bathrooms. Sensors in these areas will provide energy savings based on true occupancy and reduce energy waste as a result of use error.

3.7.2 DAYLIGHTING CONTROLS



Figure 10: WattStopper ceiling-mounted daylighting sensor

Daylighting systems are designed to dim or extinguish interior lights as daylight infiltration increases. By setting a band of acceptable illuminance levels for a space, light levels are maintained while electric lighting is minimized. When combined with occupancy sensors, daylighting controls capture a majority of the potential energy savings achievable through lighting controls. Daylight controls are recommended for the office space because of its large windows. Additionally, personnel at BVVC do not use some of the existing lights during parts of the day because of the over-illuminance that they cause, although at other times, the space appears dim. The combination of a lamp and ballast retrofit and daylighting controls would allow illuminance levels to be maintained.

3.7.3 WIRELESS CONTROLS



Figure 11: Adura wireless controller

Wireless controls systems provide the ability to control and manage lights from any location in a building. A gateway serves as the central computing hub, which wirelessly receives data from sources such as occupancy and daylighting controls and sends commands to individual light fixtures. As a result, the gateway is able to maintain desired lighting conditions while still receiving user input from wireless controls. For example, the gateway can maintain light levels in the office with a daylighting sensor, but then have light levels dynamically reduced or increased from a wall-mounted or hand-held remote. And each light connected to the system is individually addressable. As dioramas and exhibits change within the main exhibit space, the lighting can be adjusted accordingly. Lights can be turned on, off, or dimmed to provide appropriate lighting levels.

3.8 EXTERIOR PATHWAY LIGHTING

The following technologies are recommendations for lighting areas that are not presently illuminated. There is no comparable energy baseline or existing product.

3.8.1 BI-LEVEL LED BOLLARDS



Figure 12: Gardco bi-level LED bollard

Bi-level LED bollards provide energy-efficient pathway lighting. The bollard operates at 41W in high mode and 8W in low mode. An integrated, microwave occupancy sensor is encapsulated within the bollard to prevent damage or vandalism. The lifespan of the fixture is between 50,000 and 60,000 hours. The color temperature of the light output can be specified at a number of discrete values between 3300K and 6000K (between 70 and 80 CRI depending on color temperature choice). Because of extremely low occupancy levels expected at the BVVC at night, bi-level bollards may be a useful, energy-efficient lighting solution.

3.8.2 LED STEP LIGHTS



Figure 16: Gardco 960 series LED aisle light

LED step lights provide illuminance for aisleways, stairways, and other interior and exterior applications. The step lights consume only 4W of power and provide light at a color temperature of 3500K and a CRI of 85. The product also comes in a round form factor. Both form factors are available in a number of colors and two distinct faceplates. Step lights may be useful in exterior stairway applications as well as to light interior walls during A/V operations.

3.9 EXTERIOR HANDRAIL LIGHTING



Figure 17: Cooper Io LED handrail light

Depending on the material of the handrails and the light source desired, a number of designs and manufactures of handrail lighting exist. In most cases, the desired handrail material is aluminum and the light source is either a T8 or T5HO fluorescent lamp or linear LED. LED light sources generally have a 50,000-hour lifespan and a color temperature between 2700K and 5000K. Fluorescent lamps have a lifespan between 24,000 and 36,000 hours with a variety of color temperatures and CRIs.

4.0 SYSTEM LEVEL RETROFITS

The following recommendations address lighting retrofits as a complete system change. These retrofits are aimed at achieving deep energy savings in certain spaces throughout the BVVC, while simultaneously providing flexible, occupant-specified lighting levels.

4.1 OFFICE

An Integrated Office Lighting System (IOLS) retrofit would provide the largest energy savings for the office at the BVVC. The combination of energy-efficient LED task lighting and reduced ambient lighting levels not only would save energy, but also would provide occupants with the flexibility to determine their individual task light levels. Reduced ambient light levels may be achieved with a simple lamp and ballast retrofit. The Personal Lighting System (PLS) provides large energy savings when compared with incumbent task lighting and also can be configured to use a personal occupancy sensor, which increases energy savings by extinguishing task lighting when work stations are vacant. Additionally, when coupled with wireless controls systems, the PLS occupancy sensor can be linked with the ambient lighting, which maximizes energy savings.



Figure 13: The existing BVVC office (left), an example Finelite IOLS (top right), and a Finelite PLS (bottom right).

4.2 VISITOR INFORMATION AND CAMPING REGISTRATION

Existing lighting at the information desk consists of down-oriented CFLs on a track. Camping registration receives minor illumination from gooseneck fixtures oriented toward a bulletin board. To provide illumination without glare, CLTC recommends the use of wall-mounted and pendant-mounted direct/indirect fluorescent fixtures. The fixtures will provide low-profile uniform illumination for the two desk spaces. The fixtures also can include daylighting sensors to prevent unnecessary illumination during the brighter hours of the day.

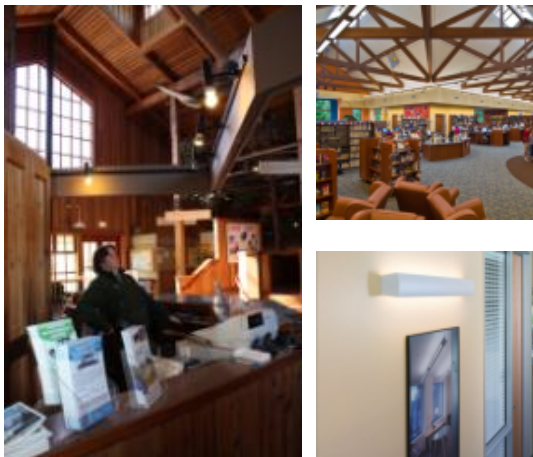


Figure 14: BVVC information desk (left), Finelite indirect / direct pendant luminaire (top right), and Finelite direct / indirect wall-mounted fixture (bottom right).

4.3 AUDIO/VISUAL ROOM

The existing A/V room is lit by pendant-mounted fixtures with CFLs. The lamps originally were incandescent but were replaced by CFLs for energy savings. As a result, the luminaires no longer are dimmable by the original incandescent dimmer. CLTC recommends replacing the existing pendant-mounted fixtures with dimmable linear direct/indirect T8 fluorescent fixtures. The fixtures would provide more uniform illuminance throughout the room, as well as upward illumination to light the ceiling.

An audio/visual exhibit currently is installed in the room. The recommended luminaires would provide A/V illumination when necessary, while otherwise providing illumination needed for normal presentations. Additionally, an occupancy sensor could be included to minimize lighting energy use when the space is vacant. This will consume more energy than the existing lighting does; however, it will provide much superior illumination and flexibility when compared to the incumbent lighting.



Figure 15: BVVC A/V room (left), Finelite indirect / direct A/V lighting (top right), Finelite indirect / direct lighting (bottom right).

5.0 PHILIPS LAMP TRIAL

Several Philips Endura lamps were installed at BVVC as a trial so the staff could consider whether the retrofits were something they want to move forward with. Philips Endura A19 lamps were installed in the office, and Philips Endura PAR30 and PAR 38 lamps were installed in spotlights in the dioramas. If the staff reacts positively to the trial, they can look for funding and begin to retrofit the facility section by section.

6.0 OUTREACH/COMMUNICATION

CLTC designed a sign to be installed in the center's entrance that educates visitors on BVVC's energy generation and use and provides tips for cutting visitors' energy use at home.

CLTC also is developing a guide to showcase the BVVC's proposed lighting design and serve as a practical workbook for all NPS visitor centers and museums and other similar facilities. The guide also will be used to promote BVVC as a leader in energy efficiency and lighting in the NPS system. It will be publicized on PORE's website and on CLTC's website and monthly newsletter, as well as in a press release to organizations such as the U.S. National Park Service, the 50 State Parks divisions, and cities' Departments of Parks and Recreation. The guide can be taken to and distributed at various trade shows that CLTC attends, such as the Illuminating Engineering Society Conference and the Emerging Technologies Summit. CLTC and BVVC could speak jointly at these conferences to promote the guide and the retrofit.

Case studies also can be written about the retrofits. Depending on how many technologies are installed, one case study can be written on the project as a whole, or many case studies can address each technology as they are completed.