Waterton-Glacier International Peace Park World Heritage Site

Application for International Dark-Sky Park Designation

"Milky way at Cameron Lake" Photo By: Alan Dyer

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Appendix A. Parks Canada Lighting Policy

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1. Letter of Nomination

November 4, 2015

Board of Directors
International Dark-Sky Association (IDA)
3223 North First Avenue
Tucson, AZ 85719

Greetings,
As the IDA Dark Skies Northwest (DSNW) chapter leader representing Idaho, Montana, Oregon and Washington, I am greatly pleased to recommend Glacier National Park (Glacier), to the Board, as an International Dark-Sky Park (IDSP).

My personal relationships at Glacier supply the basis for my recommendation. As team member of the 2012-2014 "Volunteer in Park" astronomers at Glacier, I had two outstanding Glacier park rangers share with me their interpretive skills and their unflagging vision for dark sky parks throughout the US national park system. I then passed that passion forward by introducing thousands of Glacier visitors to the natural resources of a truly pristine, dark night sky.

Visitors come from all over the world intent to see for themselves Glacier's glaciers, the goats and the grizzlies. I met many of these visitors in the dark. Through the night sky outreach program, I was able to add a fourth, unexpected, sometimes emotion filled visitor encounter; the vista of our galaxy, the Milky Way, stretched horizon-to-horizon.

I saw committed Glacier leadership, along with dark-sky advocates from the Glacier Conservancy, and two different Glacier superintendents, their staff and science programs managers all working successfully to incorporate "astronomy education and public outreach" and "dark-sky advocacy" into Glacier science programs.

I assisted Glacier staff, staff from Canadian parks and local volunteer astronomers in an inventory of Glacier lighting systems. I supported proposals to eliminate and reduce adverse artificial light at night to meet IDSP requirement limits.

Legends from people indigenous to the US and Canadian mountain ranges bestow upon Glacier the moniker, "crown of the continent".

I submit that the current and future efforts by Glacier to achieve IDSP recognition can brilliantly extend that legendary, crown-like distinction to the truly dark, star-filled night skies over the continent and the mountain ranges shared by two nations and by countless ancient and future generations.

I thank the IDA Board of Directors conceiving the IDSP program and for the consideration of Glacier National Park as an International Dark-Sky Park. I look forward eagerly to an IDA announcement of an award decision to Glacier.

Sincerely,

David W. Ingram, chapter leader
Dark Skies Northwest
20456 131st Place SE
Kent, WA 98031

2. Superintendent Letter of Support

WATERTON·GLACIER

Jim Dougherty, President
International Dark-Sky Association
3223 North First Avenue
Tucson, Arizona 85719-2103

Dear President Dougherty:

As superintendents of Waterton Lakes National Park, and Glacier National Park respectively, we support the nomination of Waterton-Glacier International Peace Park World Heritage Site for Dark-Sky Park designation. An international transboundary dark sky preserve would be a fitting tribute to the ideals that the Rotary Clubs of Alberta and Montana envisioned in 1932, the recognition that the United Nations gave to the area in 1995 as a World Heritage Site, and the ongoing efforts of Glacier National Park and Waterton Lakes National Park to manage this area cooperatively. An international boundary area unimpeded by artificial light is rare, all the more so when it includes a transboundary area of 1720 square miles (4556 square kilometres) at the heart of an area known as "the crown of the continent."

There are fabulous opportunities for stargazing on both sides of the border. Visitors to both Glacier and Waterton Lakes National Parks are invited to watch an evening theatre program, stargaze through telescopes with staff and volunteers, enjoy a moonlit walk or ski, or look up to the wonders of the Milky Way from a campsite. This protected area has some of the darkest skies, unimpeded by artificial lights, available for night sky viewing enthusiasts to enjoy in most areas of the park.

Efforts to improve artificial lighting at night are underway in Waterton-Glacier International Peace Park World Heritage Site. Glacier National Park has completed a thorough survey of all existing lights. Unnecessary lights are being eliminated, and lower wattage bulbs and shielded fixtures are being installed on remaining lights. Parks Canada is installing dark sky compliant lighting in the Townsite as part of planned infrastructure projects over the next five years. Any new development permits in Waterton Lakes National Park require dark sky compliant lighting. Over time, this reduction in artificial light will benefit migratory and aquatic wildlife, and improve night sky viewing opportunities.

Waterton-Glacier International Peace Park World Heritage Site is an ideal candidate for Dark-Sky Park designation.

Please give this nomination your utmost consideration.

Sincerely,

Ifan Thomas, Superintendent
Waterton Lakes National Park
Date Feb 29/16

Jeff Mow, Superintendent
Glacier National Park
Date 2/24/2016

Waterton Lakes National Park PO Box 200 Waterton Park, Alberta, Canada TOK 2MO
Glacier National Park PO Box 128 West Glacier, Montana 59936

3. Additional Letters of Support

UNIVERSITY OF Redlands

Department of Physics

November 5, 2015

Dear IDA Board Members:

Please allow me to recommend Glacier National Park as an International Dark Sky Park. I first visited Glacier National Park where I spoke to park employees about the importance of preserving naturally dark night skies. Natural Bridges National Monument had just been declared the first International Dark Sky Park and on the basis of these events I was invited to return in 2008 as a Glacier Artist-in-Residence to help capture images of the night sky above Glacier. Between those two visits in 2007 and 2008 I travelled extensively through America's national parks giving talks to the public and park employees about the importance of protecting dark skies. I spent nearly every clear night in approximately 30 different national parks and monuments, photographing the sky and taking measurements as to its quality of darkness. Glacier National Park more than meets the criteria for being an awe-inspiring dark sky destination for visitors from all over the world.

Glacier National Park would be unique among current U.S. parks with IDSP designations. As a mountainous park along the northern U.S. border it affords opportunities to see the aurora and Milky Way under high-altitude conditions during the extreme swings in day/night duration over the course of a year. In such a high-northern latitude region where true darkness is fleeting in the midst of summer, protecting those conditions from artificial lights from within and without the park is even more important.

Glacier is also unique in having two lodging facilities, Granite Park Chalet and Sperry Glacier Chalet that can only be hiked in to and (unlike Phantom Ranch in Grand Canyon) are far enough from other lodging and light sources that they afford a virtually pristine wilderness experience. Having seen the Perseid Meteor Shower from Granite Park Chalet, the night skies are one of the draws to these unique locations.

The effort of the park rangers and their team of astronomy volunteers to promote those dark skies at Glacier is truly impressive. Since my first visit, rangers there have begun an annual star party at the Logan Pass visitor center. Of all the parks I've visited for their annual night sky festivals, this is easily the most scenically spectacular spot and standing on the Continental Divide looking up at the Milky Way is truly awe inspiring.

Sincerely,

Tyler Nordgren
University of Redlands

P.O. Box 158 • Whitefish, MT 59937 • (406) 863-2400 • Fax: (406) 863-2419

City of Whitefish

September 25, 2015
Letter #2015-001

Jeff Mow
Superintendent
Glacier National Park
P.O. Box 128
West Glacier, MT 59937

Dear Jeff:

At their meeting on September 21, 2015, the Whitefish City Council reviewed the information you supplied regarding your joint application for designation as an *International Transboundary Dark Sky Preserve (ITDSP)* for the Waterton-Glacier International Peace Park. After their review and discussion, they Whitefish City Council voted unanimously to send a letter of support for your application for ITDSP.

The City of Whitefish has had a Dark Skies Ordinance since July, 2006 and we strongly enforce that ordinance. We hope that our ordinance has made a difference in slowing the degradation of our dark skies in this area. Waterton-Glacier IPP is certainly deserving of designation as an International Transboundary Dark Sky Preserve given the quality of your dark skies and Waterton-Glacier's efforts to preserve and improve the dark sky in the Parks.

We strongly support your application for ITDSP and we would be pleased to help your efforts in any way that we can. Please let us know if there is anything else we can do to support your application.

Sincerely,

John Muhlfeld
Mayor

CITY of COLUMBIA FALLS

130 6TH STREET WEST
ROOM A
COLUMBIA FALLS, MT 59912

PHONE (406) 892-4391

FAX (406) 892-4413

February 18, 2016

Glacier National Park
Attn. Superintendent Jeff Mow
P.O. Box 128
West Glacier, MT 59936

Dear Mr. Mow:

The City Council voted unanimously to support the application for designation as an International Transboundary Dark Sky Preserve at the regular meeting held February 16, 2016.

The City of Columbia Falls' Zoning Code encourages dark sky practices for the same reasons the Park is pursuing the designation: protect, preserve and promote night sky resources. We are blessed to live in the "big sky" country where citizens and visitors can enjoy the night sky.

The City of Columbia Falls applauds your efforts to be designated as a Dark Sky Preserve and to promote education and policies that reduce light pollution.

Sincerely,

Donald Barnhart
Mayor

November 13, 2015

Board of directors
International Dark-Sky Association
3223 North First Avenue
Tuscan, AZ 85719-2103

Dear International Dark Sky Association,

Regarding Glacier National Park's application for Dark Sky Status, This is a very good thing. I've worked with Glacier these past 7 years doing Astronomy both daily and nightly at St Mary Visitor Center and at Logan Pass. I choose St Mary as the night sky is much better there for night time Astronomy than Apgar on the West Side and the restrictions from nearby mountains is much less yielding a larger sky to view. My first impression of the night skies at Glacier were astounding to say the least. The darkness and clarity one sees in this National Park is much better than I had seen in most places. Our National Parks on whole are a treasure we must preserve for future generations and an unlikely by-product is Dark Skies. I met Dr Tyler Nordgren in 2010 at St Mary Visitor Center while preforming Solar Viewing and was impressed with his passion for preserving our pristine Dark Skies in the US NPS system. The Astronomy Program at Glacier has matured to the point we have proper equipment and staff to run a first class program both at St Mary and Apgar. Each year over 20,000 park visitors are treated to our programs with many returning to Glacier again and again, some of them to again enjoy the Night Sky. I have been privileged to start this program and nurture it's progress through these past seven years. The East Side Chief Interpretive Ranger (Mark Wagner) has been most helpful and supportive in this effort. Without Ranger Wagner's enthusiastic support, I do not feel the program would have matured so rapidly or so well. Kudos also go to Dave Ingram who accepted my invitation to join the Astronomy Program at Glacier and was instrumental in starting the initial work for applying to the IDA for Dark Sky Status. With the help of members of the Big Sky Astronomy Club (Kalispell, Mt) the work in evaluating existing lights and changes needed at both Waterton Lakes National Park and at Glacier was accomplished. Obviously, I am in favor of applying for Dark Sky Status and hope any information contained in this letter of recommendation will be helpful.

Ray Stinson
NPS Astro-VIP
TAS Public Outreach
skyray60@netzero.net

Waterton Natural History Association

Box 145
Waterton Park
Alberta
T0K 2M0

December 10, 2015

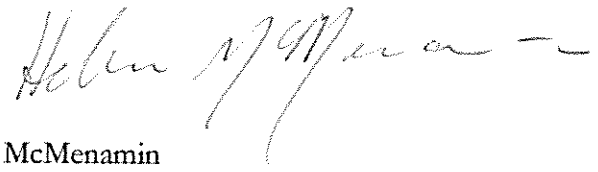
IDA Board of Directors
International Dark-Sky Association
3225 North First Avenue
Tucson, Arizona 85719-2103

Dear IDA Board of Directors:

Please accept this letter as full support for the nomination of Waterton-Glacier International Peace Park World Heritage Site as a Dark Sky preserve with both the International Dark Sky Association and the Royal Astrological Society of Canada (RASC) on behalf of the Waterton Natural History Association. Gaining this important designation will help to preserve the parks' outstanding night skies, wildlife and actively demonstrate peace and goodwill between Glacier National Park (U.S.A) and Waterton Lakes National Park (Canada).

Our organization has provided financial support for night sky viewing programs and see the Dark Sky Preserve designation as benefiting this World Heritage Site and encouraging visitors and residents to encounter and learn something of the universe. The mission of the Waterton Natural History Association is to promote the preservation, understanding and appropriate use of Waterton Lakes National Park through education, publications, retail and museum services and volunteerism.

We are excited about the possibility of dark sky preserve designation. Dark skies may add another option the range of activities our organization offers.



Helen McMenamin

Chair

Waterton Natural History Association

March 8, 2016

Jim Dougherty
President
International Dark-Sky Association
3223 North First Ave.
Tucson, AZ., 85719-2103

Mr. Dougherty,

On behalf of the local business community in Waterton Lakes National Park, AB., Canada, the Waterton Park Chamber of Commerce would like to voice its full and complete support of the Waterton-Glacier International Peace Park World Heritage Site application for a Dark Sky designation from the International Dark-Sky Association.

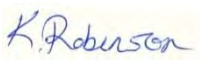
Waterton-Glacier International Peace Park offers some of the darkest, most unobstructed night sky viewing opportunities found anywhere on the planet, and the Chamber of Commerce believes that labeling this trans-boundary protected area a Dark Sky site would benefit not only Waterton-Glacier but also the IDA. By having a Dark Sky designation, Waterton-Glacier would be able to reinforce its appeal to stargazing enthusiasts, and instill in others the opportunities for night sky viewing that are available in the area. Most Park visitors live in an increasingly urbanized society and many have little idea about the stargazing experiences that could be had in the International Peace Park World Heritage Site. Furthermore, designating the Waterton-Glacier area a Dark Sky place will result in increased exposure for the IDA brand (and its associated goals, objectives and mandate), as our new Dark Sky area begins to promote the IDA via educational visitor experiences.

Labeling the area as a Dark Sky site will also offer a number of other benefits to Waterton-Glacier, as the area begins reducing light pollution. Native nocturnal wildlife will benefit from darker skies; residents and business owners will experience reduced electric bills as they make the switch to more environmentally friendly lighting (which in turn will aid in the efforts against climate change); and visitors will be able to better appreciate the natural night sky.

The Chamber of Commerce realizes that light pollution can be harmful to the natural environment and can negatively impact peoples' opportunity to experience the night sky. As such, the Chamber will endeavor to educate the local community about light pollution and encourage business owners and residents alike to actively consider responsible outdoor lighting alternatives.

It is with great pleasure that the Waterton Park Chamber of Commerce fully endorses the Waterton-Glacier International Peace Park World Heritage Site's application for Dark Sky status!

Sincerely,



Keith B. Robinson, B.Comm, TCP.
Director
Waterton Park Chamber of Commerce
www.MyWaterton.ca

Waterton Lakes
NATIONAL PARK

4. Waterton-Glacier International Peace Park History

In 1932, the United States and Canada joined together to create the world's first International Peace Park: Waterton-Glacier International Peace Park (WGIPP). The Peace Park is 4556 km^2 (1,720 sq miles) in size. Waterton Lakes National Park is 505 sq. km (195 sq. miles) 465 acres of this is leased land in the Townsite. Glacier National Park is 1,583 sq. miles (4,101 sq. km) (1,013,322 acres) 297.55 acres (.000295%) of this is private property. At the time of inscription, the Peace Park commemorated the peace and goodwill our two nations share. Today, Waterton Lakes National Park and Glacier National Park use peace and goodwill to work towards shared management: protecting the water, plants and animals that are found in the WGIPP.

"The unheralded line that separates Canada and the United States is the longest unfortified border in the world today and perhaps in all of history. It says to mankind: Let not the cartographers rule, elevate nature and human friendship."

Stewart L. Udall U.S. Secretary of the Interior, 1967

UNESCO designated the Waterton-Glacier International Peace Park as a World Heritage Site on December 6th, 1995. A World Heritage Site is a place (such as a forest, mountain, lake, desert, monument, building or city) of special cultural or physical significance to the world. The protection, management, authenticity and integrity of the sites are also an important consideration.

"Silent Night" Aurora over Lake McDonald Photo by: John Ashley

Statement of Significance:

Waterton-Glacier International Peace Park has a distinctive climate, physiographic setting, mountain-prairie interface, and tri-ocean hydrographical divide. It is an area of significant scenic values with abundant and diverse flora and fauna.

Waterton-Glacier International Peace Park sits at the apex of the three oceans that border the North American continent (a triple divide) in northwestern Montana. Its jagged peaks and crystalline lakes are remnants of extensive glaciation in the last ice age. Waterton-Glacier's high country is accessible to visitors who drive the spectacular Going-to-the-Sun Road from early summer through the fall. The road winds 52 miles up and over the divide through Logan Pass.

Waterton-Glacier has become an increasingly popular destination for visitors with a wide range of abilities and expectations. Visitors are able to enjoy the park in their own vehicles and drive Glacier's famous Going-to-the-Sun Road or other scenic roads. They can choose such recreational activities as horseback riding, canoeing, fishing, or commercial boat tours and can stay in historic hotels or campgrounds. Visitors hike on the 855 miles of trails into the backcountry where primitive sites are available for overnight camping.

The parks location in the Crown of the Continent with a variety of alpine, plains, and forest resources provides visitors with a variety of unique interactions with rare ecosystems and wildlife. The high alpine locations in WGIPP offer unique views of the milky way and other night sky resources.

The Dark Sky designation would enhance both the Peace Park and the World Heritage Site designations, and allow the Peace Park to promote itself as the world's first trans-boundary dark sky preserve, further cementing the strong ties between the two parks, and the two nations.

More information on Waterton Lakes National Park: http://www.pc.gc.ca/eng/pn-np/ab/waterton/index.aspx
More information on Glacier National Park: http://www.nps.gov/glac/index.htm

5. Map of Area to be Designated

6. Location of Waterton Glacier International Peace Park World Heritage Site

- Waterton Lakes National Park is located 271 kilometers south of Calgary, and 132 kilometers southwest of Lethbridge.
- The West Entrance of Glacier National Park is located close to Kalispell (33 miles), and Great Falls is 130 miles east of the St Mary Entrance.
- The two parks are connected by the Chief Mountain Highway and border crossing, open during the summer months.
- Both parks are accessible for night viewing.

7. Purpose and Goals of Waterton-Glacier International Peace Park Dark Sky Park Application

Waterton-Glacier International Peace Park World Heritage Site (WGIPP WHS) wishes to make a formal application to the International Dark Sky Association (IDA) and Royal Astronomical Society of Canada (RASC) for designation as a the world's first International trans-boundary Dark Sky Preserve (DSP).

To this end, Parks Canada wishes to showcase its commitment to protect and preserve the quality of the night sky by applying strict guidelines to reduce light pollution and to provide new programs for visitors to experience and learn about astronomy and light control.

WGIPP WHS is an ideal location to become the first International trans-boundary DSP in the world for a number of reasons:

- Many of the commercial facilities in both parks close for the winter, allowing for light pollution free night sky viewing.
- 83% of Waterton Lakes National Park a designated wilderness area, free of light pollution, with access to trails and backcountry campgrounds.
- Many of Waterton's prime viewing locations are in areas designated as Special Preservation, Natural Environment or Outdoor Recreation. This includes Red Rock Canyon, Cameron Lake, the Bison Paddock, and the Crandell and Belly River campgrounds.
- Many areas in Glacier and Waterton Lakes National Parks are suitable for dark sky viewing. High locations like Glacier's Logan Pass offer alpine light pollution free viewing opportunities during the summer months. In addition, the east side of Glacier and Waterton Lakes National Parks offer open skies in a prairie setting.
- Both Glacier National Park and Waterton Lakes National Park offer a wide range of accommodation and camping facilities, and are open in the winter for night sky viewing opportunities.
- The National Parks Service and Parks Canada offers an extensive interpretive program, including an astronomy program including evening theatre programs, 'hands on' stargazing opportunities at Logan Pass and East Glacier, and strong support from volunteer organizations.
- Parks Canada has a strong desire to create innovative and new engaging visitor experience products in Waterton Lakes National Park; a DSP and related star gazing programs fit well with this strategy.
- Many areas in Glacier and Waterton Lakes national parks are excellent for dark sky viewing. Glacier's Logan Pass offer alpine night sky viewing, free from light pollution during the summer months. The east side of Glacier National Park offers open skies in a prairie setting. In Waterton Lakes National Park, locations like the Bison Paddock, Red Rock Canyon and Cameron Lake offer incredible night sky viewing areas.
- Both parks are accessible year round, with few commercial facilities in the winter, creating excellent viewing opportunities free from artificial light at night during the longest periods of darkness of the year. At this point we are requesting Provisional Dark Sky Park status, due to the need to complete several lighting retrofitting projects to reach the minimum compliant light fixtures for full Dark Sky Park status. Both Waterton Lakes and Glacier are committed to reaching full compliance and have outlined several retrofitting projects to meet the IDA's requirements in the next three years if we receive this Provisional status.

8. Park Policies on Dark Skies

Glacier:

Glacier National Park Resource Management Plan 1998:

B (6). Night Sky

Desired Resource Condition:

The night sky in America's National Parks is an invaluable resource. It is impossible to place a value on the benefits derived from taking a walk at night and stargazing or increasing your knowledge of astronomy. Night lights from cities, airports, and other developments intrude upon the night sky. National Park Service management policies call for cooperation with park neighbors and local government agencies to seek to minimize the intrusion of artificial light into the night scene in parks with natural dark, recognizing the part darkness and night sky play in the overall visitor experience. In natural areas, artificial outdoor lighting will be limited to basic safety requirements and will be shielded when possible.

The desired condition is a pristine night scene that is the usual condition. Any artificial light would be in accordance with realistic guidelines and limits.

Actions Needed:

1. When local developments are planned, protection from night light intrusions should be discussed and negotiated prior to development, especially in the case of oil and gas development. Where extensive light development intrudes upon the night scene, provisions should be made--for example, shields over lights.

Glacier's Purpose

- Preserve and protect natural and cultural resources unimpaired for future generations (1916 Organic Act)
- Provide opportunities to experience, understand, appreciate, and enjoy Glacier National Park consistent with the preservation of resources in a state of nature (1910 legislation establishing Glacier National Park)
- Celebrate the ongoing peace, friendship, and goodwill among nations, recognizing the need for cooperation in a world of shared resources (1932 International Peace Park legislation)

Milky Way over St. Mary Visitor Center

Aurora Borealis over St. Mary Visitor Center (Photos By: Ray Stinson)

Waterton:

The mandate of Parks Canada is consistent with the intent and guidelines of the RASC Dark Sky Preserve program. Three key elements of Parks Canada's mandate are: protection of natural and cultural resources (Program Area 2), public education and outreach (Program Area 3), and meaningful visitor experience (Program Area 4). (Parks Canada Corporate Plan).

The Waterton Lakes National Park Management Plan 2010 identifies engaging the public and stakeholders in authentic activities that contribute to the enjoyment, presentation, stewardship and protection of Waterton's ecological and cultural resources (section 4.1.2.1, p.15). In addition, the public observation evenings offer unique volunteer opportunities as per (section 4.1.2.3, p. 16). The Dark Sky Preserve designation as a transboundary preserve would be a fitting tribute to the world's first International Peace Park and World Heritage Site (section 4.2.1, p.16). Expanding, improving and demonstration the use of environmental technologies that promote energy conservation is another objective (section 4.4.2.2, p. 21) relating Dark Sky Preserve lighting requirements. Environmental stewardship is a key outcome for the Community of Waterton (section 5.2.1, p. 28). The Blakiston Valley should also maintain its undeveloped character, and protect sensitive species (section 5.3.1, p. 30). One of the objectives for the Cameron Valley is to improve recreational opportunities in ways that promote increased understanding and protection of its unique ecological and cultural resources (section 5.4.3, p. 33).

Model Class Screening statement on lighting:

The replacement or installation of new lighting must follow the Parks Canada Guidelines and Specifications for Outdoor Lighting (PC-GOL, 2008). Outdoor fixtures must be shielded, full cut off low intensity dark sky compliant lights. Interior lighting must be designed to reduce light trespass.

The colour temperature of any new luminaires should be under 3000K, with amber LED or converted amber LED preferred.

Red Rock Canyon Trail

Photo by: Alan Dyer

Glacier:

The NPS Night Sky Quality Monitoring Reports from 2009 are based on processed CCD image data that offer the most reliable observations of night sky quality. Because the processed data accounts for naturally present light sources, the data accurately estimate the artificial sky glow component over the entire sky. Since there has been very little population growth, external development, or other lighting changes that result in increased sky glow, these data are believed to be accurate and representative of current conditions.

They Sky Quality Meter (SQM) data provides valuable information to supplement the NPS Night Sky Quality Reports from 2009. Because SQMs are lightweight, portable, and easy to use, users are able to rapidly assess a broader number of sites and larger time span than is now practically possible with existing NPS CCD imaging system. This includes data from Waterton Lakes National Park.

Night Sky Quality Monitoring Report

Glacier NP

Huckleberry Mtn 12-Sep-2009

To effectively manage any resource, we need to know what we have and what we've lost. Light pollution, the brightness in the nighttime sky due to artificial light, effectively masks natural sources of light at night such as the stars and the Milky Way. The NPS has developed a system for measuring sky brightness to quantify the source and severity of light pollution. This system, developed with assistance from professional astronomers and the International Dark Sky Association, uses a research grade digital camera to capture the entire sky with a series of images. Data clearly show that almost every park, even remote national parks, are not immune from stray artificial light. Sky brightness is measured in astronomical magnitudes in the visual band or Vband, abbreviated as "mags". The Vband measures mostly green light, omitting purple through ultraviolet and orange through infrared. The magnitude scale is logarithmic scale. A difference of 5 magnitudes corresponds to a 100x difference in brightness. Lower values (smaller or negative) are brighter. Further information on astronomical magnitudes can be found on this Sky and Telescope webpage. Data images are shown in false color, with yellow, red, and white corresponding to brighter sky and blue, purple and black corresponding to darker sky.

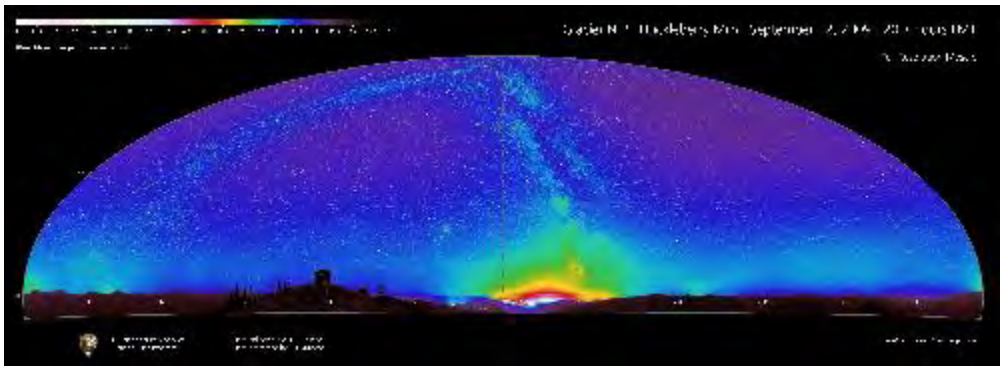
A more detailed explanation is available.

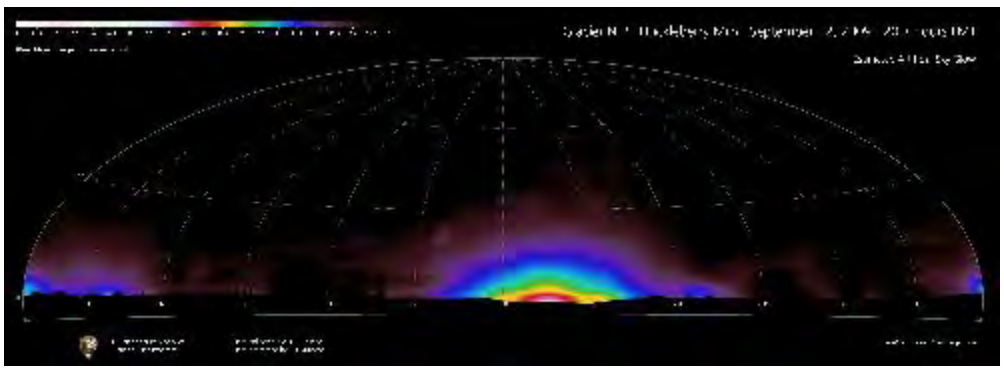
Data Set Attributes and Visual Indicators

Category	Details
Park:	Glacier NP
Site Name:	Huckleberry Mtn
Longitude:	-114.14
Latitude:	48.60
Elevation (m):	2013
Date (LMT):	12-Sep-2009
Time (LMT Hours):	20.66
Camera:	SBIG 1
Lens:	Nikon 1.8
Observers:	D Duriscoe
Air temp. (°C):	16.1
R. H. (%):	20.0
Wind Speed	6

Observed and Estimated Artificial Sky Brightness Mosaics

Click on either image for a high resolution view --**THESE ARE LARGE FILES**





(mph):	
Extinction Coeff. (mag/airmass):	0.15
NELM:	7.1
Bortle Class:	3
Synthetic SQM:	21.65
SQI All- sky:	**91.2**
SQI to Z.A. 70°:	**98.1**
Number of stars visible:	**4480**

NARRATIVE: Instrument set up on ridge just NW of the lookout. Seeing good, transparency very good. Glow to the northwest from airglow or aurora, not as bright east or southeast. Small light dome due north, fainter than Jupiter, another fainter smaller light dome northeast. Toward Columbia Falls lots of light, bright white glare illuminating the mountains from some sort of industrial yard, at least 10 unshielded lights visible, bright enough to kill night vision, casts shadows. Wonderful sky if you can get away from the glare. Milky Way directly overhead, very bright with much detail in Cygnus, all the rifts and holes apparent, North America nebula an easy visual object. Also in Cassiopeia much detail, bridge in the Milky Way north of Mirfak visible. Sagittarius Milky Way washed out by Columbia Falls area, the light dome of which extends 30 degrees from horizon upward, 40-50 degrees wide.

Photometric Indicators

Indicator	Observed		Estimated Artificial		Light Pollution Ratio (Artificial/Natural)
Sky Luminance Measures					
	mag/ arscec^2	**µcd/ m^2**	**mag/ arscec^2**	**µcd/ m^2**	
Zenith	21.59	250	> 24.5	< 17	< 0.10
Mean all-sky	21.34	316	23.18	57	0.23
Brightest	17.67	9,155	17.69	8,960	52.40
Darkest	22.08	157	> 24.5	< 17	< 0.10
Median	21.48	273	24.54	16	0.07
Illuminance Measures					
	mags	**milli-lux**	**mags**	**milli-lux**	
Horizontal	-6.25	0.80	-3.32	0.05	0.07
Max Vertical	-6.19	0.76	-5.00	0.25	0.64

Night Sky Quality Monitoring Report

Glacier NP

St Mary's VC 19-Aug-2009

To effectively manage any resource, we need to know what we have and what we've lost. Light pollution, the brightness in the nighttime sky due to artificial light, effectively masks natural sources of light at night such as the stars and the Milky Way. The NPS has developed a system for measuring sky brightness to quantify the source and severity of light pollution. This system, developed with assistance from professional astronomers and the International Dark Sky Association, uses a research grade digital camera to capture the entire sky with a series of images. Data clearly show that almost every park, even remote national parks, are not immune from stray artificial light. Sky brightness is measured in astronomical magnitudes in the visual band or Vband, abbreviated as "mags". The Vband measures mostly green light, omitting purple through ultraviolet and orange through infrared. The magnitude scale is logarithmic scale. A difference of 5 magnitudes corresponds to a 100x difference in brightness. Lower values (smaller or negative) are brighter. Further information on astronomical magnitudes can be found on this Sky and Telescope webpage. Data images are shown in false color, with yellow, red, and white corresponding to brighter sky and blue, purple and black corresponding to darker sky.

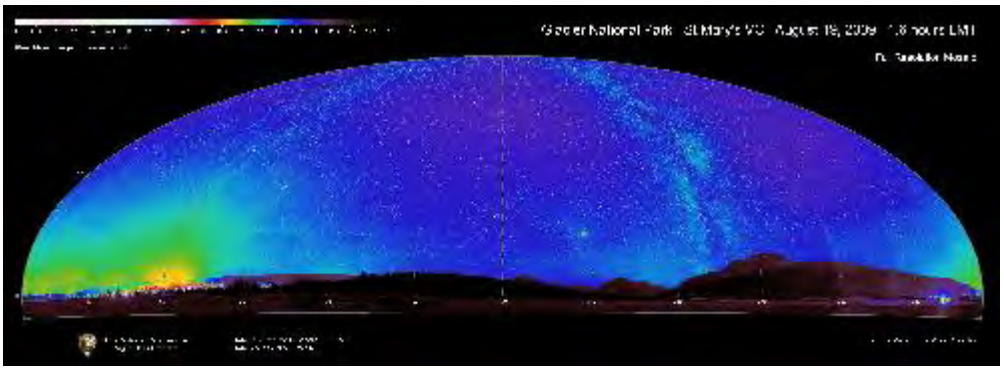
A more detailed explanation is available.

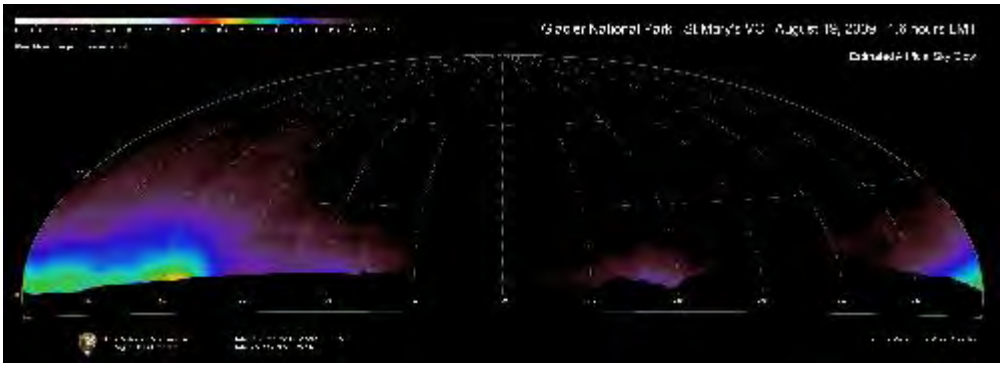
Data Set Attributes and Visual Indicators

Category	Details
Park:	Glacier NP
Site Name:	St Mary's VC
Longitude:	-113.44
Latitude:	48.74
Elevation (m):	1388
Date (LMT):	19-Aug-2009
Time (LMT Hours):	1.57
Camera:	IMG 3
Lens:	Nikon 1.8
Observers:	T Jiles C Moore
Air temp. (°C):	10.0
R. H. (%):	75.0
Wind Speed	

Observed and Estimated Artificial Sky Brightness Mosaics

Click on either image for a high resolution view --**THESE ARE LARGE FILES**





(mph):	
Extinction Coeff. (mag/airmass):	0.26
NELM:	7.1
Bortle Class:	3
Synthetic SQM:	21.56
SQI All- sky:	**90.9**
SQI to Z.A. 70°:	**96.**
Number of stars visible:	**3260**

NARRATIVE: Some direct glare creating difficulties in dark adapting looking north. M13, 31, and 33 all visible naked eye. SQM measure of 21.77

Photometric Indicators

Indicator	Observed		Estimated Artificial		Light Pollution Ratio (Artificial/Natural)
Sky Luminance Measures					
	mag/ arscec^2	**µcd/ m^2**	**mag/ arscec^2**	**µcd/ m^2**	
Zenith	21.62	244	> 24.5	< 17	< 0.10
Mean all-sky	21.30	328	23.24	54	0.22
Brightest	19.59	1,560	19.83	1,248	7.30
Darkest	21.81	202	> 24.5	< 17	< 0.10
Median	21.45	282	24.83	13	0.05
Illuminance Measures					
	mags	**milli-lux**	**mags**	**milli-lux**	
Horizontal	-6.36	0.89	-3.69	0.08	0.09
Max Vertical	-6.17	0.75	-4.86	0.22	0.56

Light Readings – Glacier National Park
Hudson Bay District
Taken by Mark Wagner, Hudson Bay District Interpreter

All readings recorded on March 29, 2016

Reading Site 1: Park Boundary, Chief Mountain International Peace Park Highway
48.58.54 -113.36.60
Cloud cover = 0%
Moon visibility = 0%
Temperature = 30 degrees F
Time: 0945 pm
Reading 1 21.73
Reading 2 21.77
Reading 3 21.82
Reading 4 21.82
Reading 5 21.82

Reading Site 2: Many Glacier valley at Sherburne Lake dam/park boundary
48.49.75 -113.31.47
Cloud cover = 0%
Moon visibility = 0%
Temperature = 29 degrees F
Time 1030 pm
Reading 1 21.80
Reading 2 21.80
Reading 3 21.80
Reading 4 21.83
Reading 5 21.83

Reading Site 3: Going-to-the-Sun Road at Mile 1 Gate near St. Mary
48.44.23 -113.27.48
Cloud cover = 0%
Moon visibility = 0%
Temperature = 29 degrees F
Time 1055 pm
Reading 1 21.82
Reading 2 21.80
Reading 3 21.81
Reading 4 21.81
Reading 5 21.83

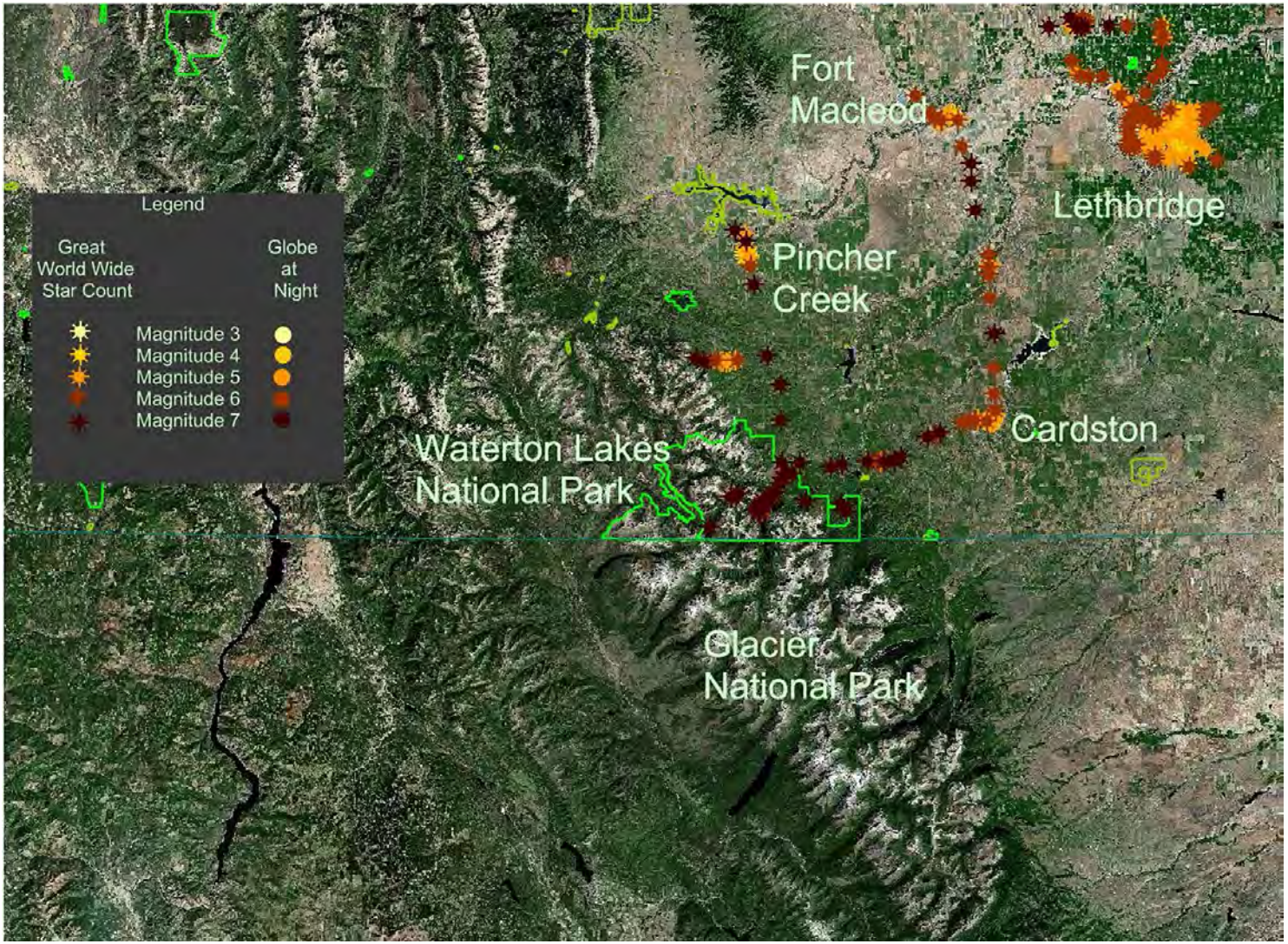
Light Readings—Glacier National Park
West Lakes
Taken by Iree Wheeler, Dark Skies Intern

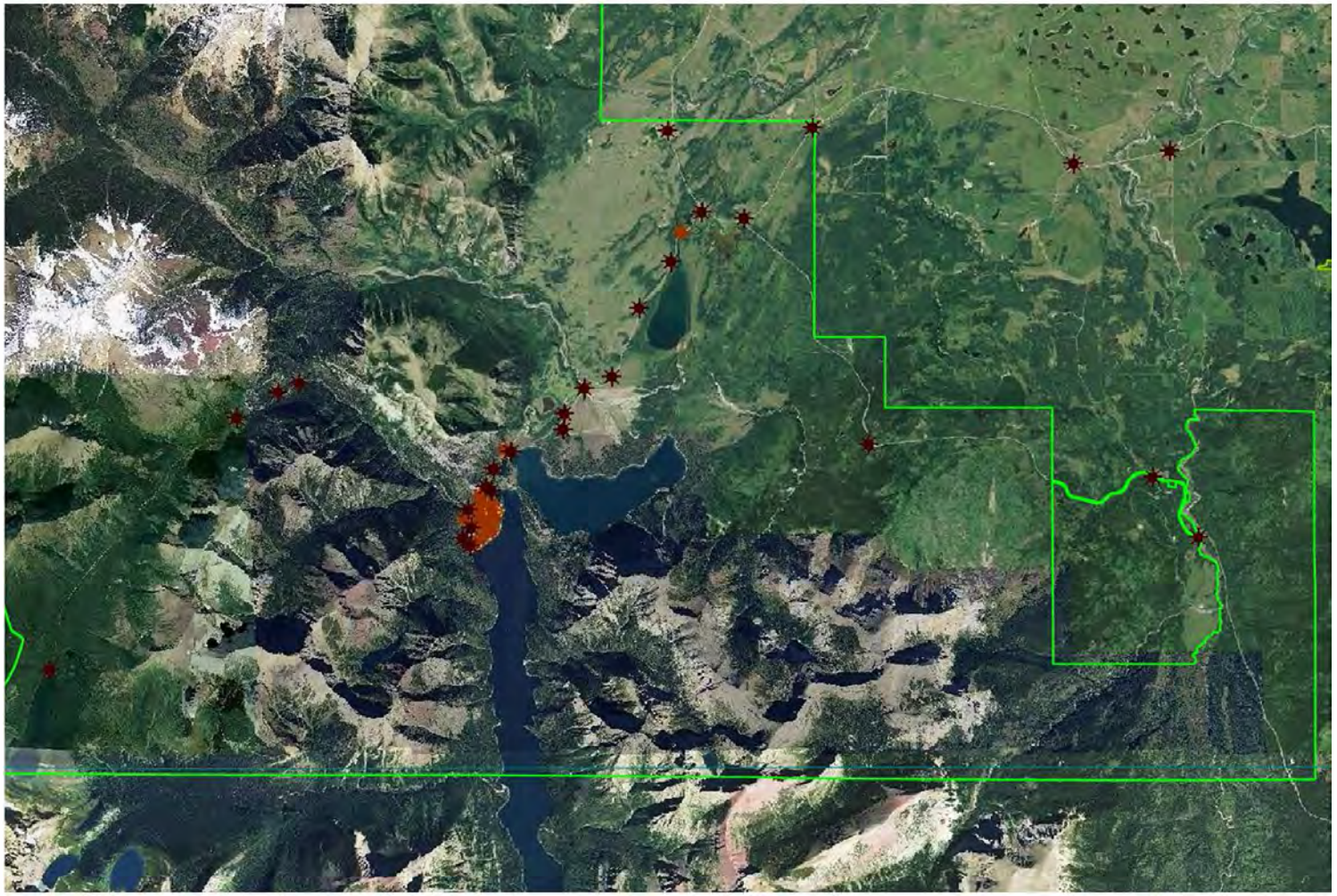
Reading Site 1: Lake Mcdonald Lodge, down beach near inlet
April 7, 2016
48.629 -113.869
Moon visibility: 1%
Cloud Cover: 12%
Time: 0935 PM
Reading 1 21.60
Reading 2 21.41
Reading 3 21.68
Reading 4 21.68
Reading 5 21.58

Reading Site 2: Apgar Village, on dock
April 7, 2016
48.528 -113.985
Moon visibility: 1%
Cloud Cover: 12%
Time: 1025 PM
Reading 1 21.44
Reading 2 21.57
Reading 3 21.57
Reading 4 21.49
Reading 5 21.50

Reading Site 3: Polebridge Entrance Station
April 8, 2016
48.783 -114.280
Moon visibility: 2%
Cloud Cover: 19%
Time: 0940 PM
Reading 1 21.52
Reading 2 21.49
Reading 3 21.52
Reading 4 21.57
Reading 5 21.58

Waterton:


Legend
Great World Wide Star Count
Globe at Night
Magnitude 3
Magnitude 4
Magnitude 5
Magnitude 6
Magnitude 7
Fort Macleod
Lethbridge
Pincher Creek
Cardston
Waterton Lakes National Park
Glacier National Park



Waterton Lakes QSM Dark Sky Meter Readings

Site 1 - Cameron Lake (Lakeshore)		GPS (WGS-84)	Latitude	Longitude	Altitude	Date	Approx. Time
Milky Way SW to NE, passing Overhead			**49° 1' 10.49" N**	**114° 2' 42.70" W**	**1662.70 m**	**21-Sep-14**	**9:50 pm MDT**
Sky Conditions: Very clear & transparent, no haze or cloud, no obvious aurora							
Reading 1	Zenith, incl Milky Way	21.59					
Reading 2	Zenith, incl Milky Way	21.57					
Reading 3	Zenith, incl Milky Way	21.60					
Reading 4	High in north, to Ursa Minor	21.69					
Reading 5	High in east, to Pegasus	21.58					
Reading 6	High in south, to Dephinus	21.47					
Reading 7	High in NE to Cepheus, incl dark trees	21.68					
Reading 8	Zenith, to Cygnus	21.58					
Reading 9	High in south, to Aquila, incl Milky Way	21.49					
Reading 10	High in NE, to Cepheus, incl dark trees	21.63					
Reading 11	Low in south, to Capricornus, some glow visible	21.45					
Reading 12	High in SW, to Ophiuchus	21.53					
Reading 13	Zenith, to Cygnus	21.56					
	AVERAGE	**21.57**					

Site 2 - Red Rock Canyon (Rim Trail)		GPS (WGS-84)	Latitude	Longitude	Altitude	Date	Approx. Time
Milky Way SW to NE, passing Overhead			**49° 7' 51.14" N**	**114° 1' 35.76" W**	**1532.30 m**	**21-Sep-14**	**10:55 pm MDT**
Sky Conditions: Very clear & transparent, no haze or cloud, no obvious aurora							
Reading 1	Zenith, incl Milky Way	21.77					
Reading 2	Zenith, incl Milky Way	21.55					
Reading 3	Zenith, incl Milky Way	21.58					
Reading 4	East, to Pegasus	21.54					
Reading 5	East, to Pegasus	21.57					
Reading 6	West, to Hercules	21.56					
Reading 7	West, to Hercules	21.57					
Reading 8	North, to Ursa Minor, incl dark tree	21.60					
Reading 9	North, to Ursa Minor, incl dark tree	21.63					
Reading 10	South, to Aquila	21.48					
Reading 11	South, to southern Cygnus	21.53					
Reading 12	NE, to Andromeda, incl dark tree	21.63					
Reading 13	NE, to Cassiopeia	21.64					
Reading 14	SE, to Pisces	21.52					
Reading 15	SE, to Pisces	21.52					
Reading 16	Zenith, incl Milky Way	21.55					
Reading 17	Zenith, incl Milky Way	21.60					
	AVERAGE	**21.58**					

Site 3 - Bison Compound (South Side on Loop Road)		GPS (WGS-84)	Latitude	Longitude	Altitude	Date	Approx. Time
Milky Way SW to NE, passing Overhead and to West			**49° 7' 16.82" N**	**113° 51' 56.72" W**	**1356.90 m**	**21-Sep-14**	**11:55 pm MDT**
Very clear & transparent, N horizon now visible, with faint aurora, with urban glows visible to NE and to the North, and townsite visible as a glow, plus a skyglow above that more distant to the south							
Reading 1	Zenith, incl Milky Way	21.56					
Reading 2	Zenith, incl Milky Way	21.52					
Reading 3	Zenith, incl Milky Way	21.52					
Reading 4	East, to Andromeda	21.53					
Reading 5	East, to Andromeda	21.52					
Reading 6	North, to Ursa Minor	21.49					
Reading 7	North, to Ursa Minor	21.48					
Reading 8	NW to Hercules	21.51					
Reading 9	NW to Hercules	21.51					
Reading 10	South, to Aquila	21.49					
Reading 11	South, to Aquila	21.49					
Reading 12	High in East, to Pegasus	21.54					
Reading 13	High in East, to Pegasus	21.52					
Reading 14	Low in the North, to Big Dipper incl glows and hor	21.36	< Note decrease when distant glows in view				
Reading 15	Low in the North, to Big Dipper incl glows and hor	21.36					
Reading 16	Low in the North, to Big Dipper incl glows and hor	21.43					
Reading 17	Low in the North, to Big Dipper incl glows and hor	21.40					
Reading 18	High in North, to Polaris	21.47					
Reading 19	High in North, to Polaris	21.43					
Reading 20	Low in NE, to Capella	21.35	< Note decrease when distant urban glows in view - Pincher Creek?				
Reading 21	Low in NE, to Capella	21.37					
	AVERAGE	**21.47**					

Site 4 - Maskinonge Viewpoint (south side of parking lot)		GPS (WGS-84)	Latitude	Longitude	Altitude	Date	Approx. Time
Milky Way SW to NE. passing high to the West (not across Zenith)			**49° 6' 36.72" N**	**113° 50' 11.56" W**	**1291.40 m**	**22-Sep-14**	**12.40 am MDT**
Very clear & transparent, urban glows visible to NE and to the North, and townsite visible as a prominent glow, distant horizon glow to the south, Entrance Gate lights exposed and glaring							
Reading 1	Zenith, with Milky Way now west of zenith	21.60					
Reading 2	Zenith, with Milky Way now west of zenith	21.55					
Reading 3	Zenith, with Milky Way now west of zenith	21.53					
Reading 4	East, to Aries	21.53					
Reading 5	East, to Aries	21.53					
Reading 6	NE to Perseus	21.53					
Reading 7	North, to Polaris	21.50					
Reading 8	North, to Polaris	21.51					
Reading 9	Low in North, to Big Dipper	21.44					
Reading 10	NW, to Hercules	21.50					
Reading 11	NW, to Hercules	21.50					
Reading 12	High in West, to Milky Way	21.50					
Reading 13	High in West, to Milky Way	21.49					
Reading 14	Low in West, incl Entrance Lights	21.38	< Note decrease when Entrance Lights in view				
Reading 15	Low in West, incl Entrance Lights	21.38					
Reading 16	Low in South, to Carpricornus	21.45					
Reading 17	Low in South, to Carpricornus	21.44					
Reading 18	Zenith, with Milky Way now west of zenith	21.53					
Reading 19	Zenith, with Milky Way now west of zenith	21.54					
Reading 20	Aimed straight at Entrance Lights	*20.99*	< Note further decrease when aimed straight at Entrance Lights				
Reading 21	Aimed straight at Entrance Lights	*21.00*	< Note further decrease when aimed straight at Entrance Lights				
	AVERAGE	**21.50**	< Average excludes last 2 readings aimed horizontally at Entrance Lights				

Site 5 - Prince of Wales Hotel Overlook (at edge of plateau south of Hote		GPS (WGS-84)	Latitude	Longitude	Altitude	Date	Approx. Time
Milky Way SW to NE. passing high to the West (not across Zenith)			**49° 3' 28.59" N**	**113° 54' 12.83" W**	**1337.10 m**	**22-Sep-14**	**1:20 am MDT**
Sky still very clear, aurora now becoming more visible, Lights on Hotel exterion were OFF, unshielded sodium vapour streetlights on service road to Hotel ON, townsite lights now prominent to the south							
Reading 1	Zenith, with Milky Way now west of zenith	21.54					
Reading 2	Zenith, with Milky Way now west of zenith	21.48					
Reading 3	Zenith, with Milky Way now west of zenith	21.48					
Reading 4	Zenith, with Milky Way now west of zenith	21.48					
Reading 5	High in South, to Pisces	21.40					
Reading 6	High in South, to Pisces	21.39					
Reading 7	High in West, incl Milky Way and nearby sodium	21.18	< Note decrease when aimed to include lights				
Reading 8	High in West, incl Milky Way and nearby sodium	21.05					
Reading 9	High in West, incl Milky Way and nearby sodium	20.99					
Reading 10	High in West, incl Milky Way and nearby sodium	20.89					
Reading 11	High in West, incl Milky Way and nearby sodium	21.03					
Reading 12	High in Northm to Polaris, incl Hotel lit by town lig	21.39					
Reading 13	High in Northm to Polaris, incl Hotel lit by town lig	21.41					
Reading 14	High in Northm to Polaris, incl Hotel lit by town lig	21.39					
	AVERAGE	**21.29**	< Despite lower reading, photos still show the Gegenschein as visible to				
			the south				

Site 6 - Cameron Bay (Lakeshore with trees blocking direct view of stree		GPS (WGS-84)	Latitude	Longitude	Altitude	Date	Approx. Time
Milky Way SW to NE. passing high to the West (not across Zenith)			49° 2' 39.95" N	113° 54' 49.47" W	1310.40 m	22-Sep-14	2:10 am MDT
Sky still very clear, aurora less visible, Streetlights on Campground road glaring but hidden from direct view behind trees between the parking lot and lakeshore							
Reading 1	Zenith, with Milky Way now well west of zenith	21.75	< Highest reading of the night! But perhaps spurious				
Reading 2	Zenith, with Milky Way now well west of zenith	21.53					
Reading 3	Zenith, with Milky Way now well west of zenith	20.94	< Lower because position or angle brought streetlight into direct view?				
Reading 4	Zenith, with Milky Way now well west of zenith	21.52					
Reading 5	Zenith, with Milky Way now well west of zenith	21.43					
Reading 6	Zenith, with Milky Way now well west of zenith	21.52					
Reading 7	East, to Perseus and Auriga	21.48					
Reading 8	East, to Perseus and Auriga	21.47					
Reading 9	East, to Perseus and Auriga	21.45					
Reading 10	East, to Perseus and Auriga	21.47					
Reading 11	South, over lake to Piscis Aust	21.57					
Reading 12	South, over lake to Piscis Aust	21.55					
Reading 13	South, over lake to Piscis Aust	21.56					
Reading 14	South, over lake to Piscis Aust	21.54					
Reading 15	South, over lake to Piscis Aust	21.56					
Reading 16	South, over lake to Piscis Aust	21.54					
Reading 17	High in West, incl Milky Way, streetlight and dark	21.59					
Reading 18	High in West, incl Milky Way, streetlight and dark	21.54					
Reading 19	High in West, incl Milky Way, streetlight and dark	21.54					
Reading 20	High in West, incl Milky Way, streetlight and dark	21.58					
Reading 21	High in West, incl Milky Way, streetlight and dark	21.58					
Reading 22	Zenith, with Milky Way now well west of zenith	21.53					
Reading 23	Zenith, with Milky Way now well west of zenith	21.51					
Reading 24	Zenith, with Milky Way now well west of zenith	21.50					
	AVERAGE	21.51					

Collection of long-term sky quality measurements and photo documentation will be the responsibility of park management staff.

Waterton-Glacier International Peace Park possess three Unihedron Sky Quality Meters.

In Waterton the visitor experience product development officer will be responsible for taking annual Sky Quality Measurements at the selected viewing sites.

In Glacier Park, the East side measurements will be the responsibility of the Hudson Bay District Ranger. The Sky Quality readings on the West side of Glacier will be conducted by the Resource Management Program Manager.

Waterton-Glacier International Peace Park World Heritage Site Lighting Plans

Glacier National Park Lighting Management Plan:

Introduction:

The purpose of this plan is to guide exterior lighting repair, replacement and installation of new fixtures in Glacier National Park to assure preservation of the park's pristine dark night skies.

In compliance with the International Dark Skies Association's Guidelines for Outdoor Lighting (GOL) and the lighting guidelines outlined in the National Park Service 2006 Park Management Policies 4.10 regarding lightscapes management. The goal of this lighting management plan is to provide visitor safety in park developed areas while preserving Glacier National Park dark sky views for future enjoyment. The extraordinary dark skies of Waterton-Glacier International Peace Park (WGIPP) are an important resource to be protected and preserved for wildlife health, and for visitors to experience truly dark skies. As light pollution becomes more prevalent in urban areas, it is less likely for citizens to have opportunities to see the Milky Way and other nightscape features and views.

A survey of the developed areas of Glacier National Park was conducted to evaluate light fixtures for dark sky compliance throughout the park. The goal was to collect the information necessary and recommend modifications to the parks existing exterior lighting, to conform to the International Dark- Skies Association (IDA) lighting regulations (colour of light, duration of illumination, extent of illumination). In order to protect night skies and to become a designated International Dark Sky Preserve.

The park's default policy will be to not install permanent outdoor lighting except in cases where specific public safety hazards have been identified that can only be mitigated through the use of outdoor lighting.

The recommendations for most lighted areas in the park are to replace applicable fixtures with shielded fixtures, and transition the remaining bulbs in the park to "Amber" LED. These lights are the most effective in providing necessary lighting for human safety without providing too much light which contributes to light pollution, as well as being harmful to human health and nocturnal animal's wellbeing and survivability.

In the developed areas of the park, some buildings are operated and maintained by the park service, while many others are owned by the park but operated by concessionaires. In the most recent contract renewals, concessionaires have been asked to shift the lighting of the buildings they operate into compliance with dark skies regulations. (See Appendix C for Xanterra Lighting Management Plan)

Recommendations and Lighting Surveys:

When developing a plan to reduce the impacts that lighting has on the park's night sky resources, several documents from the IDA were used. The Model Lighting Ordinance was used to organize how the different zones of the park will be managed. (Appendix E) Most of the Glacier National Park is managed as wilderness; much of the park has no light interference and is MLO lighting Zone 0. The few developed areas of the park are managed in Lighting Zone 1. Minimal lighting is used only to light high visitor use areas. Extra lighting that could impact flora and fauna is limited.

The Guidelines for Outdoor Lighting were used to determine what lighting was necessary in the park. The question that was asked to make every light decision was directly from the GOL: "Is the lighting necessary?" The deciding factors for "necessary lighting" are defined as:

1. Illumination should be to the minimum practical level,

2. The affected area of illumination should be as small as practical,

3. The duration of the illumination should be as short as practical, and

4. Illumination should minimize the amount of short wavelength spectral content including UV and blue light (avoid cool or wide spectrum white light). (Guidelines for Outdoor Lighting)

5. There will be a hard limit of 4000K for the correlated color temperature of any lighting installed in the park.

6. All lighting exceeding 500 initial lumens will be shielded.

Local lighting policies:
Neither the State of Montana nor the surrounding counties (Flathead and Glacier) have existing policies relating to exterior lighting, however as Glacier works towards IDA compliance local discussions will occur.

The developed sites that were surveyed:

1. Apgar Campground
2. Apgar Village
3. Avalanche Campground
4. Fish Creek Campground
5. The Glacier Institute
6. Goat Haunt
7. Headquarters
8. Lake McDonald Lodge
9. Lake McDonald Ranger Station
10. Many Glacier
11. Polebridge
12. Rising Sun
13. Sprague creek
14. St. Mary Campground
15. St. Mary—Hudson
16. Two Medicine
17. Walton
18. East Glacier Ranger Station
19. West Glacier Entrance Station

Exempt lighting:

Emergency lighting is exempt from replacement or removal for IDA Dark Sky Park designation, as it is only used in the case of an emergency.

Fixtures with no light bulb will be given recommendations in the event of light replacement, but unless necessary these fixtures should remain vacant.
! Í ÁÊÏÒÉÔÙ ÏÆ ÔÈÅ ÐÒÏÐÅÒÔÙ ÉÎ 'ÌÁÃÉÅÀÒ .ÁÔËÏ ÎÁÌ 0ÁÒË ÉÓ ÐÕÂÌÉÃÌÙ Ï × ÎÅÄ ÌÁÎÄ 4ÈÅÒÅ ÁÒÅ ÓÅÖÅÒÁÌ ÐÒÉÖÁÔÅÌÙ Ï × ÎÅÄ ÉÎÈÌÄÉÎÇ ÉÎ ÔÈÅ ÐÁÒË %ÖÅÒÙ ÙÅÁÒ ÔÈÅÒÅ ÁÒÅ ÐÒÉÖÁÔÅ ÉÎÈÌÄÉÎÇ ÌÁÎÄ Ï × ÎÅÒ Í ÅÂÔÉÎÇ ÂÔ ÔÈÅÓ Í ÅÂÔÉÎÇ ÌÁÎÄ Ï × ÎÅÒÓ ÈÁÖÅ ÂÅÅÎ ÉÎÆÏÒ Í ÄÄ ÏÆ 'ÌÁÃÉÅÒ›Ó ÁÔÔÅ Í ÐÔÓ ÔÏ ÁÃÑÕÉÒÅ Á $ÁÒËȚ3ËÙ 0ÁÒË ÄÅÓÇÎÁÔÉÏÎ ,ÁÎÄ Ï × ÎÅÒÓ ÁÒÅ ÅÎÄÏÕÒÁÇÄ ÔÏ ÒÅÔÒÏÆÍÔ ÔÈÉÒ ÐÒÏÐÅÒÔÙ ÁÎÄ ÁÒÅ ÐÒÏÖÍÄÄ ×ÉÈ ÁÃÃÅÓÓ ÔÏ ÉÎÆÏÒ Í ÁÔÉÏÎ Ï Ï)$! ÁÐÐÒÏÖÄ ÒÅÐÌÁÃÅ Í ÅÎÔ ÆÉØÔÕÒÅÓ

Lighting Replacement fixtures

RAB Designs WRDS LED fixture:

- One LED array with six LEDs, 799 lumen's out of the fixture
- NW color temperature 4000k
- Color rendering Index CRI > 70
- Operating temperature -40C to 40C

Hubbell Amber LED LNC Wallpack:

- Full cut-off neighbor friendly
- DesignLights Consortium (DLC) qualified (See specification sheet for qualified models)
- 3000K, 4000K, 5000K and Amber color temperatures
- Long life – 60,000hr L96 rating
- Photo control option offered for dusk-to-dawn control (120V only)
- Acrylic diffuser included! Use for applications near entrances or locations where reduced brightness is desired. (Maximum spacing with diffuser 30ft)
- Listed to UL1598 for use in wet locations

Progress Cylinder:

Width/Diameter: 6"
Height: 12"

Lamp Quantity: one
Lamp Type: LED
Lamp Wattage (Max): 29

Beacon Urban LED streetlight:

- Watts: 80
- Correlated Color Temperature (CCT): 3,000K
- Optical one piece cartridge system (LED engine, LED lamps, optics, gasket, stainless steel bezel)

Atlas WPS13LED Wall Pak:

- Light Output (Lumens): 1,570
- Watts: 12.95
- Lumens per Watt (efficacy): 121.5
- Color Accuracy (CRI): 82
- Correlated Color Temperature (CCT): 4500K
- Lifespan: >100,000H

RAB Design CLB-LED ceiling mounted fixture:

- Light Output (Lumens) : 1,235
- Correlated Color Temperature (CCT): 5,000k
- Color Rendering Index (CRI) >67
- Lamp Life (L70) >50,000H
- Working temperature -40C to +40C
- Input voltage 120-277V
- Ingress Protection IP65

IDA Lighting Zones

The Lighting Zone shall determine the limitations for lighting as specified in this ordinance. The Lighting Zones shall be as follows:

LZ0: No ambient lighting 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.

LZ1: Low ambient lighting 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 it is not necessarily uniform or continuous. After curfew, most lighting should be extinguished or reduced as activity levels decline.

LZ2: Moderate ambient lighting 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, lighting may be extinguished or reduced as activity levels decline.

LZ3: Moderately high ambient lighting 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 curfew, lighting may be extinguished or reduced in most areas as activity levels decline.

LZ4: High ambient lighting Areas of human activity where the vision of human residents and users is adapted to high light levels. Lighting is generally considered necessary for safety, security and/or convenience and it is mostly uniform and/or continuous. After curfew, lighting may be extinguished or reduced in some areas as activity levels decline.

Timeline of replacement plans for GNP:

The recommendations for lighting replacement have been made for all of the developed sites in the park. These areas will be managed as LZ1. (Appendix C) Due to Glacier National Parks large size and variety of developed areas, the park is currently at a very low compliance rate; however a light retrofitting project is in motion for the comfort stations in all of the parks front country campgrounds for 2016. The next step is the replacement of exterior lights on park housing at Many Glacier, Park Headquarters, and St. Mary. Light replacements projects for these locations are in the process and would be executed in the next three years to bring the park up to 67% compliance. These projects will be funded by a combination of cyclical maintenance fund, and grants from Glacier National Park community partners.

Summary of Glacier National Park's Existing Lighting:

Location:	% Compliant NPS	Compliant lights out of total	% Compliant Concession	Compliant lights out of total	NPS w/ 2016 CS fixtures	Compliant lights out of total
Many Glacier /Swiftcurrent	39	(40/101)	54	(139/256)	58	(59/101)
Lake McDonald			49	(107/215)		
Rising Sun	10	(2/20)	66	(60/90)	65	(13/20)
Apgar village	61	(56/91)	53	(57/107)	61	(56/91)
Fish creek	42	(21/50)			88	(44/50)
Avalanche	100	(2/2)			100	(2/2)
Apgar CG	32	(16/50)			96	(48/50)
Glacier Institute			25	(2/8)		
Goat Haunt	74	(14/19)			74	(14/19)
Headquarters	18	(40/220)			18	(40/220)
Polebridge	3.7	(1/27)			3.7	(1/27)
Sprague creek	0	(0/14)			71	(10/14)
St. Mary CG	33	(22/66)			57	(38/66)
St. Mary Hudson	14	(14/97)			14	(14/97)
Two Medicine	14	(9/64)	33	(3/9)	57	(37/64)
Walton	9	(1/11)			9	(1/11)
East Glacier RS	25	(3/12)			25	(3/12)
West Glacier ES	100	(9/9)			100	(9/9)
Lake McDonald RS	22	(2/9)			22	(2/9)
Total:	29	252/862	53	368/685	45	391/862

NPS operated Housing Retrofits planned for 2017:

Location:	% compliant	Lights replaced out of total	Additional Retrofits
St. Mary	67	65/97	51
Many Glacier	76	77/101	18
Headquarters	79	176/220	134

Dark Skies Lighting Replacement Plan

Waterton Lakes National Park

Waterton Lakes National Park has several areas in the park with varying levels of night time use. For the purposes of this application, areas outside of the townsite of Waterton have little to no lighting except at certain facilities, resulting in dark skies with excellent viewing opportunities at prime viewing locations including Cameron Lake day use area, Red Rock Canyon, the Maskinonge and the Bison Paddock.

The townsite area is a full service year round community including shops, restaurants, and hotels, staff housing and residential properties. There is also a full service campground which operates from May to October. The population fluctuates from 2000 at the height of the summer season to about 50 residents in the winter. Because of its proximity to the campground and residences, there are a few easily accessible star gazing locations, including at the Falls Theatre, Cameron Bay and adjacent to the Peace Park Pavilion. The Falls Theatre is the best venue for public events as it accessible, and an indoor program can be offered easily in the case of poor viewing conditions.

Replacement or installation of any new lighting in Waterton Lakes National Park must follow the Parks Canada Guidelines and Specifications for Outdoor Lighting (PC-GOL, 2008). Outdoor fixtures must be shielded, full cut off low intensity dark sky compliant lights. Interior lighting must be designed to reduce light trespass. The colour temperature of any new luminaires should be under 3000K, with amber LED or converted amber LED preferred.

None of the lights in Waterton Lakes National Park are dark sky compliant. However, the deficiencies identified in the "Report on Current Lighting Within Waterton Lakes National Park, specifically the Townsite of Waterton" prepared by Robert Dick (2014) will be addressed as the Federal Infrastructure Investment Plan is implemented. This program includes one million dollars for grounds infrastructure in the townsite. This means all streetlights, and Parks Canada facilities will be dark sky compliant by 2019. In addition, the compound area is also slated for major redevelopment. $25,000 will be spent before March 31, 2016 to retrofit all staff residences with fully shielded light fixtures.

There are only a handful of facilities that have lighting located outside the townsite/compound area.

Prince of Wales Hotel

The Prince of Wales operates from late June to early September. During the operating season, there are lights around the exterior of the building to highlight the unique architecture. A preliminary discussion on dark sky lighting has taken place regarding one particular project.

Operations Compound

The report done by Robert Dick, Lighting Consultant, identified a number of areas for improvement. However, the compound area is approved in concept for redevelopment, with design work and layout underway, including dark sky compliant lighting.

Camp Columbus

Camp Columbus is an overnight youth and retreat facility, operating from May to October

Golf Course

The Waterton Lakes Golf course operates from May to October.

Alpine Stables

Alpine Stables operates from May to early October.

Crandell Mountain Campground

Washrooms will have indoor motion activated low LED lights, and low wattage motion sensor full cut off exterior lights. Project will be complete by fall 2016.

Canyon Church Camp

The Canyon Church Camp is an overnight youth and retreat facility, operating from May to early October.

Entrance gate on Highway 5/6

New light fixtures have been installed at the park entry gate. However, further improvements will be investigated.

Chief Mountain Customs buildings

These facilities are the international border crossing between Canada and the United States. They are operated by Canada Border Services Agency and United States Customs and Border Protection. The port of entry into the United States is listed on the National Register of Historic Places as a notable example of National Park Service Rustic Style of architecture.

The two municipal districts directly adjacent to Waterton Lakes National Park (Municipal District of Pincher Creek and Municipal District of Cardston) have no by-laws related to artificial lights at nights. As retrofits within the park take place, discussions with the municipal districts will occur.

Lighting Inventory

Site	Location/Street	Building/Pole	Number	Replacement	Comments
Townsite Campground	Section A	poles	10	FII, bollards, 2017 spring	Inc=incadescent
Townsite Campground	Section A	building	3	FII, bollards, 2017 spring	PT=Park Townsite
Townsite Campground	Section B	building	6	FII, bollards, 2018 spring	PV=Park Visitor Centre
Townsite Campground	Section B	building	1	FII, bollards, 2018 spring	PC=Park Compound
Townsite Campground	Section B	pole	2	FII, bollards, 2018 spring	PG=Park Gate
Townsite Campground	Section E	building	3	FII, bollards, 2018 spring	FS=Fortis Streetlights
Townsite Campground	Section G	building	4	FII, bollards, 2017 spring	FII=Federal Infrastructure Investment
Townsite Marina	Marina	poles (8 lamps)	8	FII, bollards, 2020	
Townsite Marina	Parking	poles	6	FII, townsite infrastructure, 2020	
Townsite	Waterton Ave	poles	11	FII, townsite infrastructure, 2020	
Townsite	Waterton Ave; by camp kit.		3?	FII, townsite infrastructure, 2020	
Townsite	Cameron Falls bridge	poles	2	Not functioning	don't appear to be working
Townsite	Fortis Streetlights	poles	46	FII, townsite infrastructure, 2020	
Park Compound	Res Con Building	building	2	2016-17	entrance light, main and basement entrance
Park Compound	Res Con Building	building	1	2016-17	small secuirity light, back entrance
Park Compound	Res Con Building	building	2	2016-17	Inc, garage
	Res Con Building	building	2	2016-17	front of building flood lamps; don't appear to be working
Park Compound	Operations Building	building	6	2016-17	entrance light, restoration, carpentry, reception, back of ops, loading bay entrance
Park Compound	Operations Building	building	1	2016-17	entrance light, IRV Entrance
Park Compound	Garage	building	1	FII consolidation, 2020	small wall pack light, garage entrance
Park Compound	Garage	building	1	FII consolidation, 2020	flood light, side of garage
Park Compound	Garage Storage	building	1	FII consolidation, 2020	small wall pack light, entrance
Park Compound	bunkhouse	building	2	FII, removal, 2020	small wall pack light, walkway by laundry door & courtyard
Park Compound	bunkhouse	building	1	FII, removal, 2020	Inc, laundry door
Park Compound	bunkhouse	building	18	FII, removal, 2020	inc, bunkhouse doors (18)
Park Compound	bunkhouse	building	2	FII, removal, 2020	flood lights, bunkhouse doors (2)
Park Compound	Salt Shed	building	2	2016-17	security light, Entrance & Loading Bay (2)
Park Compound	Highways Storage Shed	building	2	2016-17	inc, loading area (2)
Upper Compound	Stables	building	1	2016-17	HPS? Entrance light small wall pack (1)
Upper Compound	Sewage lagoons	building	5	2016-17	HPS? Entrance light wall pack (5)
Upper Compound	Sewage lagoons	building	1	2016-17	HPS? Entrance light small wall pack (1)
Townsite	Administration Building	building	1	2016-17	doorway, inc. (1)
Gate	Gate Kiosk	pole	4	Luminaire replaced winter 2015	double box fixtures (4)
Gate	Gate Kiosk	pole	1	Luminaire replaced winter 2015	box fixture (1); across from Randall's house
Gate	Gate Kiosk	building	6	Luminaire replaced winter 2015	inset fixtures (6); dark sky compliant
Gate	Gate Kiosk	building	2	Luminaire replaced winter 2015	caged drop down fixture? (1 or 2)
Townsite	Marina	pole	3	FII, townsite infrastructure, 2020	double box fixtures (3)
Townsite	Marina	pole	2	FII, townsite infrastructure, 2020	box fixture (2)
Townsite	Marina	pole	6	FII, townsite infrastructure, 2020	box fixture (6)
Townsite	Waterton Ave	pole	11	FII, townsite infrastructure, 2020	box fixture (11)

11. Park Interpretive Programs on Night Skies

Glacier:

Weekly sky programs:

1:30-4:00pm Wednesday-Sunday Solar viewing:

> **"Glacier's Solar Viewing"** Drop by and take a unique look at the Earth's closest star viewed safely through a special solar telescope. Dependent on weather and sky conditions. Anytime between 1:30 pm and 4:00 pm Apgar Village Green (located across from the hotels in Apgar Village)

10:00- Midnight Five days a week Night Sky viewing:

> **"Glacier's Night Sky Viewing"** Join an astronomer-in-the-park and peer into the mysteries of the night sky. Telescope viewing is available. Binoculars encouraged. Dependent on weather and sky conditions. Apgar Visitor Center parking lot

St. Mary Dark Skies Demonstrations:

> **"Half the Park Happens after Dark"** Join an astronomer-in-the-park for a tour of the heavens and learn why protecting dark skies is so important to all life on our planet. Set up begins at 10 pm; viewing begins at dark and will go until 12:30 am. St. Mary Visitor Center parking lot Offered on clear nights only. To ensure best night sky viewing, please arrive before viewing time

Logan Pass Star Party:

Weather permitting there are three free dark-sky viewing events held at Logan Pass every summer

Glacier National Park Restoration Project:

In an attempt to set an example of the importance of preserving dark night sky resources; Dark sky demonstrations at St. Mary and Apgar Visitor Centers will include the latest SQM readings for the Glacier National Park, as well as updates on the retrofits of exterior lighting throughout the park. Following the 2016 retrofit of Fish Creek Campground Exterior Lighting, Interpretive programming at this location will include information on the new IDA compliant lighting.

There are currently no brochures or formal program materials to show. Interpretation on dark sky retrofitting within the park is new and these materials are being created.

Glacier Popular Night Sky Viewing Sites:

Logan Pass Visitor Center: Access May-September

Apgar Visitor Center: Access year-round

St. Mary Visitor Center: Access year-round

St. Mary Visitor Center -- Day

"St. Mary Visitor Center -- Night"
By: Ray Stinson

"Logan Pass -- Day"
By: Ray Stinson

"Logan Pass -- Night"
By: Ray Stinson

C. Poster by Tyler Nordgren encouraging the viewing of Glacier's night skies

D. Article in the local newspaper:

Protecting one of Glacier's Greatest Resources

Article in the Flathead Beacon July 21st, 2015 by Justin Franz

If anyone needs proof that protecting Glacier National Park's dark sky is a worthy cause, all they have to do is look at John Ashley's photos.

For nearly three decades, the Kila resident has documented the park after sunset and the results are now presented in his new book, "Glacier National Park After Dark."

"This is 28 years of my life," Ashley said, gesturing to some of his night photos. "It's the result of a lot of sleep deprivation ... Glacier is amazing during the day but it's even more amazing at night."

Ashley hopes the book brings attention to a topic that is near and dear to him: Glacier's night sky and light pollution. Ashley, who has worked as a photographer, biologist and seasonal researcher in Glacier, said that in the years since he began documenting the night sky he has noticed subtle changes. For example, years ago, when shooting on the east side of the park it was possible to see the stars from horizon to horizon. But these days, if Ashley points his camera west, light

pollution from the Flathead Valley can be seen sneaking over the horizon. The same goes for when he is shooting north at Lake McDonald, where the lights from Alberta can obscure the distant stars.

Although distant light pollution is encroaching on Ashley's viewfinder, he said that the sky around Glacier is still spectacular, so much so that you can even see the Andromeda Galaxy, which is located about 2.5 million light years from Earth.

But not everyone is so lucky. Nearly two-thirds of residents in the continental United States cannot see the Milky Way from where they live and that number is increasing because of urban light pollution. In some cases, the lights from a city or urban area more than 200 miles away can disrupt the views in a rural area.

In hopes of keeping Glacier's sky dark, the National Park Service is working with its Canadian counterpart to designate Glacier and Waterton parks as the first international transboundary dark sky preserve. Since 2006, the International Dark-Sky Association has certified more than two-dozen parks around the world as dark sky preserves. To obtain that certification, a park must reduce the amount of light pollution it produces by installing dark sky-friendly lighting, which only illuminates a space below, not above a horizon line.

Mark Biel, national resource program manager for Glacier, has been heading up the initiative and just completed a lighting assessment of the park last week. He said the assessment took three years and officials were surprised at just how many light sources are in the park. Now, the park will look at ways it can reduce its light pollution and install new dark sky-friendly lights in the future. That lighting installation plan will be part of Glacier and Waterton national parks' joint dark sky application, which Biel said will be completed later this year.

"A dark night sky is an overlooked and valuable resource here because a large percentage of Americans have never even seen the Milky Way, but they can see it from their national parks," he said. "You can see what the world looked like before the industrial revolution."

Ashley said efforts like the dark sky preserve designation for Glacier are great, but added that it will take a regional effort to protect the darkness. He said communities around the park will also have to turn off or dim their lights as well and he hopes that his new book can illustrate what is at stake. He also said that there are economic and health benefits to preserving a dark sky. Environmentally friendly lighting is known to be cheaper in the long run and there are documented health benefits to sleeping in true darkness.

"The good thing is that decreasing our light pollution is as easy as turning off a light," he said.

Waterton:

Dark sky programming in Waterton Lakes National Park includes several components – regular theatre programs, periodic night sky viewing opportunities, point duties and photography workshops.

1. Theatre programs

In WLNP, there are two interpretive theatres, the Falls Theatre located at Townsite Campground and Crandell Theatre located at Crandell Campground. Free evening theatre programs are offered at both campgrounds, typically from the end of June to early September, starting at 8pm and run about 45 minutes.

In 2011, 2012, 2013 and 2015, a dark sky themed evening program was presented at each program at least once per week. There was no 2014 program due to resource constraints. Each program is 45 minutes and has focused on various aspects of the night sky including Aboriginal lore, wildlife adaptions and reducing light pollution as well as tips for viewing. 73 programs have been offered, total attendance is 5874. Average attendance is 80 people per program.

The chart below offers detailed attendance.

Year	Attendance	# Programs	AVG	Program Title
2011	1378	18	77	Things That Don't Go Bump in The Night
2012	1456	16	91	Things That Don't Go Bump in The Night
2013	1602	21	76	Things That Don't Go Bump in The Night
2014	n/a	0	n/a	None offered
2015	1438	18	80	Night Sky National Park
Total	**5874**	**73**	80	

2. Stargazing viewing opportunities

In addition to theatre programs, WLNP has offered night sky viewing opportunities to the public. These events typically take place after the evening theatre programs. A variety of formats have been tried to determine the best possible combination of darkness, location, and interpretation. Viewing has been done in July coinciding with Canada's annual Parks Day on the 3rd Saturday in July and the Perseids meteor shower in August. Several astronomers have supported the program (Peter McMahon, Alan Dyer) and volunteers from local astronomy groups (Calgary Royal Astronomical Society (RASC), Lethbridge Astronomy Club and Montana Star Watch. The park acquired a large telescope in spring 2014, and has been able to purchase other dark sky viewing supplies like green laser pointers and star charts as giveaways. A total of 13 viewing events including both day and night time activities have taken place, attracting 1576 visitors.

The most successful event took place in July 2015 with the support of Montana Starwatch. They worked to bring moon rocks acquired during the NASA Apollo Mission for a rare viewing outside of the United States. Evening skies also cooperated allowing for some informative viewing tips, updates from the New Horizon Mission to Pluto and night sky viewing.
The best location for night sky viewing with the public is at the Falls Theatre. There is enough sky to see most of the summer night sky features, and offers access to the theatre in case of poor viewing conditions.
The park is still struggling to maintain a consistent star viewing program, particularly in July when stars are not visible until after 10 p.m. Staff are still learning the night sky, and the support of knowledgeable volunteers has been invaluable in maintaining momentum for dark skies public programming. We were able to offer two ad hoc public star gazing events on August 12 and 19, after the Night Sky National Park theatre program was completed. We engaged 60 and 25 visitors respectively, with wildfire smog affecting visibility on the second event.

3. Point duties

Occasional day time point duties have occurred, particularly in 2015. We reached 502 visitors with messaging on importance of preserving dark skies and that Waterton-Glacier International Peace Park is working towards a dark skies designation, over 8 point duty programs in July and August. Using a black bear hide, and relating this to the folklore of the The Big Dipper was a useful hook for audience engagement. The point duty also included a sun-viewing device, a constellation activity for kids, and a phases of the moon activity with oreo cookies.

In 2015, Parks Day had a special focus on astronomy. Activities offered included viewing moon rocks from NASA's Apollo Mission (a rare international viewing opportunity, solar viewing, night sky lighting awareness and crafts and activities related to the solar system. A solar viewing device has been leant to the park and there is an astronomy point duty that has been developed and will be implemented as part of the summer 2016 interpretive program.

4. Other programming

In addition to park-led night sky programming, the Waterton Wildflower and Wildlife Festivals offered several workshops on night sky photography and viewing in 2015 with an astronomy educator/photographer, Alan Dyer. The Wildflower Festival offered two night sky photography workshops, with a total of about 24 participants. On the Saturday evening of the Wildlife weekend, a star gazing presentation reached 100 visitors.

There is also a page on dark sky included in the 2012 and 2013 Xplorer booklets, activity books aimed at 6-11 year olds.

Website:

The following link lists information on stargazing in Waterton Lakes National Park.

http://www.pc.gc.ca/eng/pn-np/ab/waterton/ne/ne12.aspx

Waterton Lakes National Park Restoration Projects:

Interpretive Programs -

Communicating restoration programs:

In Waterton, a brochure from the RASC on responsible lighting is available through the Realty office, and any development permits issued that include artificial lights specify that the luminaire must be dark sky compliant.

> "*The replacement or installation of new lighting must be dark sky compliant and follow the Parks Canada Guidelines and Specifications for Outdoor Lighting Outdoor fixtures must be shielded, full cut off low intensity dark sky compliant lights. Interior lighting must be designed to reduce light trespass. The colour temperature of any new luminaires should be under 2700K, with amber LED or converted amber LED preferred.* "

In addition, stargazing information is available on our website, with a particular emphasis on why Waterton Lakes National Park is a great place to view the night sky.

http://www.pc.gc.ca/eng/pn-np/ab/waterton/ne/ne12.aspx

There will be opportunities to highlight improvements made to artificial lights at night as the infrastructure projects are completed. This could be done through enhanced information about recommended lights provided to leaseholders, news media stories highlighting the infrastructure projects, or presentations delivered to interested groups about the process to obtain dark sky preserve status.

In addition, all the interpretive programs related to night skies and wildlife discuss the importance of responsible artificial light at night. These programs include Things that go Bump in the Night (2011-2013), Night Sky National Park (2015-16), and A Dark Night (2016). Excerpts are available from both A Dark Night and Night Sky National Park.

A Dark Night – about the importance of bats, 2016
Rachelle Simard, park interpreter

> *"dark skies are important for lots of our wildlife as well! A whole new set of creatures come out at night, and depend on darkness. Unfortunately earth is losing the nights as it is invaded by light. Most us live somewhere that doesn't get dark enough for our brain to recognize it as nighttime. Artificial lighting can cause frogs to refrain from singing their mating choruses. It can alter the course of migrating birds, and can cause problems for animals trying to hide from predators in the night. Ecosystems need all parts and processes to be present to be considered healthy, and a dark night is a natural process. So I encourage you while you are here in a dark place to take some time to enjoy the dark, enjoy the sounds that you hear and the stars that you see in the night sky.*
>
> *We often light up the night because we are afraid of the dark, and the creatures that come out in the dark. If we learn a little more about them though they might not be as menacing as we thought! There is one animal that I feel represents the nighttime, and just like darkness, this animal is misunderstood and often feared! This tiny creature is actually our protector, you could even call them the Dark Knight. "*

Night Sky National Park, Waterton 2015 and Glacier National Park, Many Glacier, 2016
Sierra DakinKuiper

> *Who turned on the lights? This is supposed to be NIGHT SKY national park not LIGHT BRIGHT national park! I guess it's because the natural night is a disappearing resource… Who admits to being scared of the dark? Many humans are! That is because we are diurnal, which means we are a species most active during the day! And when it isn't day, we like to turn on the lights because this makes us feel most comfortable.*

Until very recently, we would have lighted a candle or a campfire at night but now most humans around the world flip a switch and light the world artificially. Unfortunately, all this artificial light can prevent us from enjoying the night sky. So, let's take a moment to sit in the dark and get comfortable with the idea… I will turning off the lights now… Maybe without any light, we will be able to direct our attention to other senses…

Please raise your hand if you live in a town or city! If you stand on just outside your house at night, can you see the moon? … That's not surprising, it's the brightest object in the night sky.
But what about planets? Can you see any planets? They won't twinkle like stars!
How about the milky way? Its shown here in this photograph, its that long dim glowing band arching over the night sky?

If you live in a city, the chance are your view of the night sky is impaired by street lights, porch lights, and car lights.

We've grown so used to this pervasive orange haze that the original glory of an unlit night— dark enough for the planet Venus to thro shadows on Earth—is wholly beyond our experience, beyond memory almost. Here is San Francisco at night, a French photographer a few years ago decided to experiment with combinations of city and country views to show urbanites what they have been missing. Noting the precise time, angle, latitude and longitude he shot the night sky in remote places at the same latitude to then combine these images to show what the night sky would look like if we turn out the lights! So the San Francisco bridge turns from glowing cityscape, to this…

In most cities the sky looks emptied of stars, leaving behind a vacant haze that mirrors our fear of the dark and resembles the urban glow of dystopian science fiction. Astronomers were among the first to record the negative impacts of wasted lighting on their scientific research, but for all us, there are many adverse effects.

One adverse effect is wasted energy. Here is a satellite image of the Alberta at night. We can see a lot of light being produced by Edmonton, the Tar Sands in Fort McMurray and Calgary. Here is Waterton, we aren't too bad… Who here is from Calgary? Did you know that about 10 years ago the City of Calgary replaced 40,000 lights with responsible lighting fixtures and as a result, the city saved a whole lot of energy and 1.7 million dollars that year.

Here in Waterton we are working with Glacier National Park to have the first International Peace Park Dark Sky Preserve. We don't often think of the night sky as something that needs to be protected… but as we have seen, artificial lights can really have an impact on our view of the night sky. Light at night can also impact our health and the nocturnal environment.

Humans, animals and plants live by a rhythm which is attuned to our planet's 24-hour cycle. Have you ever travelled overseas and had to adjust to another time zone? You may have noticed a change in your circadian rhythm, your very own body clock that tells you when to sleep and when to wake up, when you travel through several time zones. Were you sleepy, lethargic, not able to tie your shoes because you couldn't think straight? We know that darkness is as essential to our internal clockwork as light itself. The oscillation of waking and sleep in our is nothing less than a biological expression of the oscillation of light on Earth! So fundamental are these rhythms to our being that altering them is like altering gravity. For example, being exposed to light at night can suppress the production of melatonin, a hormone that helps to regulate sleep cycles. Scientists are now discovering that light at night is linked to obesity, depression and other diseases!

Artificial light can impact animals circadian rhythm just like our own. Darkness is a very important process in any ecosystem. These images were captured on our remote wildlife cameras located throughout the park. There are many animals active at night!

In Waterton, we want to continue to protect ecosystems where wildlife are very active at night. Wherever human light spills into the natural world, some aspect of life — migration, reproduction, feeding – is affected.

Scientists are only just starting to study the effects of this increased night light on humans and animals. When you consider that life on earth evolved with bright days and dark nights, and need both for health, you start to understand how flooding the world with light might not be the greatest thing we could be doing.

Mammals like bears can experience a decline in reproduction, difficulty foraging for food because of too much light and other mammals experience more exposure to predators because of artificial light.

Insects like moths are attracted to artificial lights and can stay near them all night. This interferes with mating and migration.

As you can see light can be a big problem!

For many nocturnal creatures, light pollution is like a bulldozer, destroying their lives.
In order to protect nocturnal species found in the park, that is those species who are the opposite of humans, who are active at night. like great horn owls, bats, flying squirrels, and frogs, then we need to protect the darkness of the night. Like most other creatures, we need darkness for our health and wellbeing too.

Responsible lighting reduces light pollution. Light pollution is artificial light that is allowed to illuminate or intrude upon areas not intended to be lit like upwards or on to a neighbor's house.

Milky Way over Waterton Lakes National Park © Wally Pacholka / AstroPics.com

12. Agency Policy on Outdoor Lighting and Dark Sky Protection

Parks Canada has a policy on Outdoor Lighting (See Appendix A).

The National Park Service also has a policy on Outdoor Lighting in General Management plan

4.10 Lightscape Management

"*The service will preserve, to the greatest extent possible, the natural lightscapes of parks, which are natural resources and values that exist in the absence of human-caused light. The absence of light in areas such as caves and at the bottom of deep bodies of water influences biological processes and the evolution of species, such as the blind cave fish. The phosphorescence of waves on dark nights helps hatchling sea turtles orient to the ocean. The stars, planets, and earth's moon that are visible during clear nights influence humans and many other species of animals, such as birds that navigate by the stars or prey animals that reduce their activities during moonlit nights.*

Improper outdoor lighting can impede the view and visitor enjoyment of a natural dark night sky. Recognizing the roles that light and dark periods and darkness play in natural resource processes and the evolution of species, the Service will protect natural darkness and other components of the natural lightscape in parks. To prevent the loss of dark conditions and of natural night skies, the Service will minimize light that emanates from park facilities, and also seek the cooperation of park visitors, neighbors,

and local government agencies to prevent or minimize the intrusion of artificial light into the night scene of the ecosystems of parks. The Service will not use artificial lighting in areas such as sea turtle nesting locations where the presence of the artificial lighting will disrupt a park's dark-dependent natural resource components.

The Service will

- Restrict *the use of artificial lighting in parks to those areas where security, basic human safety, and specific cultural resource requirements must be met;*
- *Use minimal-impact lighting techniques;*
- *Shield the use of artificial lighting where necessary to prevent the disruption of the night sky, natural cave processes, physiological processes of living organisms, and similar natural processes."*

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Guidelines and Specifications for Outdoor Lighting at Parks Canada

Ecosystem protection, energy savings and dark skies

March 2008

Prepared by the Real Property and Ecological Integrity Branches of Parks Canada

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1.0 PURPOSE

This document presents best practices for outdoor lighting at Parks Canada facilities and specifies equipment to help achieve these best practices. The document outlines the rationale for the need to protect the night time environment from the excessive use of artificial lighting and specifies degrees of protection. There are three objectives for this Best Practices and Specifications for Outdoor Lighting document: ecosystem protection, energy savings and darker skies.

This document also serves as a reference tool for parks or sites that wish to become designated as Dark Sky Preserves. The initiative in establishing dark sky preserves in Canada came from the Muskoka Heritage Foundation working with the Ontario Ministry of Natural Resources, Parry Sound District. This cooperation led to the establishment of the Torrance Barrens Conservation Preserve as Canada's first dark sky preserve in 1999. This was followed in 2005 by the designation of the Cypress Hills Preserve, which includes Fort Walsh National Historic Site, then by Point Pelee and Elk Island National Parks in 2006.

For additional information on being designated a Dark Sky Preserve, please visit the Royal Astronomical Society of Canada general site: www.rasc.ca.

2.0 SCOPE

Categories of areas and facilities within Parks Canada are identified that may require artificial outdoor lighting. Lighting hardware is described and specified for each area category to assist in minimizing the impact of artificial lighting on the night time environment while maintaining safety.

3.0 GLOSSARY

CARS Canadian Aviation Regulations
CF Compact Florescent lamps

EI Ecological Integrity

FCO Full Cut-Off luminaires (0% up-light, Fully Shielded)

HID High Intensity Discharge lamps (LPS, HPS, MH lamps)
HPS High Pressure Sodium lamps (“yellow” coloured lamps)

IESNA Illumination Engineering Society of North America

LEDs Light Emitting Diodes
LPS Low Pressure Sodium lamps (monochromatic, single colour lamps)

MH Metal Halide lamps ("white" coloured lamps)

SCO Semi Cut-off luminaires (<2% up-light)
SAD Seasonal Affective Disorder

4.0 RATIONALE

The availability of electrical energy and efficient lighting fixtures has enabled the current urban lifestyle of non-stop "24-7" activity. Further, the advances in illumination technology have permitted illumination levels to increase over the last 50 years by a factor 10, with the use of the same amount of electrical power. The result is that most commercial luminaires are designed for high levels of illumination. Low intensity fixtures are primarily limited to decorative lighting such as Christmas lights.

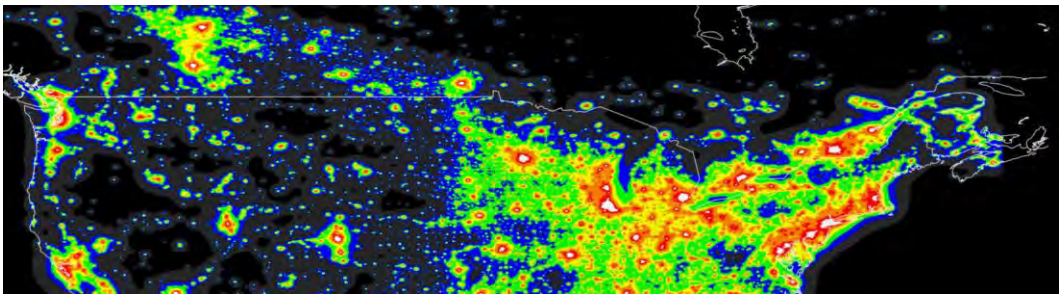

Figure 3.0.1 Mid Latitudes at Night[1]

It is now common in a city to be able to read a newspaper at night under the city's sky glow. In Figure 3.0.2, the light polluted skies of Toronto are compared to relatively good skies southwest of Ottawa on the Rideau Canal system to the dark skies of Algonquin Park. In Toronto only the brightest stars are visible. On the Rideau Lake, the Milky Way is easy to see but has the sky glow from Ottawa extending half way up in the northeast and from Kingston on the southwestern horizon. From Algonquin Park, there is virtually no visible sky glow and the Milky Way dominates the landscape after dark.

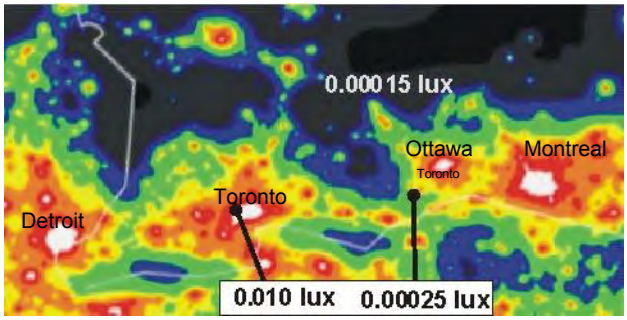

Figure 3.0.2 Light Pollution in Southern Ontario
(Readings under clear skies)

[1] P. Cinzano 2001

One of the most prevalent reasons given in cities for night time lighting is to reduce crime. This is generally based on the notion that more light improves visibility, and that this visibility discourages criminals. However, there is little evidence to indicate that more lighting reduces crime[2]. Most research literature about crime is based on studies of urban areas and more specifically the inner city neighbourhoods. A few researchers have looked at the impacts that more natural looking environments have on crime. They report that more natural environments lower the reports of crime and the fear of it[3]. This work is by no means conclusive, but it questions the appropriateness of extrapolating urban criminal studies into rural environments, and by extension into the extremely low population densities of a wilderness park or remote historic site.

Human Health

This proliferation of outdoor lighting can have an impact on the health and behaviour of humans[4]. "Biological clocks control our sleep patterns, alertness, mood, physical strength, blood pressure, and every other aspect of our physiology"[5]. The dominant mechanism for synchronizing this biological clock to our activity (the circadian rhythm) is the day-night contrast and the timely release of the hormone melatonin. This hormone regulates the ebb and flow of other hormones in our bodies. The timing of the circadian rhythm also affects our behaviour.

Ecological Health

Although many people are familiar with the activity of the natural world during the day (i.e., photobiology), few people are as familiar with similar activity at night. Humans are not the only species whose biological clock is controlled by day-night contrasts and the release of melatonin. It is found in animals wherein it plays a similar role[6]. Wildlife depends on the darkness of the night and the study of this dependence is called scotobiology. There is mounting scientific evidence documenting the profound impact of artificial light on the ecology of the night.

Animal Behaviour

Artificial lighting changes the night time behaviour of species[7]. Over a month, the changing phases of the moon affect the ground illumination at night. Nocturnal mammals adapt their behaviour over the month in sympathy to moonlight to avoid predators. This behaviour includes, in part, limiting the foraging area and carrying food back to their shelters instead of eating it in the field. This latter adaptation limits how much they can eat[8].

[2] The Indiana Council on Outdoor Lighting Education (ICOLE), P.O. Box 17351, Indianapolis, IN 46217
[3] Environment and Crime in the Inner City, Environment and Behavior, Vol. 33, No. 3, 343-367 (2001)
[4] Light Research Organization, Electric Power Research Institute, (www.epri.com/LRO/index.html)
[5] WebMD, March 06, 2007, www.webmd.com/cancer/news/20040908/light-at-night-may-be-linked-to-cancer
[6] "Lighting for the Human Circadian Clock", S. M. Pauley, Medical Hypotheses (2004) 63,588–596
[7] The Urban Wildlands Group (www.urbanwildlands.org/abstracts.html)
[8] Ecological Consequences of Artificial Night Lighting, C. Rich, T. Longcore, Island Press, 2006, Pg. 28

Predator and prey behaviour depends on the darkness of the night[9]. Illumination levels that significantly affect wildlife are believed to be at the level of the full moon, although the effect begins to be evident at lower light levels[10]. To put this in context, an urban parking lot is often lit at more than 100 times this level (see Appendix A).

It is well documented that some insects are drawn towards light sources. This interrupts their normal mating and foraging activities and it concentrates them within a small area thus enhancing predation[11]. Animals separated from their normal foraging grounds by an illuminated road cannot see field beyond the lights. Their natural instinct is to wait until they can see where they are going. This can leave them in the open and vulnerable to predation. This may lead to them abandoning their established foraging patterns for new ones, which will impact other species as they compete for resources[12].

Aquatic Life and Navigation

Historically, waterways have been used for transportation and recreation. However, they are also important ecosystems that support wildlife. Shoreline property is valued by our society and this is causing human developments along rivers and around lakes. An increasing number of properties have shore lighting that illuminates the waterway. This impacts the river and lakes in two ways. From the human standpoint, bright lights along the shoreline make it very difficult to navigate the channel. Glare from unshielded shore lighting prevents our eyes from becoming adapted to the darkness. At night, a boater will only be able to see the points of light long the shore rendering the channel markers and out-of-channel hazards very difficult to see.

The second impact is on the fish and water plants[13]. The studies in Florida on the affect of artificial light on turtle hatchlings demonstrate how light can interfere with the normal behaviour of turtles[14]. When the hatchlings emerge from the sand they naturally head towards light. Usually this would be emitted by waves breaking on a beach. However, inland artificial lighting distracts the hatchlings and they travel inland instead of to the sea. They become vulnerable to predators and may try to cross roadways. These studies are not specific to Canadian waters, however they highlight the care that must be exercised in any alteration of the environment with something as apparently innocuous as light.

The effect of light on fish is not clear. Fish are attracted to the light from their natural feeding depths. The increase in the concentration of fish changes the hunting efficiency of predators. Although the behaviour of the nocturnal predator may not be compromised by artificial light, the ability of its prey to recognize the danger and to escape will affect their survival.

[9] Ecological Consequences of Artificial Night Lighting, C. Rich, T. Longcore, Island Press, 2006
[10] ibid., Chapter 11
[11] ibid., Chapter 13
[12] Ecological Consequences of Artificial Night Lighting, C. Rich, T. Longcore, Island Press, 2006
[13] Ecological Consequences of Artificial Night Lighting, C. Rich, T. Longcore, Island Press, 2006, Part V
[14] B. E. Witherington, R. E. Martin, Florida Fish and Wildlife Conservation Commission, FMRI Technical Report TR-2, Second Edition 2000

Cultural Impact

There is also a cultural imperative to protect the darkness of the night sky. Throughout recorded history (about 6,000 years) astronomy has been the focus of stories and mythologies. Those who have seen a dark sky are impressed by the serene majesty of the celestial sphere. It comes as no surprise that all civilizations have the constellations and asterisms woven into their culture.

After stepping outside from a lighted room and under a dark rural sky, our initial count of a few stars with photopic vision increases a hundred fold after only 10 minutes. This may increase by another order of magnitude after less than an hour as our eyes become fully dark-adapted. However, urban sky glow overwhelms the faint stars, and the glare from discrete light fixtures prevents our eyes from becoming dark-adapted. These limit the number of stars we can see from many thousands to only a few hundred. Our current generation is the first for whom much less than half the population has seen a star-filled night sky. Most children have never seen the Milky Way.

Energy Consumption

Light directed towards the sky represents inefficiency and waste. Focussing light to where it is needed as well as minimizing light output levels and duration will reduce electricity costs and greenhouse gas emissions.

Summary

While it is recognized that lighting is important and necessary in certain situations, proper management and reduction of lighting will contribute to ecosystem protection, energy savings and darker skies.

5.0 GENERAL BEST PRACTICES

This section provides an overview of the general techniques that may be used to minimize light pollution with references to wildlife nocturnal behaviour. The equipment requirements and illumination levels are described more fully in Section 6.0.

Where necessary for basic safety:

- illumination should be to the minimum practical level;
- the affected area of illumination should be as small as practical;
- the duration of the illumination should be as short as practical; and
- illumination colour should be biased towards the red part of the visual spectrum.

What is "practical" depends upon the specific conditions of the area concerned and the technology available to illuminate the area.

5.1 Illumination Levels

Maximum illumination levels should be comparable to that of the full moon (1 lux max – 0.2 typical). The variation of illumination between new moon and full moon is up to 10,000:1. Where pedestrian traffic volume is known to be high after dark, illumination levels should be no more than 5 times that of the full moon. A lighting curfew should be imposed in all areas except where specifically identified. Where higher illumination levels are required for specific purposes, the area of illumination should be minimized.

5.2 Extent of Illumination

The light from non-shielded fixtures can be seen, literally, as far as the eye can see. Tall trees around a lighted area will significantly restrict the illumination to a small area, however it is more effective to use light fixtures that are engineered to limit the extent of the illumination.

Full cut-off fixtures (also called fully shielded fixtures) (see Figure 5.2) prevent light from shining beyond the immediate area and up into the sky. Since no light shines horizontally, the amount of glare at a distance from the fixture is significantly reduced from that of semi cut-off or unshielded luminaires. By reducing glare, eyes of both animals and humans can become more accustomed to the darkness allowing them to see into areas with lower illumination levels farther from the fixture.

The improvement in visibility at light levels that are lower with full cut-off fixtures permits lower wattage bulbs to be used that in turn reduce energy consumption. By lowering the illumination levels, less light will reflect off the ground into the sky. This further reduces the extent, and impact, of the artificial light on the night environment.

To further limit the extent of the illuminated area, pole heights should be limited to below the surrounding trees so that the tree canopy will help to contain stray light from shining into the adjacent areas.

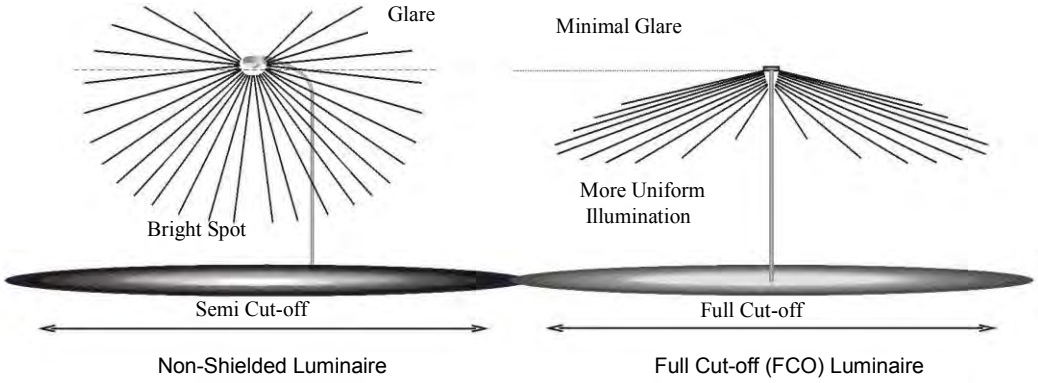

Figure 5.2 Luminaires

All luminaires should use full cut-off fixtures. Where it is not practical to replace fixtures, durable shields should be securely affixed to the existing luminaires such that no light shines from the fixture above the horizon and so that it provides reduced illumination within 10 degrees of the horizon (see light pattern for the full cut-off fixture in Figure 5.2).

5.3 Duration of the Illumination

Artificial illumination should be reduced or eliminated, where feasible, following a reasonable time after dark. Natural illumination levels are approximately 0.1% that of full sunlight just after sunset (100 lux) and 100X that of a full moon (see Appendix A). At that time, indoor illumination (approximately 200 lux) is higher than the outdoor levels. After about 30 minutes, the natural illumination level due to dusk is about that of a full Moon (1 lux)[15].

If indoor lighting, especially for offices and stores, shines through windows it may have an impact on the areas outside. It may also produce glare that will prevent dark adaptation for people and animals. This has no effect until after sunset, at which time the sky illuminates the ground to a lower level. Window coverings should be used to prevent continued spillage of the indoor light through the windows.

A “dark time” may be defined, after which illuminated activity is discouraged. This recognizes that low-level activity may continue after sunset and dusk. Exterior lighting may remain on during this time, after which there should be a lighting curfew that would apply to Parks Canada lighting. The time of this curfew will depend on the nature of the facility and type of activity. A reasonable lighting curfew time (such as 2 hours after sunset) should be determined.

Timing circuits should turn off all exterior lighting fixtures at the beginning of the lighting curfew except where identified in this document. A light detector that is triggered

[15] R. Dick, Carleton University, Ottawa, 2006

by sunset should activate a timing circuit to turn light fixtures off within 30 minutes of sunset. Manually activated switches should also be available to turn off exterior lighting.

In areas with high volume of pedestrian traffic and where limited activity continues after dark that requires illumination, motion detectors should control light fixtures. Automatic timers should be used to turn them off after a reasonable period of time.
On a technical note, only Light Emitting Diodes (LEDs), compact fluorescent and incandescent lamps can be switched on for short periods of time. High Intensity Discharge (HID) lamps (Low Pressure Sodium and High Pressure Sodium) require several minutes to heat up before they will reach full brightness.

5.4 Colour of Illumination

Various light sources (lamps) have different colour content. These are discussed in Appendix B. Section 6.0 Specifications identifies where these lamps should be used.

Humans and animals are affected by the colour of light. Blue light (short wavelengths) affects their low level scotopic vision whereas red light (long wavelengths) is seen well by their photopic vision. The use of long wavelength light allows animals to see without degrading their sensitive scotopic vision.

Specifically, insects and birds[16] are affected more by white than red lights. The effect of lighting on birds has been documented in studies of bird mortality around communication towers that have navigation avoidance beacons[17].

The colour and type of light that is used may vary depending on the extent and use of the illuminated area. Colour content of light (spectral content) assists in identifying cars by colour or persons by the colour of their clothing. When artificial lighting is deemed necessary due to high pedestrian traffic, the colour content of the light source should provide sufficient colour content to allow fair colour recognition.

Where low illumination levels are necessary (pathways), lighting may only be possible with incandescent bulbs or yellow Light Emitting Diodes (LEDs). Where necessary, roadway marker lighting should use low pressure sodium sources.

Where there is high volume pedestrian or vehicle traffic, light emitting diodes, incandescent or high pressure sodium lamps should be used. The level of required illumination should determine the specific type of lamp. Larger areas where high-level illumination is required may need high pressure sodium sources (i.e. parking lots).

5.5 Light Pollution Abatement in Interpretive and Outreach Education Programs

In order for the public to understand and appreciate the efforts taken by Parks Canada to protect the nocturnal environment, an interpretation or an outreach program could be

[16] Ecological Consequences of Artificial Night Lighting, Rich, Longcore, Island Press, 2006, Part II, V
[17] Gehring,J. Aviation Collision Study for the Michigan Public Safety Communications System (MPSCS): Summary of Spring 2005 Field Season, Central Michigan University, August 12, 2005

provided where human and financial resources for such programs exist. These initiatives present a very good opportunity for interpretation and outreach education personnel to take an active role in changing the public's perception of the nocturnal environment. By highlighting nature's vulnerabilities to human impacts as subtle as outdoor lighting, they will inform visitors of the benefits of more responsible lighting with the saving of energy and the reduction of power plant emissions.

6.0 SPECIFICATIONS

These specifications contain descriptive information to aid in the selection of the:

- type of lighting fixtures;
- wattage of luminaires;
- area of illumination;
- duration of the permitted illumination;
- colour of the illumination; and
- approximate illumination level.

The values for these parameters are summarized in tables for each area and application. Similar fixture hardware is specified to minimize the number of different spare parts required to be kept for repairs or replacement.

Illumination levels specified in this document are lower than urban areas for which most luminaires have been designed. This restricts the type of light sources that may be used. Although high intensity discharge lamps are very efficient, they may emit more light than is required to meet this specification. To address this, relatively inefficient, incandescent lights may be used for short periods of time or more advanced light emitting diode luminaries may be installed.

Parks Canada is responsible for a variety of properties. In this section, specific areas are identified with a range of lighting conditions that reflect their varied use. Assessment of lighting levels that are most appropriate for their facility within the limits defined in General Best Practices is left to the discretion of Parks Canada staff.

These specifications address the use of the facility and expected pedestrian and vehicle traffic. Priority is given to respecting and protecting the natural environment. Lighting is limited to provide only what is required for navigation in built up areas. The artificial lighting is restricted to these areas and for the periods of human activity unless otherwise noted.

The following tenets have been used in developing these specifications.

1. Buildings require illumination only when open or available to humans. After people have left, all lighting visible from the outside should be turned off or covered.

2. To save energy and minimize the duration and extent of light pollution, lighted pathways should be illuminated only when pedestrians are in transit. All reasonable effort should be made to turn off lighting when pedestrian traffic is low or is no longer expected.

3. The areas covered by this specification should only provide a safe transition between lighted structures and the surrounding unlighted area and to assist in navigation.

4. The area of illumination should be limited.

5. Light activated timing circuits should turn off outdoor lighting. The time delay should begin at sunset and should extend to an appropriate time to permit the activity to end.

"Dark Time" is a term used to identify the end of significant activity within an area. This term is used herein to identify when light should be discouraged. In this document "Dark Time" is further assumed as being 2-hours after sunset. Appendix D contains a reference table with the approximate times of sunset for southern Canada.

6.1 Buildings

This section identifies six types of structures that may require illumination. In all cases, full cut-off luminaires should be used and illumination controlled to prevent light scattering beyond the immediate area. Further, the colour of this light should have minimal blue (short wavelength) content and lighting curfews should apply.

Interior and exterior lighting that remains on for extended periods after operating hours not only wastes energy but can also cause a nuisance. Insects are attracted to exterior building lights and interior lighting that shines through windows. In addition to the need for cleaning before the building opens for the public, the light distracts insects from their normal activity.

Illumination levels and luminaire types for various buildings are listed in Table 6.1.

This document uses five classifications for buildings:

- administrative and operational buildings;
- public buildings;
- stores;
- vending machine enclosures; and
- toilet and washroom facilities.

6.1.1 Administrative and Operational Buildings

Administrative and operational buildings are defined as those occupied by Parks Canada employees such as administration buildings, garages, workshops, warehouses, warden stations, etc. These buildings will generally be closed after dark. Illumination of the main

doorway and especially any steps leading to the main door may be required after sunset or before the sunrise depending on the season.

After hours, either all interior lighting should be turned off, or window and door blinds should be used to prevent interior light from shining outside. Light activated timing circuits should turn off all outdoor lighting within 30 minutes of the office being closed. Manual reset switches may be used to extend this period.

6.1.2 Public Buildings

Public buildings are defined as those open to the public during business hours and may also contain private offices. Due to the public nature of these buildings with high pedestrian traffic, exterior illumination may be higher than for administration buildings.

After hours, either all interior lighting should be turned off, or window and door blinds should be used to prevent interior light from shining outside. All outdoor lighting should be turned off within 30 minutes of the office being closed. Exterior lighting should be limited to the main door area and steps (if any). Light activated timing circuits should turn the lighting on after dusk and off after a period of time specified. Manual reset switches may be used to extend this period.

6.1.3 Retail Stores

It is assumed retail stores will have higher pedestrian traffic than most other areas after dark while they remain open for business. Window coverings should be used so that interior lighting will not shine outside after sunset. Exterior light is permitted, and restricted to, the area around the door using full cut-off fixtures. All exterior lighting should be turned off within 30 minutes after business hours.

6.1.4 Vending Machines

There are several ways to reduce the extent of illumination coming from vending machines. These methods consist of eliminating display lighting, installing occupancy sensing devices or installing the vending machine in an enclosed space.

The first options are simple and inexpensive. They require that you talk to your vending machine supplier about disconnecting the lighting from the machines completely or retrofitting the machine with a simple timing mechanism to turn the lights off in unoccupied hours or retrofitting the machine with a passive infrared technology to cut power to vending machines while an area is unoccupied. In the latter option, the device is designed so that a machine will be shut down for up to two hours if no one walks by. At that point, the machine is turned back on to run a compressor cycle, after which it turns back off if the occupancy sensor indicates that the area is still vacant. When someone approaches the machine, the sensor sends a signal to turn the lights and other electronic components back on, and the compressor runs a cooling cycle if needed.

If these options are not feasible, then where possible vending machines should be located in an enclosed space such as an existing public building so their lights do not shine directly outside through doorways or windows. Figure 6.1.4 shows an example of a dedicated vending machine enclosure. Only full cut-off fixtures should be used to illuminate the area outside the entrances. The extent of this outside illuminated area is restricted to less than 5 meters from the entrance.

Light from vending machines is usually from a number of fluorescent tubes behind the translucent display and may emit significant amounts of blue light. This light undermines dark adaptation. Therefore, the illumination levels outside these enclosures may be higher than for other buildings.

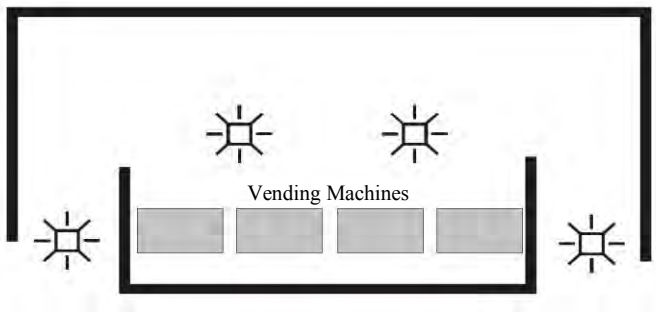

Figure 6.1.4 – Sample Vending Machine

Doorway lighting should be turned off within two hours of sunset. Interior lighting may remain on at the owner's discretion.

6.1.5 Toilet and Washroom Facilities

Toilet and washroom facilities will be available throughout the night. Full cut-off fixtures may be used to illuminate the entrance and any steps leading to the doorway. If deemed necessary, these structures may have a marker light by the door.

Table 6.1 Building Illumination Specifications

6.1 Area	Type	Light	Illumination Level (lux)	Height	Curfew
6.1.1 Administrative & Operational Bldgs.	FCO	25 w incandescent, yellow LED	~2 lux	2.5 m	Yes
6.1.2 Public Bldgs.	FCO	25 w incandescent, yellow LED	~2 lux	2.5 m	Yes
6.1.3 Retail Stores	FCO	25 w incandescent, yellow LED	~2 lux	2.5 m	Yes
6.1.4 Vending Machine	FCO	25 w incandescent, yellow LED	~2 lux	2.5 m	Yes
6.1.5 Toilet & Washroom Facilities	Marker (FCO)	25 w incandescent, yellow LED	~2 lux	2 m	No

Note: 2 lux = illumination of dusk about 20 minutes after sunset

6.2 Parking Lots

Generally, parking lots have less traffic at night than during the day. Parking lots may require lighting after Dark Time due to special after-dusk activities.

Where required, pole mounted full cut-off luminaires should be placed one pole-height from the extreme corners of the parking lot and distributed evenly along the perimeter with an approximate pole spacing of no less than 4-times the luminaire height. Their light distribution pattern should be "full forward" and aimed into the lot. This is symbolically shown in Figure 6.2. If necessary, poles may be located within the parking lot area.

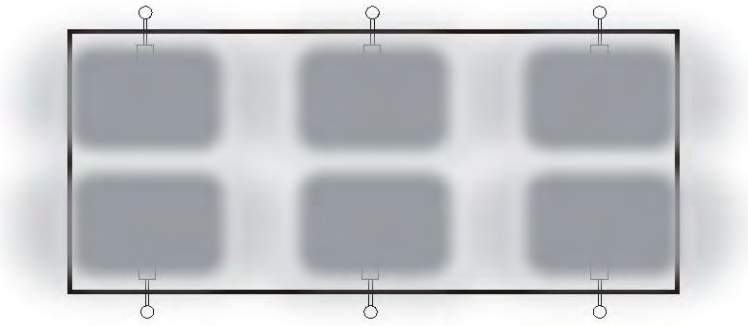

Figure 6.2 Parking Lot

6.2.1 Administration Parking Lots

Administration personnel will generally leave when offices close. Luminaires in administration parking lots should be turned off within 30 minutes of the office closure. A timing circuit should control the lights with a manual reset for employees working late.

6.2.2 Visitor Parking Lots (Small)

Generally small lots (less than 10 cars) experience little traffic and should not be illuminated.

6.2.3 Visitor Parking Lots (Large)

Larger parking lots (spaces for approximately more than 10 cars) may require better visibility than smaller lots. These lots may be illuminated.

Table 6.2 Parking Lot Illumination Specifications

6.2 Area	Type	Light	Illumination Level (lux)	Height	Curfew
6.2.1 Administration Lot	FCO	35 watt HPS	~3	6 m	Yes
6.2.2 Visitor Lot < 10 cars	N/A	None	N/A	N/A	N/A
6.2.3 Visitor Lot > 10 cars	FCO	35 watt HPS	~3	6 m	Yes

N/A – not applicable

6.3 Roadways

6.3.1 Class 1 to Class 3 Roadways

Class 1 to Class 3 roadways (Parks Canada classification) are subject to high (Class 1), to medium (Class 3) traffic volumes. They are defined as highways and are part of a larger highway network. Parks Canada's policy for these types of roadways is to adopt provincial highway standards.

6.3.2 Class 4 to Class 6 Roadways

Class 4 to Class 6 roadways (Parks Canada classification) have low traffic volumes with class 6 roads being park service roads, providing primarily access to administrative and operational uses and purposes. Recognizing the limited use of these roads and the potential impact they may have on remote areas, illumination should be minimized or avoided entirely.

6.4 Pathways

Pathways and sidewalks provide a relatively level surface for pedestrian traffic, and aid in navigation around the site. Visibility of the site is necessary for navigation but excessive illumination will prevent pedestrians from seeing off the path. Although some visitors use flashlights (i.e. campgrounds), additional lighting along pathways may be required to guide visitors to public facilities.

Since overhead full cut-off luminaires will illuminate areas much wider than the path, low wattage bollard lighting should be used such that the bollard-mounted lights are directed down to the path. The fixture should be shielded such that the illumination pattern is approximately limited to within the path width.

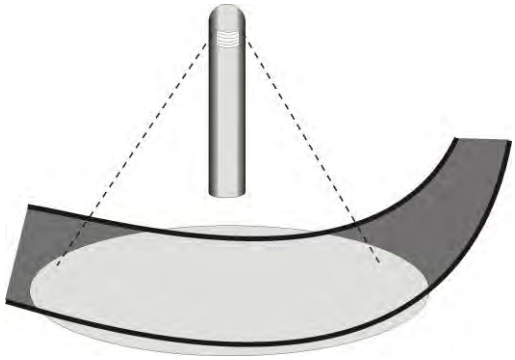

Figure 6.4.1 Bollard Luminaire

Generally, individuals walking along a pathway will have left the area after a minute or so (a distance of 30 meters) unless they remain for an activity. To minimize unnecessary light exposure, motion detectors may be used to turn on the string of lights and timing circuits to turn them off after a few minutes. Detectors may be installed at the entrances to pathways.

The closeness of the luminaires to the ground necessitates very low intensity lights. This limits the current products available to low wattage incandescent bulbs and light emitting diodes.

Paths are also used by wildlife. Therefore, pathway lighting should be restricted to areas like those near buildings, parking lots and campgrounds, and only those paths that are considered appropriate should be illuminated.

Illuminated pathways should have shielded bollard mounted lighting fixtures. Pathway lighting should be turned off after the Dark Time lighting curfew. Retro-reflective markers on the bollards should assist pedestrians after Dark Time.

Table 6.4 Pathway Illumination Specifications

6.4 Pathways	Type	Light	Illumination Level (lux)	Height	Curfew
6.4.1 Pathways	none	None	N/A	N/A	N/A
6.4.2 Illuminated Paths	FCO	7 watt incandescent, Yellow LEDs	~1 lux	1 m	Yes
6.4.3 Main Pathways	FCO	7 watt incandescent, Yellow LEDs	~1 lux	1 m	No

N/A – not applicable

6.5 Shoreline Areas

Shoreline areas consist of canals, docks, jetties, lock facilities, boat launching areas, beaches, homes, cottages and undeveloped lands. The direct illumination of the shallow water near shore alters the behaviour of aquatic species and the foraging patterns of landed species and insects.

This specification provides guidance for reducing the impact of lighting along a waterway. Shoreline lighting should consist of yellow or red light with minimal content of blue. White lights should not be permitted.

Light within 10 meters of a shoreline should be prohibited unless it is deemed necessary. Overhead luminaires that shine into the water should not be permitted. Where applicable, the illumination level and colour should minimize their impact on the ecosystem.

Where shoreline lighting is permitted, it should have full cut-off fixtures with low wattage yellow light. Shielded bollard lighting with incandescent or yellow light emitting diodes should be used where their needs have been identified. High traffic areas and near machinery (lock facilities) may require higher levels of illumination.

Table 6.5 Shoreline Illumination Specifications

6.5 Waterways	Type	Light	Illumination Level (lux)	Height	Curfew
6.5.1 General Areas	N/A	None	N/A	N/A	N/A
6.5.2 Docks Bollards	FCO	15 w incandescent, Yellow LEDs	~1 lux	1m	No
6.5.3 Lock Facilities	FCO	35 watt HPS	~1 lux	6 m	Yes

N/A – not applicable

6.6 Signage

Signage plays an essential role by facilitating access to, and navigation within, our national parks, national historic sites and national marine conservation areas. Parks Canada has developed new standards (*Exterior Signage: Standards and Guidelines, 2007*) to facilitate the consistent application and implementation of signage across the system with a goal to ensure signs function within the context of their environment. The new signage standards require that all signs, both vehicular and pedestrian, be retro-reflective in order to ensure safe navigation both at night and during the day and therefore do not require added illumination. Some vehicular signs, such as signs mounted to overhead structures, may require illumination to ensure increased visibility. Parks and sites should be aware of any provincial/territorial traffic control standards that would require roadway signs to be illuminated.

6.7 Tower Navigation Avoidance Beacons

Communication towers and wind turbines are often erected in wilderness areas that may have heights of hundreds of meters. Personnel should be aware of the options available for tower navigation beacons that are regulated by Transport Canada[18].

Single wind turbine towers less than 90 meters high do not have to be lighted unless specifically identified by Transport Canada as a hazard to aviation. For wind farms with several towers, the towers on the edge of the array and the central tower must be illuminated[19].

There are several types of navigation avoidance beacons that may be used on towers (see Appendix E). Those less likely to cause bird casualties seem to be flashing red lights[20]. Birds are not attracted to red light as much as white light and they appear to be less able to orient themselves to the flashing beacons compared to non-flashing types. One beacon in the list of those approved by Transport Canada consists of a collimated rotating beam (CL864 in Appendix E). In principal, its luminous intensity can be lower than other types of beacons and would emit less light into the air.

Communication towers erected on Parks Canada property should not be fitted with night time navigation beacons unless strictly required by Transport Canada regulations (Canadian Aviation Regulations 621.19). The brightness of night time navigation beacons should be the minimum required by Transport Canada regulations (Canadian Aviation Regulations 621.19). And, all towers requiring night time navigation beacons should use red flashing lights.

6.8 Development on Parks Canada Lands

These developments include buildings, structures and site development on leased and licensed lands in national parks and national historic sites and municipal infrastructure in townsites within national park boundaries. Lessees and municipalities within national parks should be informed of the impact of artificial lighting on wildlife. They should be encouraged to remove “dusk to dawn” lights, replace "yard lights” with full cut-off luminaires and replace metal halide bulbs with either high pressure sodium or low pressure sodium. All municipal lighting, including street lighting, should be full cut-off and illumination levels should be no greater than minimum recommended by Illumination Engineering Society Guidelines.

Use of outdoor lighting on leased and licensed lands in national parks and national historic sites and within municipalities in national parks should be discouraged 2 hours after sunset (as per “Dark Time” definition in section 6.0), and should be turned off.

[18] Canadian Aviation Regulations (CARS) 621.19
[19] Wind Turbine and Windfarm Lighting, CAR621.19 Advisory Circular 1/06 - DRAFT 9, Transport Canada
[20] Gehring,J. Aviation Collision Study for the Michigan Public Safety Communications System (MPSCS): Summary of Spring 2005 Field Season, Central Michigan University, August 12, 2005

Table 6.8 Other Properties Illumination Specifications

6.8 Other Properties	Type	Light	Illumination Level (lux)	Height	Curfew
6.8.1 Door Lights	FCO	15 watt Incandescent	~3	1.5 m	Yes
6.8.2 Yard Lights	FCO	<35 watt HPS, or < 35 watt LPS	~3	6 m	Yes
6.8.3 Municipal Lights (including street lights)	FCO	typically 70 watt HPS	≤ minimum IESNA	TBD	No

6.9 Light Pollution Abatement Beyond Parks Canada Boundaries

As with air and water pollution, light pollution has no boundaries. It is only reduced by distance from its source. Some cities are actively promoting the replacement of luminaires that contribute to sky glow but these policies are not wide spread. Parks Canada influences the producers of air and water pollution that passes through parks. This influence could be extended to include light pollution by introducing and encouraging programs of light pollution abatement in municipalities around Parks Canada facilities with the goal of reducing glare across Parks Canada boundaries and sky glow from artificial lighting.

7.0 REFERENCES

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Ecological Consequences of Artificial Lighting T. Longcore, C. Rich Island Press, 2006 ISBN 1-55963-129-5

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Lighting for the Human Circadian Clock, S. M. Pauley, Medical Hypotheses (2004) 63,588–596

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Pierantonio Cinzano 2001, University of Padova, Italy

Preliminary Recommendations: Outdoor Lighting at Highlands Center, Cape Cod National Seashore, Chad Moore, March 25, 2006

Shutting Off the Night, H. Marano, Psychology Today, Sep/Oct 2002

Tested Strategies to Prevent Crime: A Resource for Municipal Agencies and Community Groups, National Crime Prevention Council, Copyright © 1995

Wind Turbine and Windfarm Lighting, CAR621.19 Advisory Circular 1/06 DRAFT 9, Transport Canada

Web Sites

International Dark Sky Association
www.darksky.org
Royal Astronomical Society of Canada (RASC) Light Pollution Abatement Program
www.rasc.ca/lpa/index.shtml
National Crime Prevention Council
www.ncpc.org/ncpc/ncpc/?pg=2088-10802
Canadian Aviation Regulations (CARS) 621.19
www.tc.gc.ca/CivilAviation/publications/tp14371/AGA/6-0.htm
Shoreline Booklet downloadable from IDA
www.uwsp.edu/cnr/uwexlakes/humanimpact/lighting.pdf
Ecology of the Night Conference Proceedings
www.muskokaheritage.org/ecology-night/
Light Pollution by Pierantonio Cinzano
www.lightpollution.it/indexen.html/
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www.webmd.com/cancer/news/20040908/light-at-night-may-be-linked-to-cancer
Psychology Today, Sep/Oct 2002
http://psychologytoday.com/articles/pto-20021002-000003.html
BC Hydro Power Smart Program – 42 watt LED sufficient for urban pathway
http://dmdeng.com/pdf/learning/Power_Smart_Roadway_Lighting,_BCH.pdf
Light Research Organization, Electric Power Research Institute,
www.epri.com/LRO/index.html
The Indiana Council on Outdoor Lighting Education (ICOLE),
P.O. Box 17351, Indianapolis, IN 46217, USA
http://home.att.net/~icole/crime_ref_guide.html
Fatal Light Awareness Program
www.flap.org/new/nestegg_3.htm/
Florida Fish and Wildlife Conservation Commission
www.floridamarine.org/publications/default.asp
The Urban Wildlands Group
www.urbanwildlands.org/abstracts.html
Sample of Luminaire Product Sources
http://store.starrynightlights.com/depali.html
LED Landscape Lighting
www.superbrightleds.com/malibu.htm
Astronomy Outreach and Education Materials
www.starlight-thatre.ca

APPENDIX A - Reference Illumination Levels

Condition	Illumination Levels* (lux)**
Clear night sky (no Moon)	0.000 05
Clear Urban Sky with Light Pollution	0.015
Twilight	0.1
Overcast Urban Sky with Light Pollution	0.15
Full Moon	1 max. (0.2 typical)
Urban Road Artificial Illumination	2
Car Dealership Lot	200
Full Sunlight	100,000

* Clarity of the atmosphere is highly variable over hours and days. These values are presented to provide only a rough guide to approximate illumination levels.

** "lux" is a Système internationale unit of illumination equal to 1 candela/m^2 = 0.093 foot-candles

To place these levels in context, people have reported seeing "fine" at full Moon illumination levels in the absence of glare[21].

[21] Preliminary Recommendations: Outdoor Lighting at Highlands Center, Cape Cod National Seashore, Chad Moore, March 25, 2006

APPENDIX B - Colour from Various Light Sources

These six light types convey "colour" from bright white to deep yellow. The last light source, light emitting diodes, can be designed to provide a range of colour. The accompanying table lists these sources in order from white to yellow.

Metal Halide	They allow very good colour recognition because of the wide spectrum emission (blue to red) from the bulb. It is a high intensity discharge bulb that must be warmed up before it can design brightness. The light-emitting region in the bulb is small so lenses and shields can control where the light is projected. The white light gives very good colour recognition.
Compact Fluorescent	These produce white light but their light-emitting region is very large compared to metal halide so their light is difficult to control with optics and shields. They perform well in cool temperatures and can be used for motion detection systems, but they take several minutes to warm up in sub-zero temperatures.
High Pressure Sodium	These are bright yellow and allow fair colour recognition. A high pressure sodium bulb has a small light-emitting region for very good control over where the light is focused. As a high pressure sodium source, they require a few minutes to heat up before they reach their design brightness.
Incandescent bulbs	These emit a yellowish light and are available in a very wide range of light outputs but they have very low energy efficiency. Two characteristics make them desirable for some applications. They can be turned off and on very quickly so they can be used for motion detection systems. Very low wattage bulbs are readily available if low illumination levels are required.
Low Pressure Sodium	Deep yellow light is virtually a single colour offering very poor colour recognition. It is the most energy efficient of the above lamps. They are so efficient that even low wattages may produce too much light our purposes. The light-emitting region in the bulb is quite large compared to other high pressure sodium bulbs. In this document they are recommended for use as roadway marker lights.
Light Emitting Diodes	These can produce a range of colours but currently (2007) only relatively low illumination levels. However, they produce very directed illumination, which is very desirable for a number of applications identified in this document. They are currently more expensive than the other types of bulbs but their cost is falling quickly.

APPENDIX C - Light Output from Typical Bulbs for Comparison Purposes

Bulb Types	Lumens$^{\forall}$ (Intensity)	Lux$^{\forall\forall}$ at 6 m (no losses*)	Lux$^{\forall\forall}$ at 2 m (no losses*)	Lux$^{\forall\forall}$ at 1 m (no losses*)
Incandescent				
7 watt	46	0.1	0.9	3.7
15 watt	112	0.25	2.3	9.1
40 watt	365	0.8	7.3	29.0
60 watt	740	1.4	12.7	50.9
100 watt	1530	3.8	34.0	136.1
Metal Halide				
70 watt	3,000	6.6	59.7	238.7
100 watt	5,800	12.8	115.4	461.6
High Pressure Sodium				
35 watts	2025	4.5	40.3	161.1
50 watts	3600	8.0	71.6	286.5
70 watts	5450	12.1	108.4	433.7
100 watts	8550	18.9	170.1	680.4
Low Pressure Sodium				
18 watts	1570	3.5	31.2	124.9
35 watts	4000	8.8	79.6	318.3
55 watts	6655	14.7	132.4	529.6
Compact Florescent				
9 watt (40 w equivalent)	550	1.2	10.9	43.8
13 watt (60 w equivalent)	850	1.9	17.9	71.6

* The fixture and bulb degradation before cleaning or replacement may decrease these to as low as 50%.

$\forall$ Lumens is the total amount of light emitted in all directions (over 4π steradians)

$\forall\forall$ Lux is the amount of light illuminating a surface of one-meter square

$$1 \text{ lux} = \frac{1 \text{ Lumen}}{4\pi \text{ dist}^2} \quad \text{(where distance is in meters)}$$

APPENDIX D - Approximate Times of Sunset for Areas in Southern Canada

The time of sunset depends on the time of year and the latitude for a site. The following table lists the approximate time of sunset (DST) for latitude of about +50 degrees from May to the end of September.

May 1	8:17
8	8:29
15	8:38
22	8:48
29	8:57
June 1	9:00
8	9:08
15	9:11
22	9:13
29	9:13
July 1	9:13
8	9:09
15	9:04
22	8:57
29	8:48
August 1	8:42
8	8:31
15	8:19
22	8:06
29	7:50
September 1	7:45
8	7:30
15	7:15
22	6:59
29	6:44

From the Royal Astronomical Society of Canada
Observers Handbook

APPENDIX E - Navigation Light Photometric Distribution[22]

			Minimum Intensity (candelas) **(a)**				Intensity (candelas) at gi	
Light Type	Colour	Signal type	day	Twilight	night	Vert. beam spread **(b)**	- 10deg **(d)**	- 1deg **(e)**
CL810	red	fixed	N/A	32min	32min	10deg	-----	-----
CL864	red	flashing 20-40fpm	N/A	N/A	2,000 ±25%	3 deg min	-----	50% min 75% max
CL865 **(f)**	white **(f)**	flashing 40fpm	20,000 ±25%	20,000 ±25%	2,000 ±25%	3 deg min	3% max	50% min 75% max
CL866	white	flashing 60fpm	20,000 ±25%	20,000 ±25%	2,000 ±25%	3 deg min	3% max	50% min 75% max
CL885 Catenary	red	flashing 60fpm	N/A	N/A	2,000 ±25%	3 deg min	-----	50% min 75% max
CL856	white	flashing 40fpm	270,000 ±25%	20,000 ±25%	2,000 ±25%	3 deg min	3% max	50% min 75% max
CL857 Catenary	white	flashing 60fpm	140,000 ±25%	20,000 ±25%	2,000 ±25%	3 deg min	3% max	50% min 75% max

(a) Effective intensity, as determined in accordance with External Transport Canada Document

(b) Beam spread is defined as the angle between two directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the intensity shown in columns 4, 5 and 6. The beam pattern is not necessarily symmetrical about the elevation angle at which the peak intensity occurs.

(c) Elevation (vertical) angles are referenced to the horizontal.

(d) Intensity at any specified horizontal radial as a percentage of the actual peak intensity at the same radial when operated at each of the intensities shown in columns 4, 5 and 6.

(e) Intensity at any specified horizontal radial as a percentage of the lower tolerance value of the intensity shown in columns 4, 5 and 6.

(f) In the case of rotating type CL865 one third of the flash display should be red in colour. e.g. WWRWW

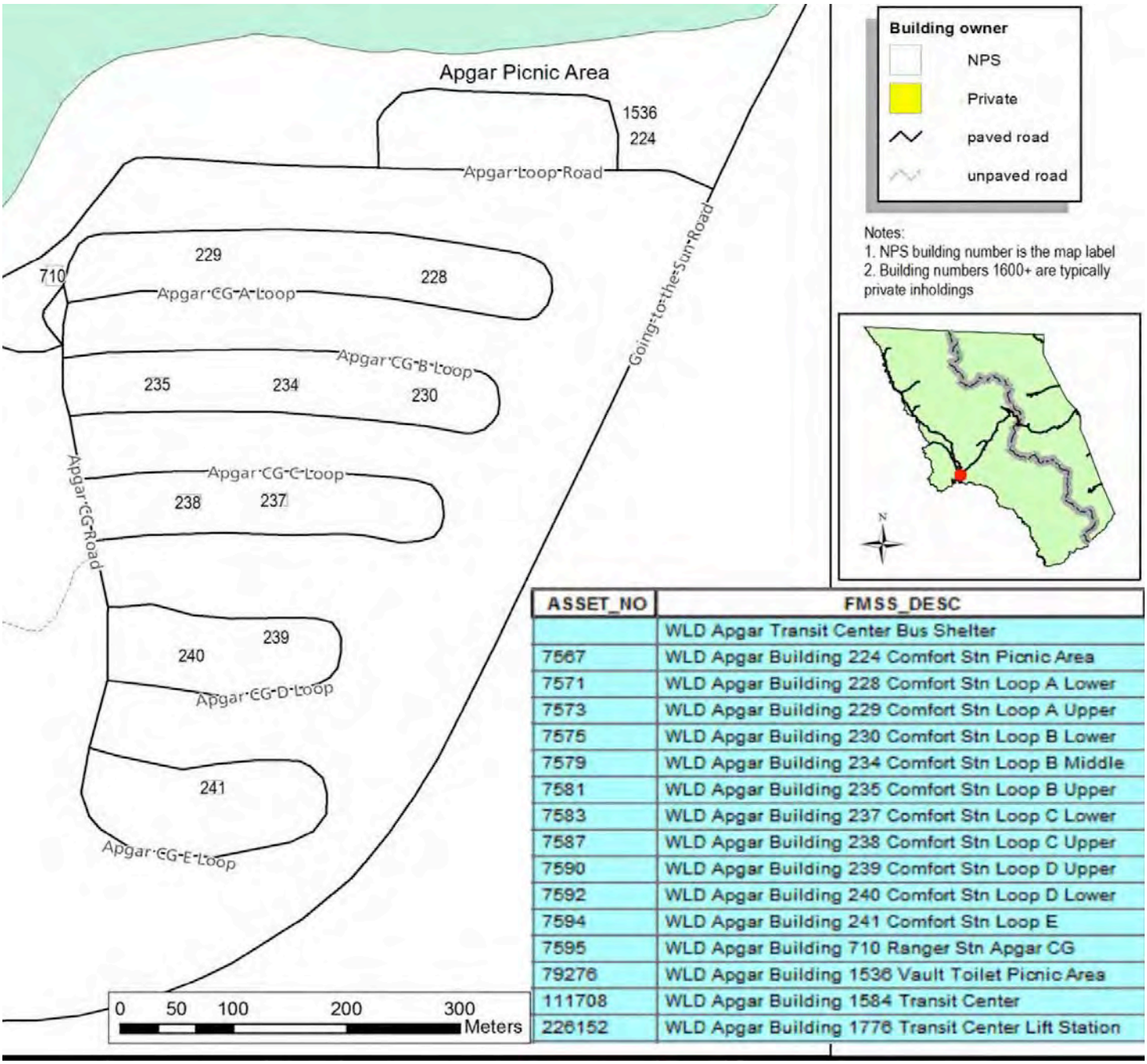
[22]Wind Turbine and Windfarm Lighting, CAR621.19 Advisory Circular 1/06 - DRAFT 9, Transport Canada

Glacier National Park
Exterior Lighting Inventoryy
2015

Methodologys:

The methodology for creating an account of the current state of the lighting in Glacier National Park began with site visits to all of the developed areas of the park. At each site a map of the buildings was used to document and photograph every visible exterior lighting fixture. Once all of the lighting fixtures were documented the data was sent to the International Dark-Sky Association, who developed lighting recommendations to replace the current lighting used that was not determined to be compliant with IDA Guidelines for Outdoor Lighting regulations. Lights that were determined to be unnecessary were recommended to be removed; lights that were shielded are compliant and can remain as they currently are, non-compliant fixtures were given recommendations for light replacement that complied with dark sky regulations while still providing the necessary light to achieve specified function

Site No. 1: Apgar Campground



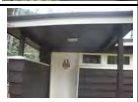
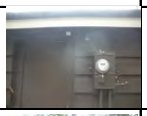
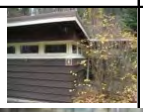
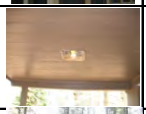
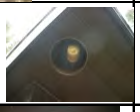
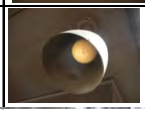
ASSET_NO	FMSS_DESC
	WLD Apgar Transit Center Bus Shelter
7567	WLD Apgar Building 224 Comfort Stn Picnic Area
7571	WLD Apgar Building 228 Comfort Stn Loop A Lower
7573	WLD Apgar Building 229 Comfort Stn Loop A Upper
7576	WLD Apgar Building 230 Comfort Stn Loop B Lower
7579	WLD Apgar Building 234 Comfort Stn Loop B Middle
7581	WLD Apgar Building 235 Comfort Stn Loop B Upper
7583	WLD Apgar Building 237 Comfort Stn Loop C Lower
7587	WLD Apgar Building 238 Comfort Stn Loop C Upper
7590	WLD Apgar Building 239 Comfort Stn Loop D Upper
7592	WLD Apgar Building 240 Comfort Stn Loop D Lower
7594	WLD Apgar Building 241 Comfort Stn Loop E
7595	WLD Apgar Building 710 Ranger Stn Apgar CG
79276	WLD Apgar Building 1536 Vault Toilet Picnic Area
111708	WLD Apgar Building 1584 Transit Center
226152	WLD Apgar Building 1776 Transit Center Lift Station

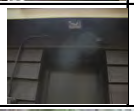
Figure 1.1

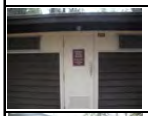
Summary of recommendations:

All of the wall mounted fixtures in the comfort stations will be replaced with Atlas WPS13LED Wall Paks this winter. The remaining lights in this developed area will be replaced with PAR30 Amber LED Bulbs.

Responsible Party: National Park Service

Picture (Wide)	Picture (Detail)	Light No.	# of light type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec
				**Building Type:**	Restroom							
		1		Flood		N			Walk way, Security	N	15° tilt	Atlas WPS13 LED Wall Pak
		2		Recessed		Y			Entry	Y		
		3		Wall Lantern - no bulb		N			Entry	N		Atlas WPS13 LED Wall Pak
		4		Recessed		Y			Entry	Y		
		5		Flood		N		Incandescent	Walk way, Security	N	30° tilt	Par30 Amber LED
				**Building Type:**	Restroom							
		1	2	Flood		N	60W	Incandescent	Walk way, Security	N		Par30 Amber LED
		2		Recessed, Bare Bulb		N		Compact Flourescent	Entry	N		Light Shield
		3		Wall Lantern, no bulb		N			Entry	N		Atlas WPS13 LED Wall Pak
		4		Recessed		Y			Entry	Y		
				**Building Type:**	Restroom							
		1		Flood		N			Walk way, Seecurity	N		Par30 Amber LED
		2	2	Recessed		Y			Entry	Y		
		4		Flood		Y		Incandescent	Walk way, Security	Y		Par30 amber LED

			**Building Type:**	Restroom							
 	1	2	Flood		N		Incandescent	Walk way, Security	N		Par30 amber LED
 	2	2	Recessed		Y			Entry	Y		
 	3		Recessed, Bare Bulb		Y		Incandescent	Entry	Y		Light Shield
			**Building Type:**	Restroom							
 	1	2	Flood		N			Walk way, Security	N		Par30 amber LED
 	2	3	Recessed, Bare Bulb		Y		Incandescent	Entry	Y		
			**Building Type:**	Restroom							
 	1	2	Flood		N			Security, Walk way	N		Par30 amber LED
 	2	3	Recessed		Y			Entry	Y		
			**Building Type:**	Restroom							
 	1	3	Wall Lantern		N		CF	Entry	N		Atlas WPS13 LED Wall Pak
 	3				N			Security	N		Remove
			**Building Type:**	Restroom							
 	1	3	Wall Lantern		N		CF	Entry	N		Atlas WPS13 LED Wall Pak

				**Building Type:** Restroom								
		1		Wall Lantern		N			Entry	N		Atlas WPS13 LED Wall Pak
		2	2	Ceiling		N			Entry	N		Par30 amber LED
		3				N			Security Light	N		remove
				**Building Type:** Restroom								
		1		Wall Lantern		N			Entry	N		Atlas WPS13 LED Wall Pak
		2	2	Ceiling		N			Entry, Walk way, Security	N		Par30 amber LED
				**Building Type:** Restroom								
		1		Wall Lantern		N			Entry	N		Atlas WPS13 LED Wall Pak
		2	2	Ceiling		N			Entry, Walk way, Security	N		Par30 amber LED
		3				N			Security Light	N		Remove
				**Building Type:**	Park Services - Ranger Station							
		1		Recessed		Y			Entry	Y	On at time of inspection.	CLB-LED amber LED ceiling mounted fixture (RDA -RAB Designs Canada)
		2				N				N		RDA WRDS Amber LED fixture
		1		Post		N				N		Beacon Urban LED SL

Site No. 2 Apgar Village:

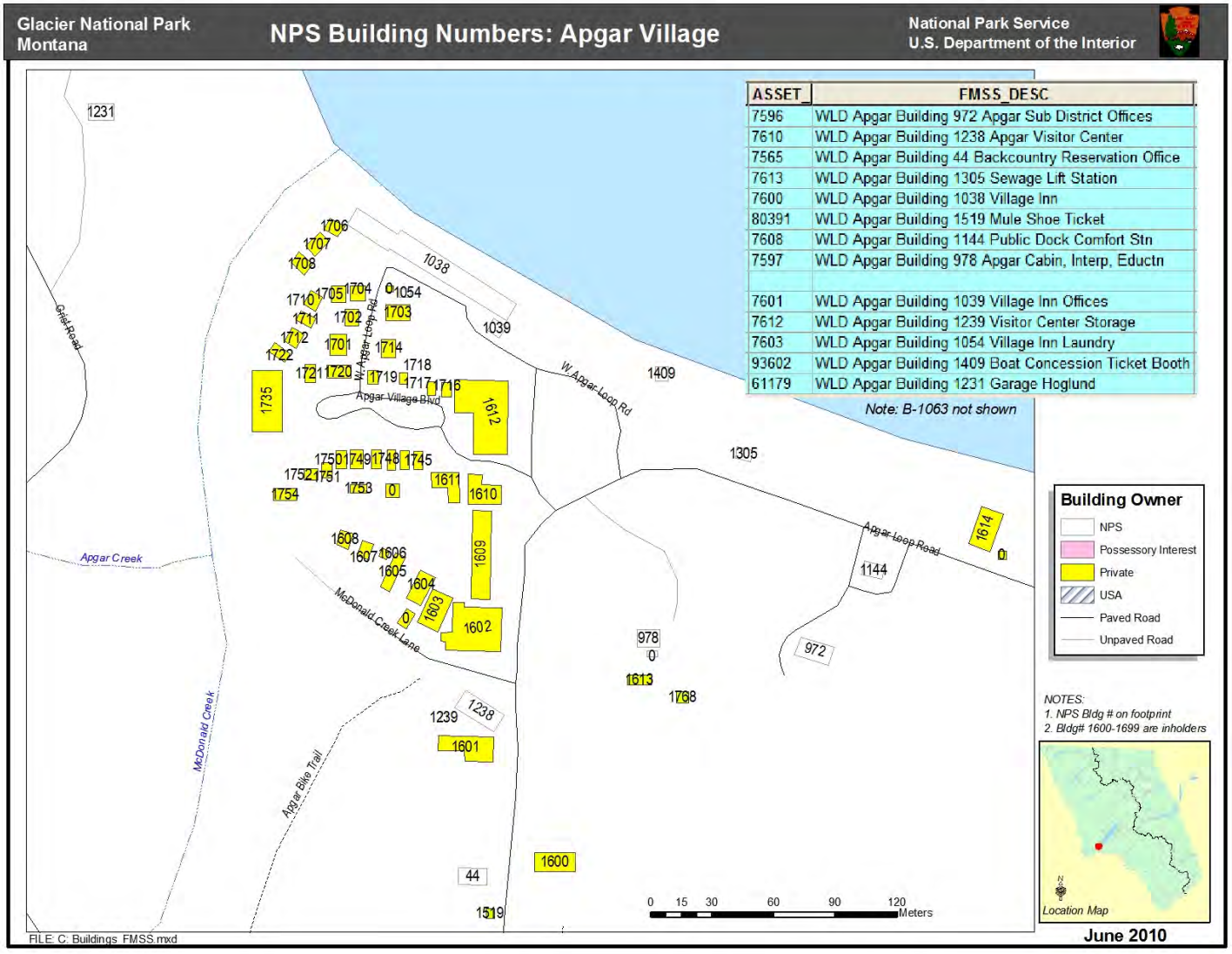


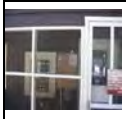
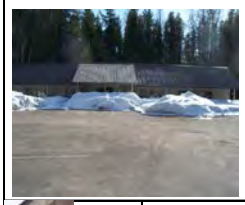
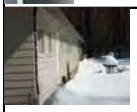
Figure 1.2

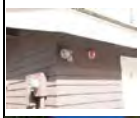
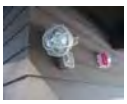
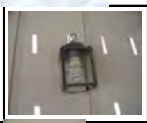
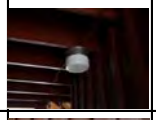
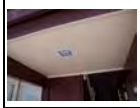
Park operated buildings in Apgar village:

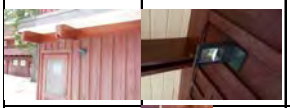
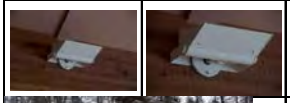
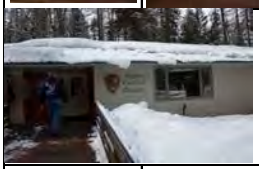
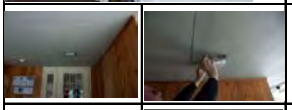
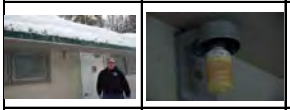
Summary of recommendations:

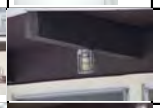
Replace non-compliant ceiling lights with Amber LED Par16 bulbs. Replace wall lanterns with Atlas WPS13 LED Wall Paks.

Responsible Party: National Park Service

Picture (Wide)	Picture (Detail)	Light No.	# of type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Recommendation
				**Building Type:**	Park Services							
		1		Wall Lantern		N	20	Compact Fluorescent	Entry Light	Y	Inside screened Porch, Back Country Permits Office.	Atlas WPS13 LED Wall Pak
				**Building Type:**	Restroom							
		1		Flood Light		Y		No Bulb	Security Light	Y	Compliant if pointed down.	Amber LED Par16
		2	2	Recessed Light		Y			Entry Light	Y		
		3		Wall Lantern		N		No Bulb	Entry Light	N		Atlas WPS13 LED Wall Pak
		5		Flood Light		N		Compact Fluorescent	Security Light	N		Amber LED Par30
				**Building Type:**	Park Service						Apgar Subdistrict Office	
		1	4	Recessed Light		Y			Entry Light	Y		
		5	3	Wall Lantern		N			Entry Light	N		Amber LED par16 lamp (preferably in progress cylinder fixture)

				**Building Type:**								
		1		Wall Lantern		N			Entry Light	N		Atlas WPS13 LED Wall Pak
		2		Flood Light		N		PAR	Security	N		Amber LED Par30 - direct downward
				**Building Type:**	Park Service							
		1		Wall Lantern		N		Compact Fluorescent	Entry	N		Atlas WPS13 LED Wall Pak
		2		Wall Lantern	Motion Sensor	N		Incandescent	Entry	N		Atlas WPS13 LED Wall Pak
				**Building Type:**	Commercial							
		1		Flood		N				N		Relamp: Amber LED Par30 (aim downward)
		2	14	Wall Lantern		N			Entry Light	N		Atlas WPS13 LED Wall Pak
		15		Ceiling					Walk Way Light			RAB Designs Canada CLB-Amber LED fixture
		16		Glare Buster		Y			Walk Way Light	Y		
		17	13	Recessed		Y			Walk Way Light	Y		
		31	3	Flood		N				N		amber LED par38 bulb (1) aim down-cap 2 other sockets- or replace
		34	15	Recessed		Y			Walk Way Light			

			**Building Type:**	Commercial							
	1		Glare Buster		Y			Security	Y		
	2		Fluorescent		N			Sign	N		Amber sleeve
	3		Fluorescent		N			Task	N		Amber sleeve
	4		Glare Buster		Y			Security	Y		
	5		Sign		N			Sign	N		vending machine motion control
			**Building Type:**	Park Services							
	1	6			Y			General Light	Y	Compliant if positioned correctly	
			**Building Type:**	Park Services							
	1	6	Wall Pack		Y	26W	Compact Fluorescent	Entry Light	Y		Hubbell LNC Amber LED wallpack
	2	2			Y			Entry Light	Y	Compliant if positioned correctly	
			**Building Type:**	Park Services							
	1		Recessed		Y			Entry Light	Y		
	2		Ceiling		N	90	Incandescent	Directional	Y	Compliance is position dependant	
	3		Wall Lantern		N		Compact Fluorescent	Entry Light	N		Atlas WPS13 LED Wall Pak
	4		Ceiling		Y		Incandescent	Entry Light	Y		

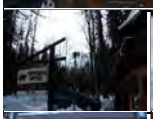
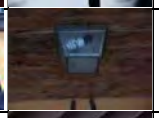
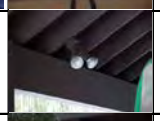
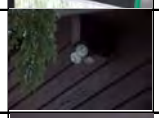
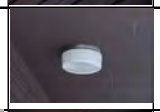
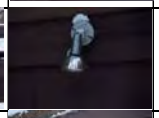
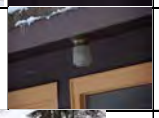
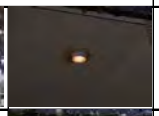
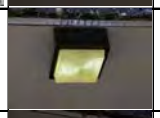
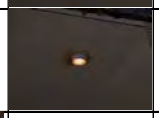
				**Building Type:**	Restrooms							
		1		Ceiling		N	14	Compact Fluorescent	Entry Light	N	Entrance light over maintenance door	Amber LED Par16
		2		Ceiling		N	14	Compact Fluorescent	Entry Light	N	Entrance light overWomen's restroom	Amber LED Par16
		3		Ceiling		N	14	Compact Fluorescent	Entry Light	N	Entrance light over Men's restroom	Amber LED Par16

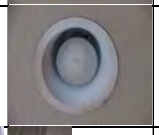
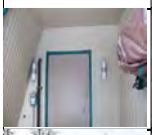
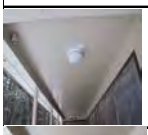
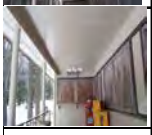
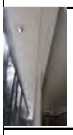
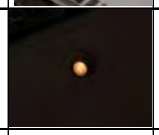
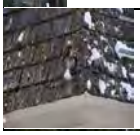
Concession operated buildings in Apgar Village:

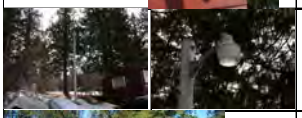
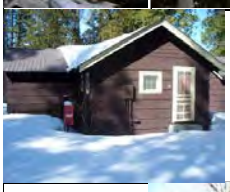
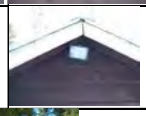
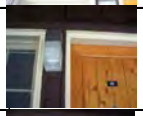
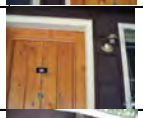
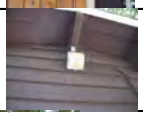
Summary of recommendations:

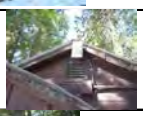
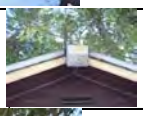
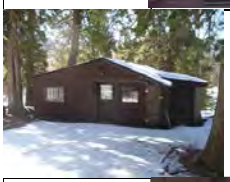
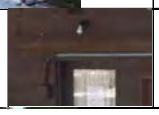
Replace non-compliant bulbs with PAR16 and PAR 30 amber LED bulbs when existing bulb is not compliant with IDA GOL regulations. Some large lights in concessions buildings will be refitted with CLB-LED ceiling mounted fixtures. Progress Cylinder fixtures are recommended to replace wall lanterns.

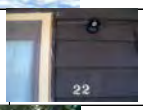
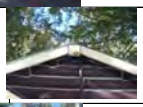
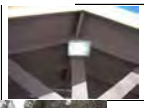
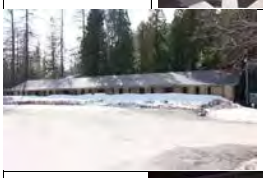
Responsible Party: Xanterra

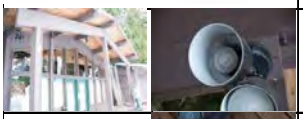
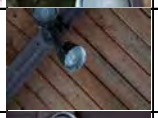
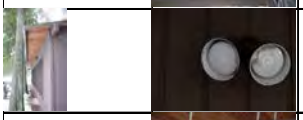
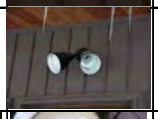
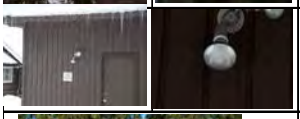
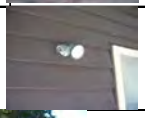
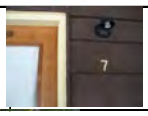
Picture (Wide)	Picture (Detail)	Light No.	# of type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant ?	Notes	Recommendation
				**Building Type:**	Commercial						Montana House Gifts	
		1		Flood		N			Walk Way Light	N		remove
		2		Ceiling		N		Compact Fluorescent	Entry Light	N		Amber LED CLB-LED fixture (RAB Designs Canada)
		3		Flood		N			Security Light	N		PAR30 Amber LED Bulb
		4		Flood		N			Security Light	N		PAR30 Amber LED Bulb
		5	3	Ceiling		N			Entry Light	N		Amber LED CLB-LED fixture (RAB Designs Canada)
		8		Flood		N			Entry Light	N		PAR30 Amber LED Bulb
		9		Ceiling		N			Entry Light	N		Amber LED CLB-LED fixture (RAB Designs Canada)
				**Building Type:**	Commercial							
		1		Recessed Directional		Y		Compact Fluorescent	Entry Light	Y		
		2		Ceiling		N			Entry Light	N		Amber LED CLB-LED fixture (RAB Designs Cananda)
		3		Recessed Directional		Y		Compact Fluorescent	Entry Light	Y		
		4	3	Recessed Directional		Y			General Light	Y		
		7		Sign		N		Neon	Sign Light	N		turn off at close of business hours
		8	2	Recessed		Y		Compact Fluorescent	General Light	Y		

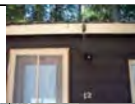
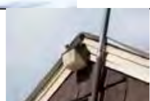
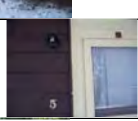
		10		Recessed		Y	65	Incandescent	General Light	Y		
		11		Recessed		Y		Compact Fluorescent	General Light	Y		
		12	2	Wall Lantern		N			Entry Light	N		Progress cylinder fixture with amber LED par16
		14		Yard		N				N		Atlas WPS LED Wall Pak
		15		Double Flood Light	Motion Sensor	N		2 PAR	Entry Light	N		Amber LED Par30 lamp (1)- direct downward- cap spare socket
		16		Recessed Directional		N	60	Incandescent	General Light	N	Bulb extends past fixture.	Amber LED par16
		17	2	Recessed Directional		Y	60	Incandescent	General Light	Y		
		19		Recessed Directional		N		Compact Fluorescent	General Light	N	Bulb extends past fixture.	Amber LED par16
		20		Ceiling		N			General Light	N		Amber LED CLB-LED fixture (RAB Designs Cananda)
		21	2	Flood		Y		Compact Fluorescent	Task Light	Y		
		22		Flood		Y	65	Incandescent	Task Light	Y		
		24	3	Recessed Directional		N		Compact Fluorescent	General Light	N	Bulb extends past fixture.	Amber LED par16
		27		Recessed Directional		Y	60	Incandescent	General Light	Y		
		28	2	Recessed Directional		Y		Compact Fluorescent	General Light	Y		
		30		Flood		N		PAR	Walk Way Light	N		Amber LED Par30

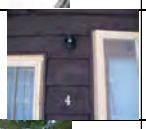
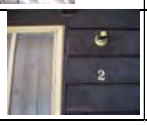
			**Building Type:**	Commercial							
	1		Umbrella Light		N	20	Compact Fluorescent	Entry Light	N		Amber LED Par30
	2		Flood Light Double		N	20	Compact Fluorescent	Entry Light	N	Only one Bulb	Amber LED Par16 with Progress cylinder fixture
	3		Flood Light Double		N	26 1300 Lumens	PAR	Security	N	Only One Bulb Parking Lot	Amber LED Par30 (direct downward) or Hubbel LNC amber LED wallpack
	1		Yard Light	Dusk to Dawn	N			General Light	N		Bypass ballast install Amber LED Par38 with mogul to medium base adapter
			**Building Type:**	Commercial Cabin							
	1		Wall Pack	Dusk to Dawn	N		Halogen	Entry Way Light	N		Hubbel LNC Amber LED wallpack - remount
			**Building Type:**								
	1		Loose wires over door					Entry Light			Remove
	2		Wall Pack		N		Halogen	Yard Light	N		Hubbell LNC amber LED wallpack - remount
			**Building Type:**	Commercial Cabin							
	1	2	Flood Light		N		No Bulb	Entry Way Light	N	9 units this building. By McDonald Creek	Amber LED CLB-LED (RAB Designs Canada)
	2	2	Wall Lantern	Dusk to Dawn	N			General Light	N		Progress Cylinder fixture with Amber LED par16
	3	7	Wall Lantern	Switched	N		No Bulb	Entry Way Light	N		Progress Cylinder fixture with Amber LED par16
	12		Wall Pack		N			General Light	N		Hubbell Amber LED LNC wallpack

			**Building Type:**								
	1		Wall Lantern	Dusk to Dawn	N		Incandescent	Entry Light	N		Progress cylinder fixture with Amber LED par16
			**Building Type:**	Commercial Cabin							
	1		Wall Pack		N			Entry Way Light	N		Hubbell LNC Amber LED wallpack
			**Building Type:**	Commercial Cabin							
 	1		Wall Pack	Dusk to Dawn	N		Halogen	Entry Way Light	N		Hubbell LNC Amber LED wallpack-remount
			**Building Type:**	Commercial Cabin							
	1		Wall Pack	Dusk to Dawn	N		Halogen	Yard Light	N		Hubbell LNC Amber LED wallpack-remount
			**Building Type:**	Commercial Cabin							
	1		Wall Pack	Dusk to Dawn	N		Incandescent	Yard Light	N		Hubbell LNC Amber LED wallpack-remount
			**Building Type:**	Commercial Cabin							
	1		Wall Pack	Dusk to Dawn	N		Halogen	Yard Light	N		Hubbell LNC Amber LED wallpack-remount
			**Building Type:**	Commercial Cabin							
	1		Bare Bulb		N		Incandescent	Entry Light	N	Cabin by Creek	Progress cylinder fixture with Amber LED par16

			**Building Type:**	Commercial Cabin							
	1		Wall Lantern	Switched	N		No Bulb	Entry Way Light	N		Progress Cylinder fixture with Amber LED par16
			**Building Type:**								
	1		Wall Pack	Dusk to Dawn	N		Halogen	Entry Way Light	N		Hubbell LNC Amber LED wallpack
			**Building Type:**	Commercial Cabin							
	1		Wall Pack		N		Halogen	Entry Way Light	N		Hubbell LNC amber LED wallpack
			**Building Type:**	Commercial							
	1	11	Wall Lantern		N		No Bulb	Entry Light	N		Amber LED Par16
	12		Post		N		Halogen	General Light	N		remove- install Beacon Amber LED Beacon Viper fixture 18W type3
			**Building Type:**	Commercial							
	1		Flood Light		N	50	PAR	Sign Illumination			only on during operation hours
	2		Flood Light	Motion Sensor	N		PAR	Security	N		Amber LED Par30
	3	2	Flood Light	Motion Sensor	N		PAR	Walkway Light	N		Amber LED Par30
	5		Bollard		Y			Walkway Light	Y		NA
 	6		Wall Lantern		Y			Entry Light	Y		NA
	7		Vending Machine		N			Sign Illumination	N		vending machine motion sensor

			**Building Type:**	Commercial							
	1		Wall Lantern	Switched	N		Incandescent	Entry Light	N		Amber LED Par16
			**Building Type:**	Commercial						Cedar Tree	
	1		Double Flood Light		N		2 Compact Fluorescent	Entry Way Light	N		Amber LED par30 or CLB-LED (RAB Designs Canada)
	2		Flood Light		N		Compact Fluorescent	Entry Way Light	N		Amber LED Par30 or CLB-LED (RAB Designs Canada)
	3		Double Flood Light		N		2 Compact Fluorescent	Entry Way Light	N		Amber LED par30 or CLB-LED (RAB Designs Canada)
	4		Double Flood Light		N		2 Compact Fluorescent	Entry Way Light	N		Amber LED Par30 (direct downward)
	5		Double Flood Light		N		1 Compact Fluorescent 1 No Bulb	Entry Way Light	N		Amber LED Par30 (direct downward - remove one socket)
	6		Yard Light		N		Mercury	General Light	N		Bypass Ballast and install amber LED Par38 with mogul to medium base adapter
	7		Double Flood Light		N		2 Compact Fluorescent	Entry Way Light	N		
			**Building Type:**								
	1		Wall Pack		N		Halogen	General Light	N		
	2		Flood Light Double		N	100	1 PAR 1 No Bulb	Entry Way Light	N		
			**Building Type:**	Commercial							
	1		Wall Lantern	Switched	N		No Bulb	Entry Light	N		Progress Cylinder fixture with Amber LED par16

			**Building Type:**	Commercial Cabin							
	1		Wall Lantern	Switched	N		No Bulb	Entry Light	N		Progress Cylinder fixture with Amber LED par16
			**Building Type:**	Commercial Cabin							
	1		Wall Lantern	Switched	N		No Bulb	Entry Light	N		Progress Cylinder fixture with Amber LED par16
			**Building Type:**	Commercial Cabin							
	1		Wall Lantern	Switched	N		No Bulb	Entry Light	N		Progress Cylinder fixture with Amber LED par16
			**Building Type:**	Commercial Cabin							
 	1		Wall Pack	Dusk to Dawn	N		Halogen	Yard Light	N		Atlas WPS13 LED Wall Pak
			**Building Type:**	Commercial Cabin							
	1		Wall Lantern	Dusk to Dawn	N			Entry Light	N		Atlas WPS13 LED Wall Pak
			**Building Type:**	Commercial Cabin							
	1		Wall Lantern	Switched	N		No Bulb	Entry Light	N		Progress Can fixture with Amber LED par16
			**Building Type:**	Commercial Cabin							
	1		Wall Lantern	Switched	N		No Bulb	Entry Light	N		Progress cylinder fixture with Par16 Amber LED bulb

				**Building Type:**	Commercial Cabin							
		1		Wall Lantern	Switched	N		No Bulb	Entry Light	N		Progress cylinder fixture with Amber LED par16
				**Building Type:**	Commercial Cabin							
		1		Wall Lantern	Switched	N		No Bulb	Entry	N		Progress cylinder fixture with Amber LED Par16

Site No. 3 Avalanche Campground:

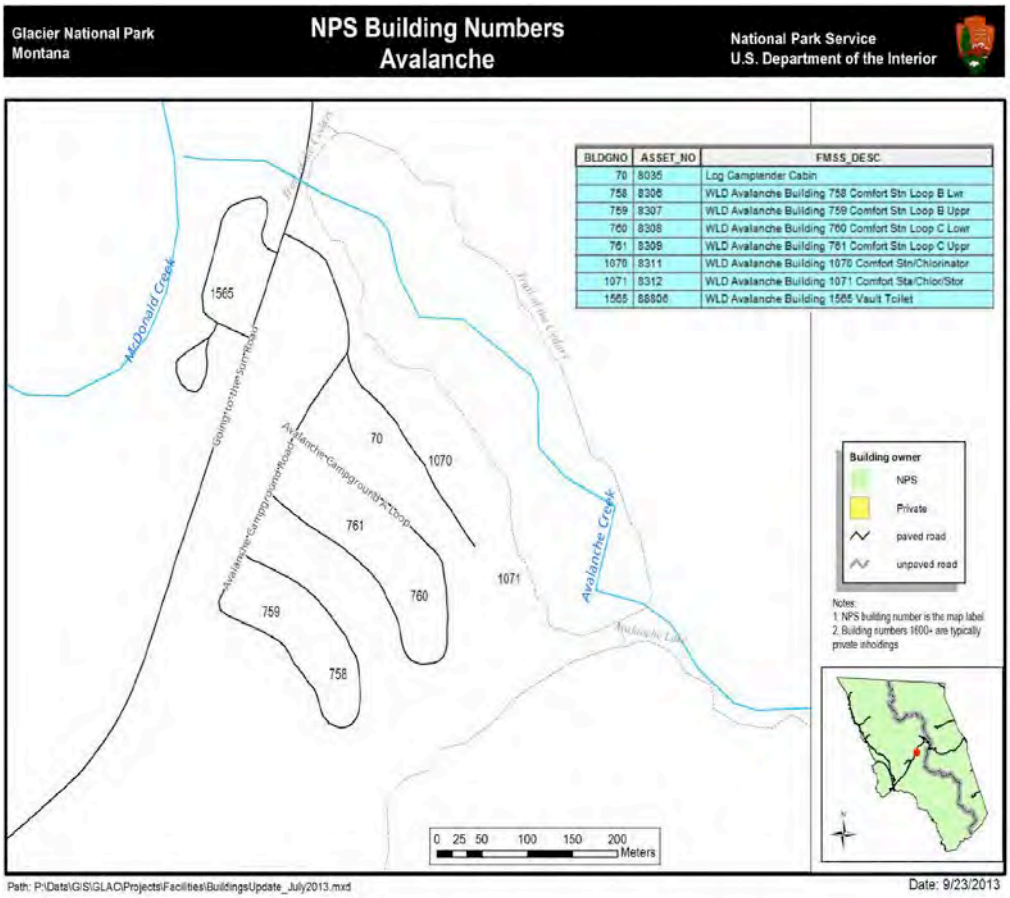
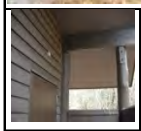


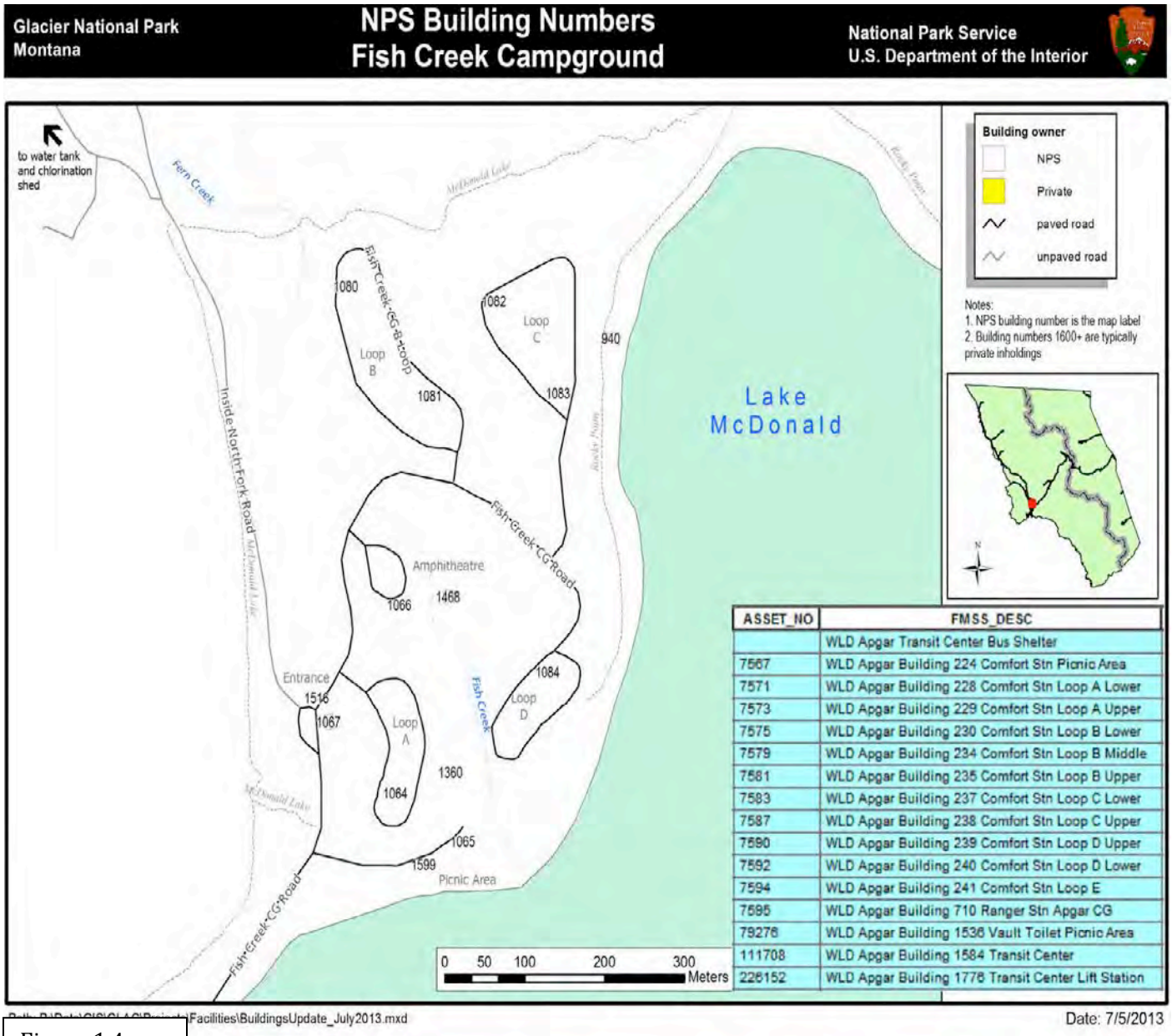
Figure 1.3

Summary of recommendations: This campground has no electricity. The two existing lights are LED solar wall packs.

Responsible Party: No improvements needed

Picture (Wide)	Picture (Detail)	Light No.	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec
			**Building Type:**	Restroom							
		1	Wall Pack		N			Entry	Y		
		2	Wall Pack		N			Entry	Y	On at time of inspection	

Site No. 4 Fish creek campground:



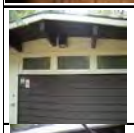
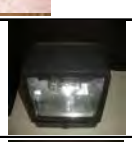
ASSET_NO	FMSS_DESC
	WLD Apgar Transit Center Bus Shelter
7567	WLD Apgar Building 224 Comfort Stn Picnic Area
7571	WLD Apgar Building 228 Comfort Stn Loop A Lower
7573	WLD Apgar Building 229 Comfort Stn Loop A Upper
7575	WLD Apgar Building 230 Comfort Stn Loop B Lower
7579	WLD Apgar Building 234 Comfort Stn Loop B Middle
7581	WLD Apgar Building 235 Comfort Stn Loop B Upper
7583	WLD Apgar Building 237 Comfort Stn Loop C Lower
7587	WLD Apgar Building 238 Comfort Stn Loop C Upper
7590	WLD Apgar Building 239 Comfort Stn Loop D Upper
7592	WLD Apgar Building 240 Comfort Stn Loop D Lower
7594	WLD Apgar Building 241 Comfort Stn Loop E
7595	WLD Apgar Building 710 Ranger Stn Apgar CG
79276	WLD Apgar Building 1536 Vault Toilet Picnic Area
111708	WLD Apgar Building 1584 Transit Center
226152	WLD Apgar Building 1776 Transit Center Lift Station

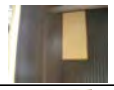
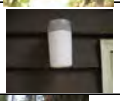
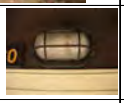
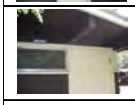
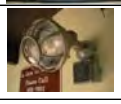
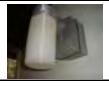
Figure 1.4

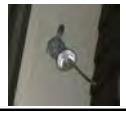
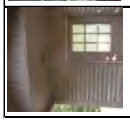
Summary of recommendations:

Wall packs in comfort stations will be replaced with Atlas WPS13 LED Wall Paks. Atlas Wall Paks have been ordered for the comfort stations in this campground, and replacement will begin in the winter. Lanterns on buildings such as the ranger station should be replaced with RAB Designs WRDS LED fixtures. The remaining lights in this developed area are security lights and should be replaced with Par30 amber LED bulbs. Following the replacement of lights in the comfort stations will be the switch of other non-compliant lights to Atlas WPS13 LED Wall Paks on other park services buildings such as the entrance station and amphitheater.

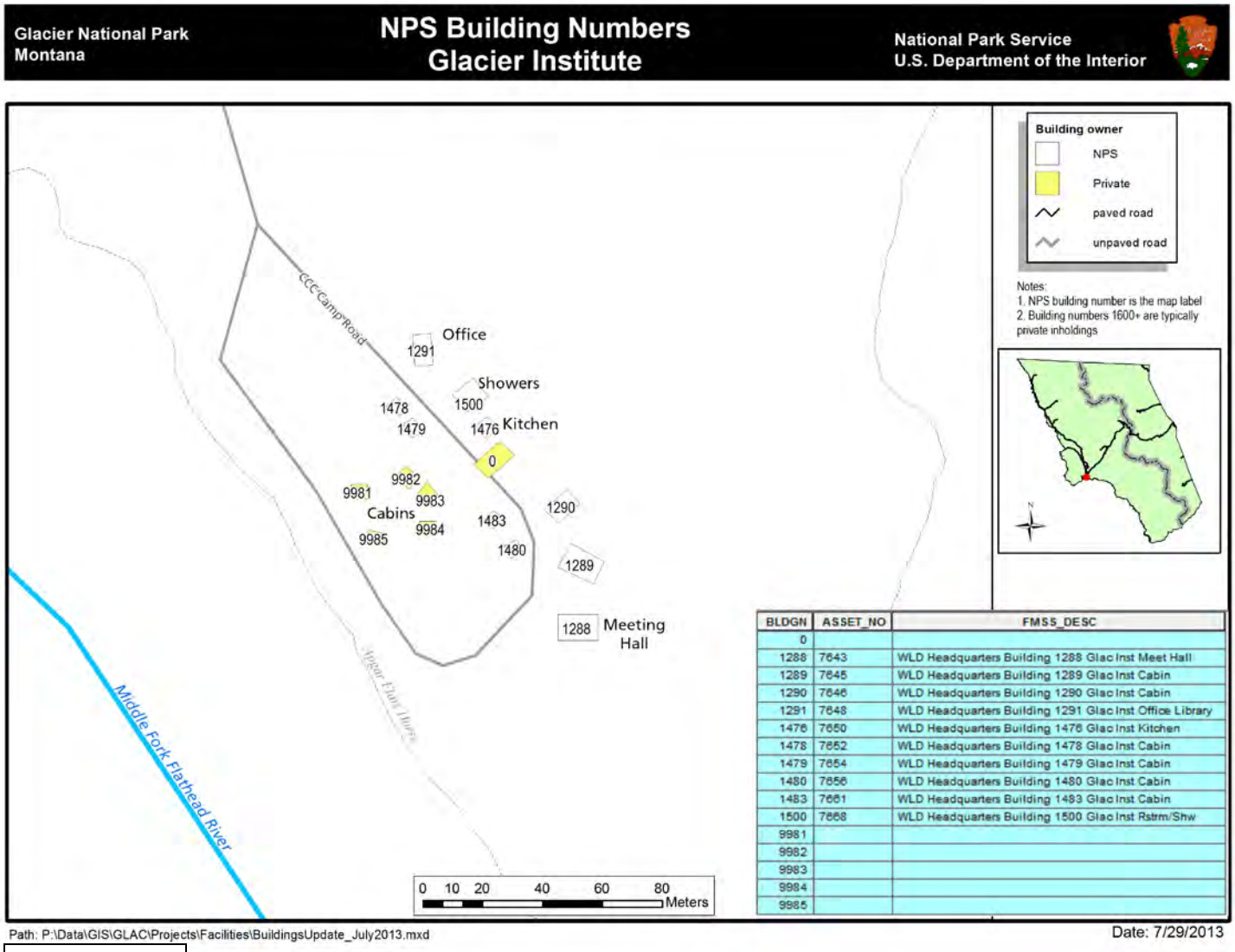
Responsible party: National Park Service

Picture (Wide)	Picture (Detail)	Light No.	# of light type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec.
				**Building Type:**	Restroom, Showers							
		1	4	Wall Pack		Y			Security, Walk Way	Y		
		2	7	Wall Lantern, Sconce		N			Entry	N		Atlas WPS13 LED Wall Pak
				**Building Type:**	Restroom							
		1		Wall lantern, Sconce		N			Entry	N		Atlas WPS13 LED Wall Pak
		2		Emergency Light		N			Emergency	N	Emergency light	
		3		Wall Pack		Y			Entry	Y		
		4		Wall Lantern		N			Entry	N	Inside corridor	Atlas WPS13 LED Wall Pak
		5		Wall Pack		Y			Entry	Y	Inside corridor	
				**Building Type:**	Restroom							
		1		Wall Lantern, Sconce		N			Entry	N		Atlas WPS13 LED Wall Pak
		2	2	Wall Pack		Y			Entry	Y		

				**Building Type:**	Cabin - Ranger Station							
		1		Double Flood		N		CF PAR	Security	N		Hubbell Amber LED LNC 7L Wallpack
		2	3	Wall Lantern		N			Entry	N		RDA WRDS Amber LED fixture
				**Building Type:**	Restroom							
		1	2	Wall Lantern, Sconce		N			Entry	N		Atlas WPS13 LED Wall Pak
		2	2	Wall Pack		Y			Entry, Walk Way	Y		
				**Building Type:**	Restroom							
		1	2	Wall Lantern, Sconce		N			Entry	N		Atlas WPS13 LED Wall Pak
		2	2	Wall Pack		Y			Entry	Y		
				**Building Type:**	Restroom							
		1	2	Wall Lantern, Sconce		N			Entry	N		Atlas WPS13 LED Wall Pak
		2	2	Wall Pack		Y			Entry, Walk Way	Y		
				**Building Type:**	Restroom							
		1	2	Wall Lantern, Sconce		N			Entry	N		Atlas WPS13 LED Wall Pak
		4		Flood		N			Security	N	45° tilt	Atlas WPS13 LED Wall Pak
		5	2	Wall Pack		Y			Entry	Y	In corridor	
		6		Wall Lantern		N			Entry	N	In corridor	Atlas WPS13 LED Wall Pak

				**Building Type:**	Restroom							
		1	2	Wall Lantern, Sconce		N			Entry	N		Atlas WPS13 LED Wall Pak
		2	2	Wall Pack		Y			Entry	Y		
				**Building Type:**	Maintenance (gas or gen?)							
		1		Wall Lantern	Switch	N			Entry	N		RDA WRDS Amber LED fixture
				**Building Type:**	Park Services - ampitheater							
		1		Flood		N		CF PAR	Security, General	N	20° tilt	Par30 amber LED bulb
				**Building Type:**	Park Services							
		1	2	Wall Lantern					Security, General	Y	Pointed directly down	Par30 amber LED bulb
		2		Recessed	Switch				Entry	Y	Pointed directly down	Par16 amber LED bulb

Site No. 5 The Glacier Institute:



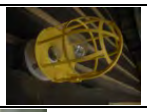
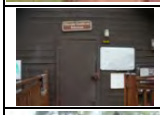
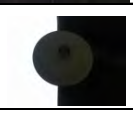
BLDGN	ASSET_NO	FMSS_DESC
0		
1288	7643	WLD Headquarters Building 1288 Glac Inst Meet Hall
1289	7645	WLD Headquarters Building 1289 Glac Inst Cabin
1290	7646	WLD Headquarters Building 1290 Glac Inst Cabin
1291	7648	WLD Headquarters Building 1291 Glac Inst Office Library
1476	7650	WLD Headquarters Building 1476 Glac Inst Kitchen
1478	7652	WLD Headquarters Building 1478 Glac Inst Cabin
1479	7654	WLD Headquarters Building 1479 Glac Inst Cabin
1480	7656	WLD Headquarters Building 1480 Glac Inst Cabin
1483	7661	WLD Headquarters Building 1483 Glac Inst Cabin
1500	7668	WLD Headquarters Building 1500 Glac Inst Rstrm/Shw
9981		
9982		
9983		
9984		
9985		

Figure 1.5

Summary of Recommendations:

Wall lanterns will be replaced with RDA WRDS fixtures with Amber LED bulbs. Shielded ceiling fixtures should be given Par30 amber LED bulbs.

Responsible Party: This site is owned by the National Park Service but the Glacier Institute is responsible for maintaining the property. Part of this maintenance is replacing fixtures. The Glacier Institute has been asked by the park to make all light updates dark sky compliant.

Picture (Wide)	Picture (Detail)	Light No.	# of Light Type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant ?	Notes	Rec
				**Building Type:**	Cabin							
		1		Wall Lantern	Switch	N		Incandescent	Entry, Patio	N		RDA WRDS Amber LED fixture
				**Building Type:**	Cabin							
		1		Wall Lantern	Switch	N		Incandescent	Entry, Patio	N		RDA WRDS Amber LED fixture
				**Building Type:**	Park Services - Office/Library							
		1		Flood, Bare Bulb		N		CF PAR	Entry	N		RDA WRDS Amber LED fixture
				**Building Type:**	Park Services - Kitchen							
		1		Wall Lantern	Switch	N			Entry	N		RDA WRDS Amber LED fixture
				**Building Type:**	Park Services - Meeting Hall							
		1		Wall Lantern		Y		CF	Entry	Y		par30 amber LED bulb
		2		Wall Lantern		Y		CF	Security, General	Y		par30 amber LED bulb
				**Building Type:**	Restroom - Shower							
		1		Ceiling		N			Security, General	N		par30 amber LED bulb
		2		Ceiling		N			Security, General	N		par30 amber LED bulb

Site No. 6 Goat Haunt:

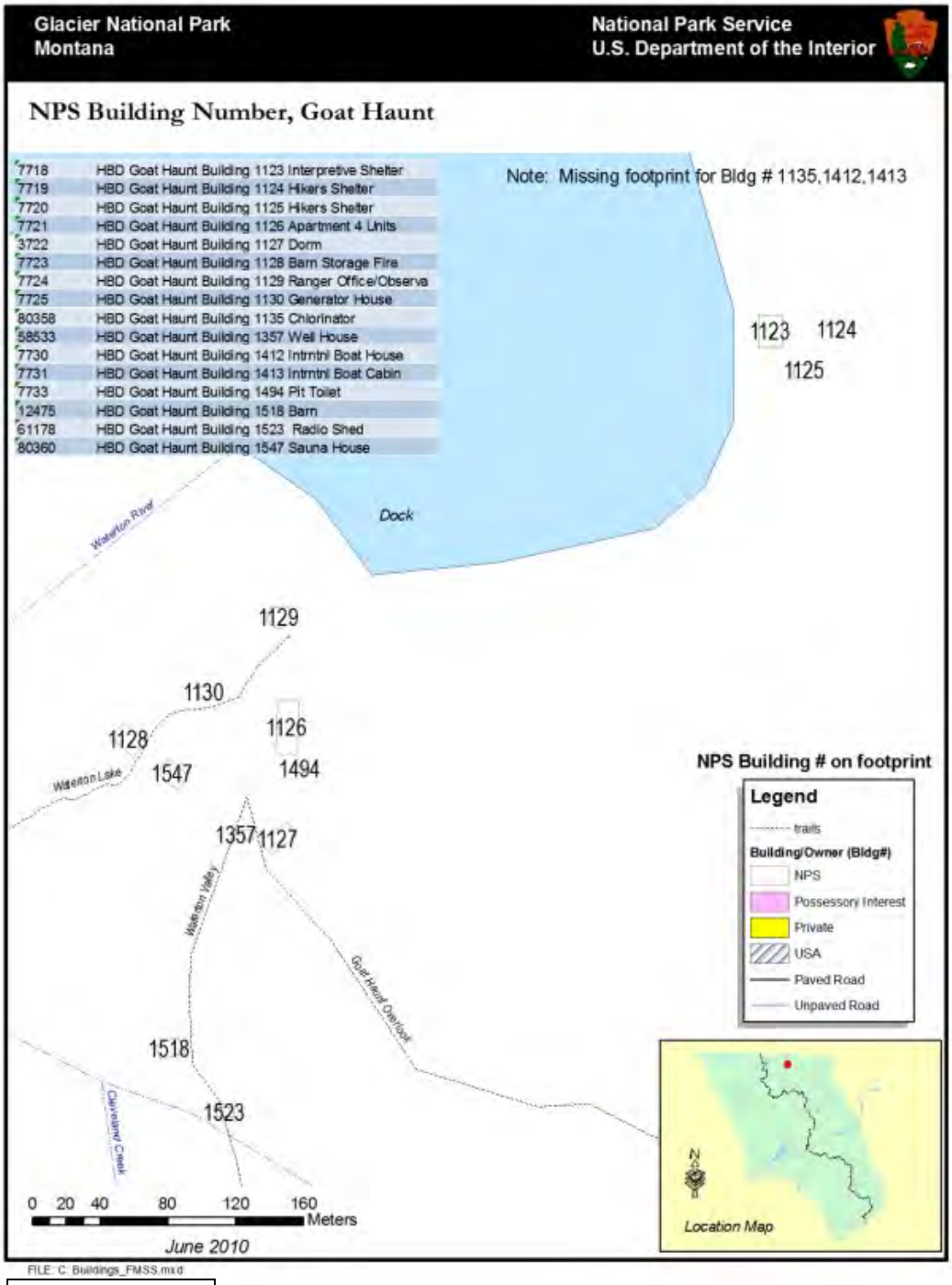
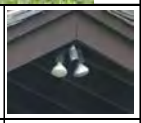
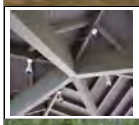
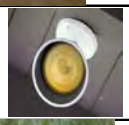
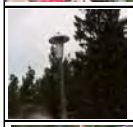
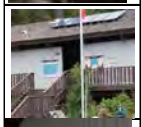
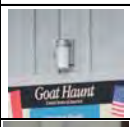
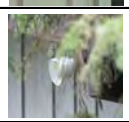


Figure 1.6

Summary of recommendations:

Replace non-compliant wall lanterns with RAB Designs WRDS Amber LED fixtures. Replace the bulbs in the triple flood light with Par30 Amber LED.

Responsible Party: National Park Service

Picture (Wide)	Picture (Detail)	Light No.	# of light type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec
				**Building Type:**	Park service residence							
		1		Triple Flood Light		N		PAR	General Light	N	One bulb missing	Par30 amber LED bulb
		2		Wall Lantern		N			Entry Way Light	N		RDA WRDS amber LED fixture
				**Building Type:**	Pavilion							
		1	11	Flood Light		Y		PAR	General Light	Y	Fixtures compliant since they were facing under the roof.	
				**Building Type:**	Visitor Center							
		1		Post		Y			General Light	Y		
		2	2	Wall Lantern		N			Entry Way Light	N		RDA WRDS Amber LED fixture
		4		Wall Lantern		N		Compact Fluorescent	Entry Way Light	Y	Under Roof	RDA WRDS Amber LED fixture
				**Building Type:**								
		1		Wall Lantern		N			Entry Way Light	N		RDA WRDS Amber LED fixture
		1		Flood Light		Y			Security	Y	Compliant if positioned correctly.	Par30 amber LED bulb (aim down)

Site No. 7 Head Quarters:

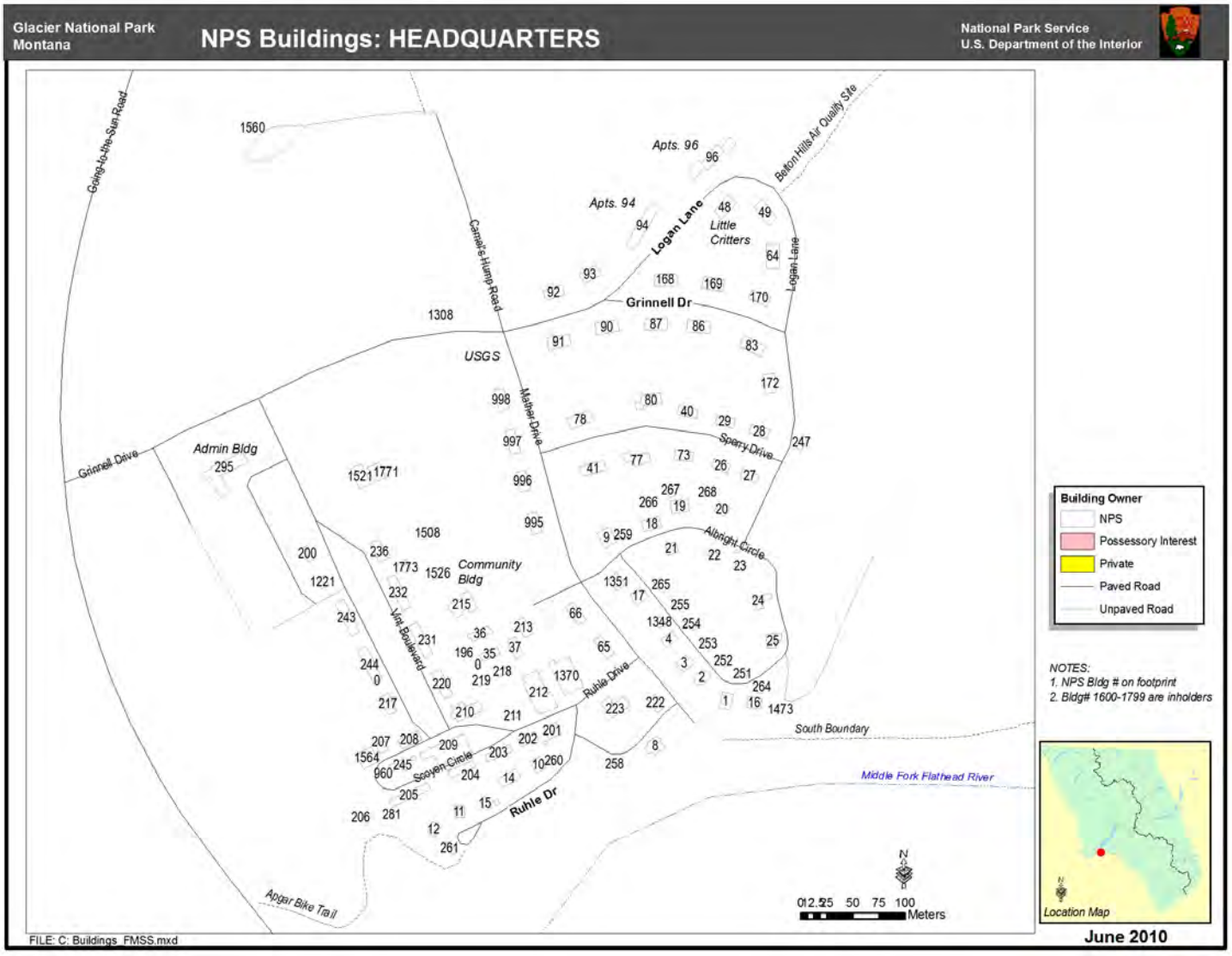
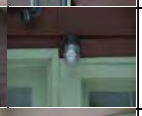
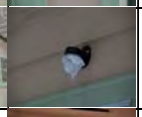
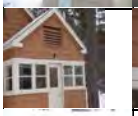
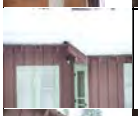
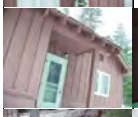
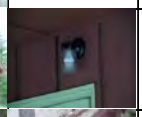
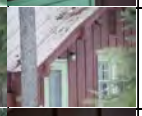
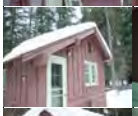
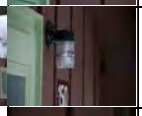
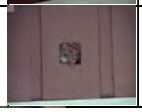


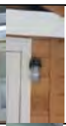
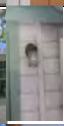
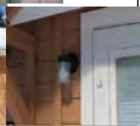
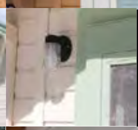
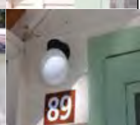
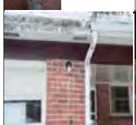
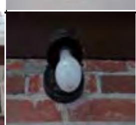
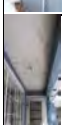
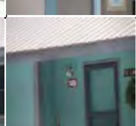
Figure 1.7

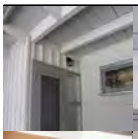
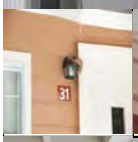
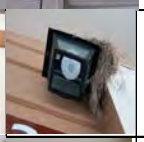
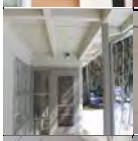
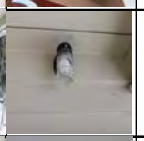
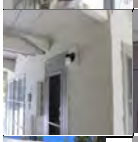
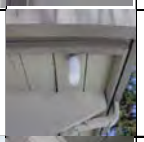
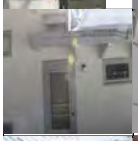
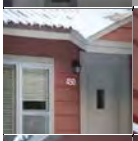
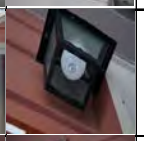
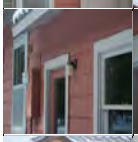
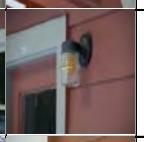
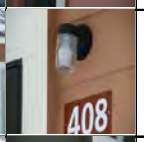
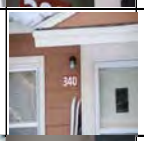
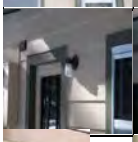
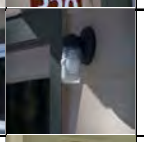
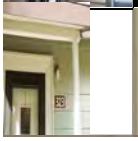
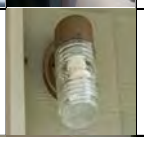
Summary of recommendations:

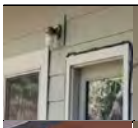
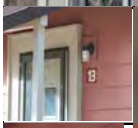
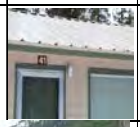
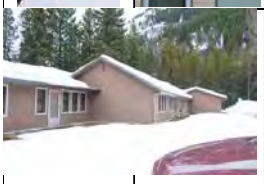
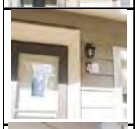
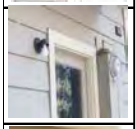
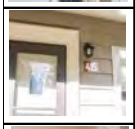
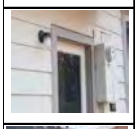
The first priority in the lighting replacement for this large developed area will be the wall lanterns and lamps on the exterior of the park housing and maintenance buildings. Light fixtures such as the streetlights will be replaced in a longer term Streetlight Management Plan. House lights and yard lights will be replaced with amber LED bulbs. Where it is necessary existing fixtures will be replaced with Hubbell Wall Packs or Progress Cylinder fixtures. In places where lights are used for security or yard work, installation of motion sensor systems will occur to minimize unnecessary lighting. Through a Streetlight Management Plan location and frequency of streetlights will be reviewed and Beacon Urban LED fixtures will be installed.

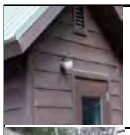
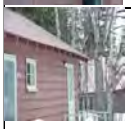
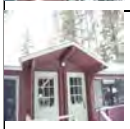
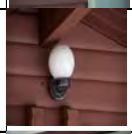
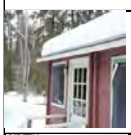
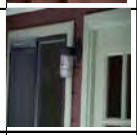
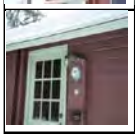
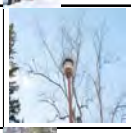
Responsible party: National Park Service

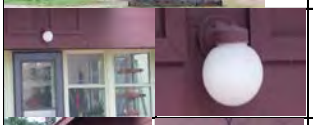
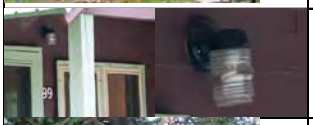
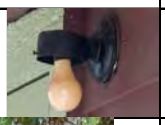
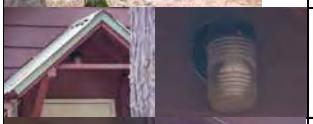
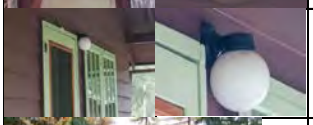
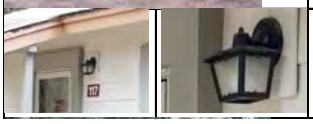
Picture (Wide)	Picture (Detail)	Light No.	# of light type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec
		1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par30 amber LED bulb
		1	3	Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		2		Wall Lantern	Switched	N			Entry Way Light	Y	Light shielded by porch roof	Hubbell Amber LED LNC 7L Wallpack
		1		Flood Light		N			General Light	N	Triple Light Fixture - One Bulb	Hubell Amber LED LNC 9L Wallpack
		1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		2		Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1	2	Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		2		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N	Globe broken	Par16 amber LED bulb in Progress cylinder fixture
		1	2	Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N			Entry Way	N		Par16 amber LED bulb in Progress cylinder fixture
		1	2	Wall Lantern	Switched	N			Entry Way	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N			Entry Way	N		Par16 amber LED bulb in Progress cylinder fixture
		1	2	Wall Lantern	Switched	N			Entry Way	N		Par16 amber LED bulb in Progress cylinder fixture
		1	3	Wall Lantern	Switched	N		Compact Fluorescent	Entry Way	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N			Entry Way	N		Par16 amber LED bulb in Progress cylinder fixture
		2		Wall Lantern	Switched	N		Incandescent	Entry Way	N		Par16 amber LED bulb in Progress cylinder fixture
		3									Empty Exposed Electrical Box	Remove

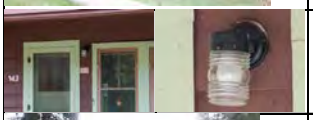
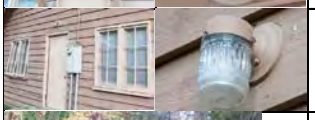
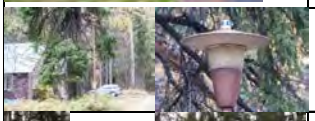
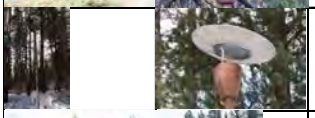
		1	2	Wall Lantern		N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1	2	Wall Lantern		N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1	2	Wall Lantern		N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1	2	Wall Lantern		N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1	2	Wall Lantern		N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Ceiling	Switched	N		Incandescent	Entry Way Light	N		Amber LED par30
		2		Wall Lantern	Switched	N		Incandescent	Walkway Light	N	Bare Bulb - Globe is missing	Par16 amber LED bulb in Progress cylinder fixture
		3		Wall Lantern	Switched	N			Entry Way Light	N	No bulb - fixture hanging by wires	Par16 amber LED bulb in Progress cylinder fixture
		4		Bare Bulb	Switched	N		Incandescent	Entry Way Light	Y	Bulb shielded by porch	amber LED par30
		1	3	Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		2	2	Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		2	2	Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1	2	Wall Lantern		N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture

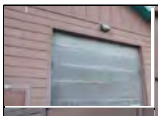
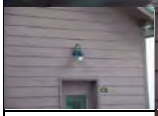
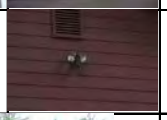
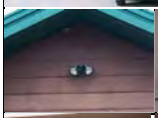
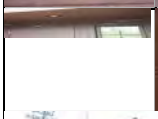
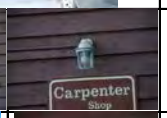
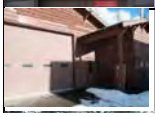
		1	3	Wall Lantern		N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1	2	Wall Lantern	Switched	N	75	Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern		N		Incandescent	Entry Way Light	Y	Shielded by porch	Par16 amber LED bulb in Progress cylinder fixture
		2		Wall Lantern		N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		3		Ceiling		N			General Light	N		CLB-LED amber ED ceiling mounted fixture (RAB Desgins Canada)
		4		Wall Lantern		N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N	60	Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		2		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1	2	Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1	2	Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		2		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture

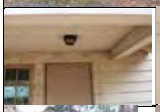
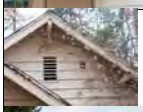
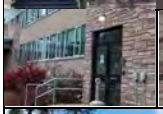
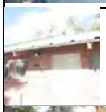
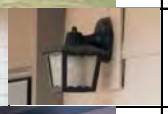
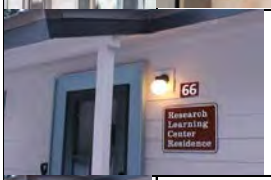
		2		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		2		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
				**Building Type:**	Residential Apartment							
		1	18	Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
				**Building Type:**	Residential Apartment							
		1	18	Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		2		Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		2		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		2		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N	60	Incandescent	Entry Way Light	N	Bug Light	Par16 amber LED bulb in Progress cylinder fixture
		1		Double Flood Light		N			Walkway Light	N		CLB-LED amber ED ceiling mounted fixture (RAB Designs Canada)

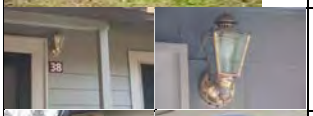
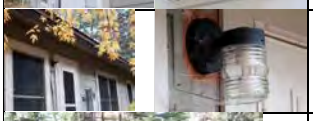
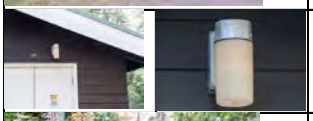
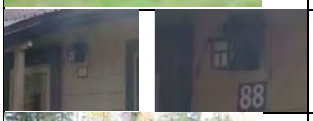
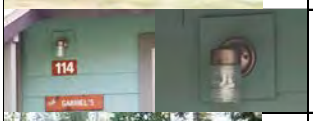
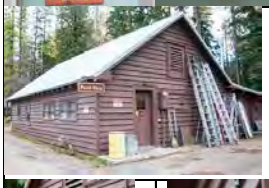
		1		Wall Lantern	Dusk to Dawn			Compact Fluorescent	Entry Way Light			Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		2		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		3		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		1		Wall Lantern		N		Compact Fluorescent	Entry Light	N		Hubbell Amber LED LNC 7L Wallpack
		1		Post		Y			Street Light	Y		
		1		Post		Y			Street Light	Y		
		1		Post		Y			Street Light	Y		
		1		Post		Y			Street Light	Y		
		1		Post		Y			Street Light	Y		
		1		Post		Y			Street Light	Y		
		1		Post		Y			Street Light	Y		
		1		Post		N			Street Light	N		Beacon UrbanLED CAP21/LED32/AM/ DIR3/BZ

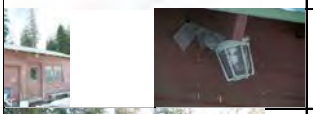
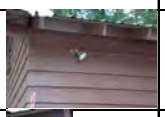
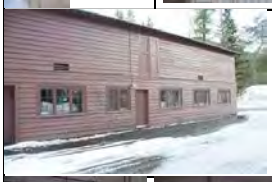
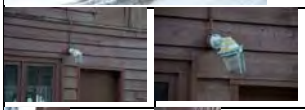
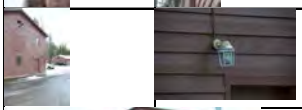
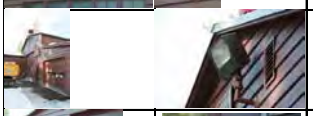
			**Building Type:**								
	1		Wall Lantern	Switched	N			Entry Way Light	N		PAR16 Amber LED
	2		Pendant	Switched	N		Compact Fluorescent	Porch Light	Y	Shielded by porch	
	3		Pendant	Switched	N			Porch Light	Y	Shielded by porch	
			**Building Type:**								
	1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Progress Cylinder fixture PAR16 Amber LED
			**Building Type:**								
	1	2	Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		PAR16 Amber LED
			**Building Type:**								
	1		Wall Lantern	Switched	N		Incandescent	Entry Way Light	Y	Shielded by roof.	
	2		Wall Lantern	Switched	N			Entry Way Light	N		PAR16 Amber LED
			**Building Type:**	Fire Management Office							
	1	2	Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		PAR16 Amber LED

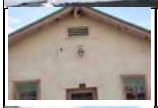
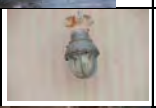
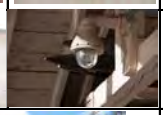
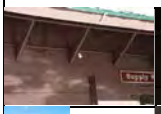
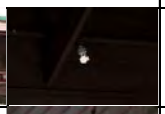
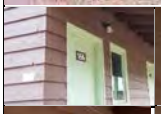
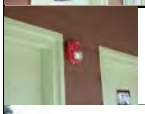
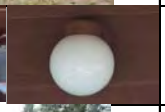
			**Building Type:**								
	1	2	Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		PAR16 Amber LED
			**Building Type:**	Dorm							
	1		Wall Lantern	Switched	N		Incandescent	Entry Way Light	Y	Shielded by roof.	PAR16 Amber LED
	2		Wall Lantern	Switched	N			Entry Way Light	N		PAR16 Amber LED
			**Building Type:**	Street Light							
	1		Post		N			Street Light	N		Beacon UrbanLED LED32-AM-DIR3-BZ
			**Building Type:**	Street Light							
	1		Post		N			Street Light	N		Beacon UrbanLED LED32-AM-DIR3-BZ
	1		Post		N			Street Light	N		Beacon UrbanLED LED32-AM-DIR3-BZ
			**Building Type:**	Gas Station							
	1		Ceiling Light		N			General Light	Y	Shielded by roof.	
	2		Ceiling Light		N			General Light	Y	Shielded by roof.	
			**Building Type:**	Park Services							

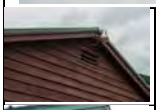
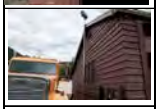
 	1	3	Wall Pack		Y	70W	Mercury	General Light	Y		
 	4		Emergency Light		N			Emergency	N	Emergency use only.	
			**Building Type:**	Park Services							
 	1		Wall Lantern	Switched	N			Entry Way Light	N		Hubbell Amber LED LNC 7L Wallpack
	2		Flood Light - Double	Motion Sensor	N		2 PAR	General Lighting	N		Hubbell Amber LED LNC 7L Wallpack
			**Building Type:**	Park Services							
 	1	2	Double Flood	Motion Sensor	N		Compact Fluorescent PAR	General Light	N		Hubbell Amber LED LNC 7L Wallpack
	2		Recessed Light	Switched	Y		PAR	Entry Way Light	Y		PAR16 Amber LED
			**Building Type:**	Park Services							
 	1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Hubbell Amber LED LNC 7L Wallpack
 	2		Wall Lantern	Dusk to Dawn	N			Entry Way Light	N		Hubbell Amber LED LNC 7L Wallpack

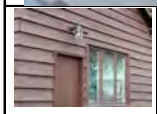
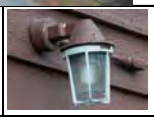
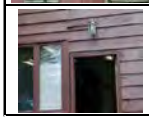
			**Building Type:**	Dorm								
 	1	2	Ceiling Light	Switched	N			Entry Way Light	Y	Shielded by roof	
 	3		Emergency Light		N			Fire Alarm	N	Emergency use only.	
			**Building Type:**	Street Light								
 	1	3	Post	Dusk to Dawn	Y			Street Light	N	Compliant if directed down	
 	4		Post		N			Street Light	N		Beacon UrbanLED LED32-AM-DIR3-BZ
			**Building Type:**	Administration								
 	1	2	Recessed Light		Y			Entry Way Light	Y		RAB Design CLB-LED
 	3	2	Wall Lantern		N			Entry Way Light	N		Hubbell Amber LED LNC 7L
			**Building Type:**	Park Services								
 	1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Hubbell Amber LED LNC 7L Wallpack
			**Building Type:**									
 	1	2	Wall Lantern	Switched	N			Entry Way Light	N		Par16 Amber LED
			**Building Type:**	Research Learning Center Residence								
	1		Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture

			**Building Type:**								
	1		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par 16 Amber Led
	2	3	Wall Lantern		Y		Compact Fluorescent	Walk Way Light	Y		Hubbell Amber LED LNC
	5		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par 16 Amber Led
			**Building Type:**								
	1	2	Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED in Progress Cylinder fixture
			**Building Type:**								
	1	2	Wall Lantern	Dusk to Dawn	N			Entry Way Light	N		Par16 Amber LED in Progress Cylinder fixture
			**Building Type:**								
	1	2	Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED
			**Building Type:**	Residence							
	1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 Amber LED
			**Building Type:**	Paint Shop							
	1		Wall Lantern	Switched	Y		Compact Fluorescent	Entry Way Light	Y		

			**Building Type:**	Park Services							
	1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Hubbell Amber LED LNC 9L Wallpack (possibly
			**Building Type:**	Park Services							
	1	2	Flood Light	Switched	N		PAR	Walk Way Light	N		Hubbell Amber LED LNC 7L Wallpack
	2	4	Bare Bulb	Switched	N		Incandescent	Walk Way Light	N		Hubbell Amber LED LNC 7L Wallpack
			**Building Type:**								
	1		Double Flood Light	Switched	N		No Bulbs	Entry Way Light	N		Amber LED par30 (aim downward)
			**Building Type:**	Park Services							
	1		Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
	2		Flood Light - Double		N		No bulb	Staircase Light	N		Par16 amber LED bulb in Progress cylinder fixture
	3		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
			**Building Type:**	Park Services							
	1		Wall Pack		N			General Light	N		Hubbell LNC2 12LU-3K-3 12 LED 3000K type 3 (color rendering
	2		Wall Pack		N			General Light	N		Hubbell Amber LED LNC 7L Wallpack
	3		Wall Lantern		N			Entry Way Light	N		Hubbell Amber LED LNC 7L Wallpack

			**Building Type:**	Park Services							
 	1		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Amber LED par30
 	2		Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Amber LED A-Lamp
			**Building Type:**	Park Services							
 	1		Bare Bulb		N		Compact Fluorescent	Entry Way Light	N		Amber LED par30 bulb
 	2		Flood Light - Double		N	120W	PAR	General Lighting	N		Amber LED par30 bulb (Aim downward)
			**Building Type:**	Dorm							
 	1		Wall Lantern	Switched	N		Incandescent Yellow	Entry Way Light	Y	Shielded by roof.	
 	2		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	Y	Shielded by roof.	
 	3	2	Wall Lantern	Switched	N		Incandescent	Entry Way Light	Y	Shielded by roof.	
 	5		Emergency Light	Emergency	N			Emergency Light	N	Emergency use only.	
			**Building Type:**	Community Building							
 	1	2	Wall Lantern	Switched	N			Entry Way Light	N		Par16 Amber LED
			**Building Type:**	Park Services							
 	1	2	Wall Lantern	Dusk to Dawn	N			Entry Way Light	N		Hubbell Amber LED LNC 7L Wallpack

			**Building Type:**	Park Services							
 	1		Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED in Progress Cylinder fixture
 	2		Ceiling Light	Switched	N			Porch Light	Y	Shielded by roof.	
			**Building Type:**	Science Center							
 	1	2	Wall Lantern	Switched	N			Entry Way Light	N		Par16 Amber LED
 	2		Wall Lantern	Switched	N		Incandescent	Staircase Light	Y		
			**Building Type:**	Park Services							
 	1		Double Flood Light	Dusk to Dawn	N		2 PAR	General Light	N		Par30 Amber LED
			**Building Type:**	Park Services							
 	1		Yard Light	Switched	N			General Light	N		Par30 Amber LED
 	2		Flood Light	Dusk to Dawn	N		No bulb		N		
 	3		Double Flood Light	Switched	N		No bulbs		N		
 	4		Flood Light	Switched	N		PAR	General Light	N		PAR30 Amber LED
	5		Yard Light		N			General Light	N		PAR30 Amber LED
			**Building Type:**	Garage							
 	1		Ceiling Light	Switched	Y		Incandescent	General Light	Y		

				**Building Type:**	Park Services							
		1		Wall Lantern	Switched	N			Entry Way Light	N		Par16 Amber LED in Progress Cylinder fixture
		2		Double Flood Light	Switched	N		2 Compact Fluorescent PAR	General Light	N		Par30 Amber LED
		3		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 Amber LED in Progress Cylinder Fixture

Site No. 8 Lake McDonald Lodge:

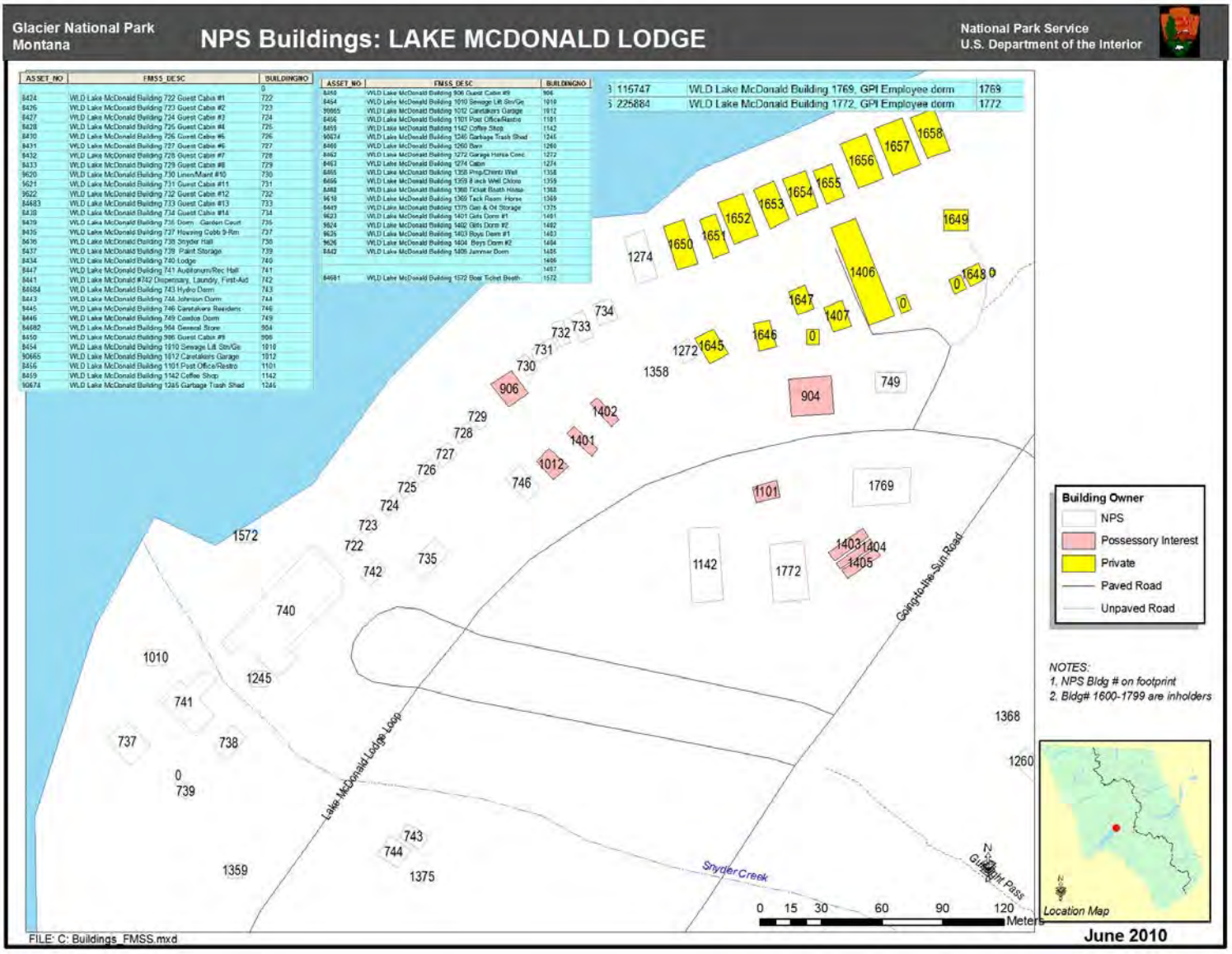
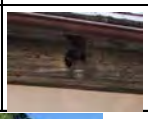
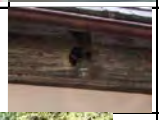
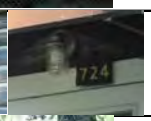
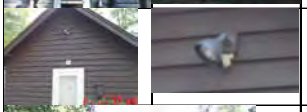
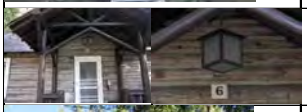
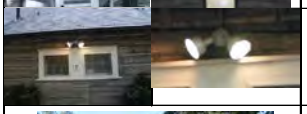
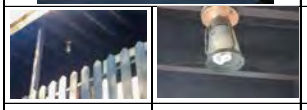


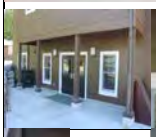
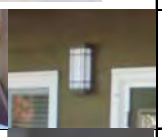
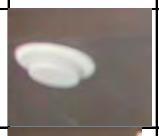
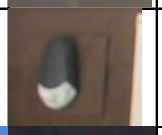
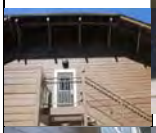
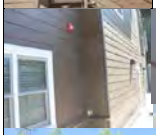
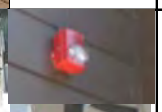
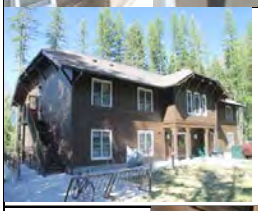
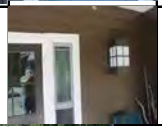
Figure 1.8

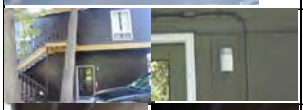
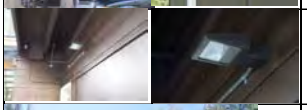
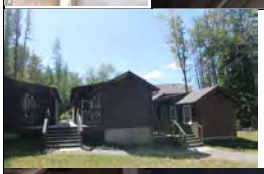
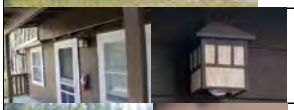
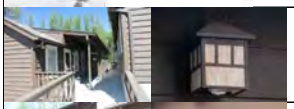
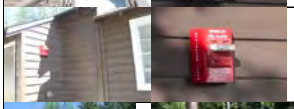
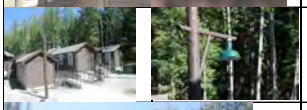
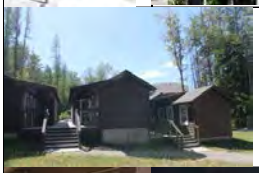
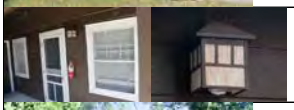
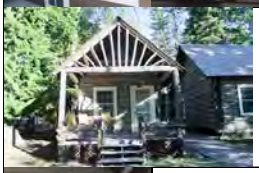
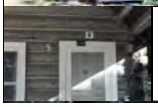
Summary of recommendations: Shielded wall lanterns and pendants should be retrofitted with Par16 amber LED bulbs. Ceiling lights should be replaced with CLB-LED Amber Ceiling mounted fixtures. Non-shielded wall lanterns and wall packs should be replaced with Hubbell Amber LED wall pack or Atlas WPS13 LED Wall Pak.

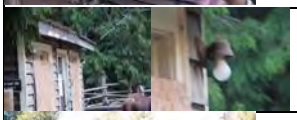
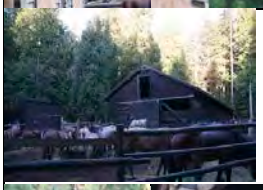
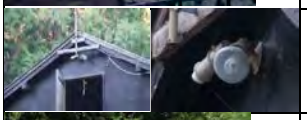
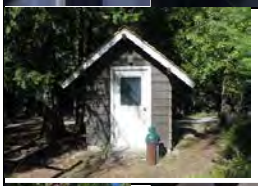
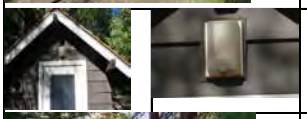
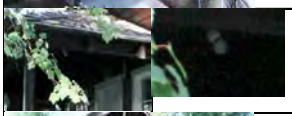
Responsible Party: Concession operators will be responsible for replacing fixtures in this developed area. According to regulations in their contract concessioners will replace light fixture to make buildings IDA compliant using this lighting survey and Xanterra Lighting Management Plan.

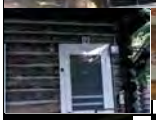
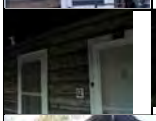
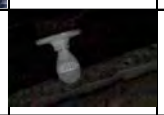
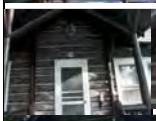
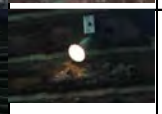
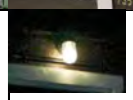
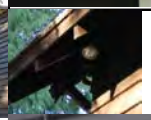
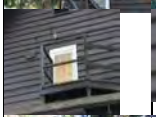
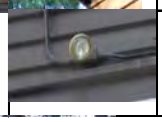
Picture (Wide)	Picture (Detail)	Light No.	# of light type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec
				**Building Type:**	Guest Cabin							
		1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	Y	Shielded by roof	
		2		Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb
				**Building Type:**	Guest Cabin							
		1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	Y	Shielded by roof	
		2		Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
				**Building Type:**	Guest Cabin							
		1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	Y	Shielded by roof	
				**Building Type:**	Guest Cabin							
		1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	Y	Shielded by roof	
		2		Flood Light		N			Entry Way Light	N		Amber LED par30

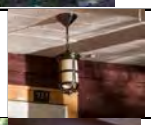
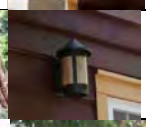
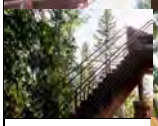
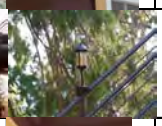
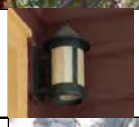
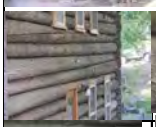
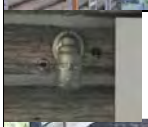
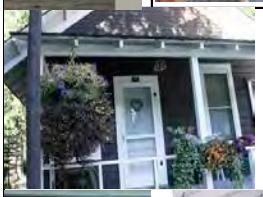
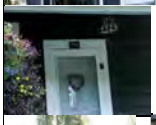
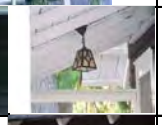
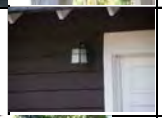
			**Building Type:**	Guest Cabin							
	1		Pendant		N			Entry Way Light	N		Amber LED par16
	2		Flood Light		N		PAR	Entry Way Light	N		Amber LED par30
			**Building Type:**	Guest Cabin							
	1		Pendant		N			Entry Way Light	N		Amber LED par30
			**Building Type:**	Guest Cabin							
	1		Pendant		N			Entry Way Light	N		Amber LED par30
	2		Double Flood Light		N			General Light	N		Amber LED par30 (aim downward)
			**Building Type:**	Motel							
	1	5	Ceiling		N		Compact Fluorescent	Entry Way Light	N		CLB-LED amber ceiling mounted fixture
	6	5	Ceiling		N		Compact Fluorescent	Entry Way Light	N		CLB-LED amber ceiling mounted fixture
			**Building Type:**								
		1		Post		Y			Walk Way Light	Y		
		1		Post		Y			Walk Way Light	Y		
		1	9	Post		Y			Walk Way Light	Y		
		1	5	Post		N			Walk Way Light	N		Beacon UrbanLED LED32-AM-DIR3-BZ

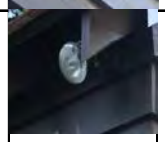
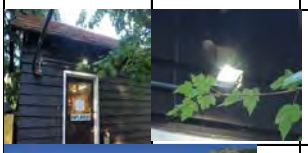
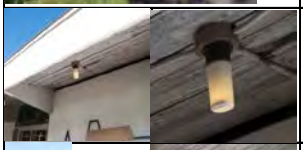
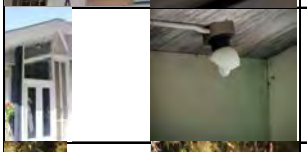
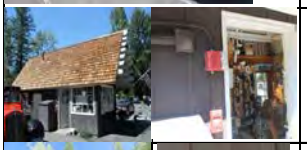
			**Building Type:**								
 	1	4	Post		Y		Compact Fluorescent	Walk Way Light	Y		
			**Building Type:**	GPI Employee Dorm							
 	1	4	Wall Lantern		N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
 	3	5	Ceiling		Y			Patio Light	Y		
	11	3	Ceiling		Y			Patio Light	Y		
	14	6	Sconce		N				N		Par16 amber LED bulb in Progress cylinder fixture
 	15	4	Wall Pack		Y			Entry Way Light	Y		
 	23		Fire Alarm		N			Emergency Light	N		Not compliant but only used in emergency
			**Building Type:**	GPI Employee Dorm							
	1		Fire Alarm		N			Emergency Light	N		Not compliant but only used in emergency
 	2	2	Wall Pack		Y			Entry Way Light	Y		
 	4	2	Wall Lantern		N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture

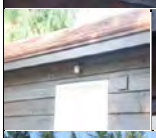
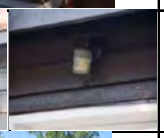
			**Building Type:**	Boat Ticket Booth							
	1		Ceiling		Y			Task Light	Y		
			**Building Type:**	Motel							
	1	4	Wall Lantern		N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
	5		Recessed Directional		Y		LED	Entry Way Light	Y		
			**Building Type:**	Jammer Dorm							
	1	2	Wall Lantern		N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
	3		Fire Alarm		N			Emergency Light	N		Not compliant but only used in emergency
			**Building Type:**	Boys Dorm 1							
	1	5	Wall Lantern		N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
	6		Fire Alarm		N		LED	Emergency Light	N		Not compliant but only used in emergency
	7		Post		Y			Walk Way Light	Y		
			**Building Type:**	Boys Dorm 2							
	1	3	Wall Lantern		N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
			**Building Type:**	Guest Cabin							
	1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture

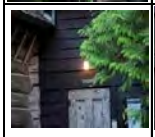
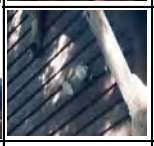
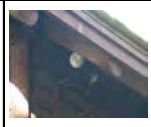
			**Building Type:**	Ticket Booth Horse							
	1		Wall Lantern		N			Entry Way Light	N		Hubbell Amber LED LNC 7L Wallpack
			**Building Type:**	Barn							
	1		Double Flood Light		N		1 No Bulb 1 Compact Fluorescent	General Light	N	One bulb broken	Amber LED par30 (aim downward)
			**Building Type:**	Well Pump							
	1		Wall Pack		N			Entry Way Light	N		Hubbell Amber LED LNC 7L Wallpack
			**Building Type:**	Cabin							
	1		Ceiling		N			Entry Way Light	N		CLB-LED amber LED ceiling mounted fixture (RAB Designs
			**Building Type:**	Linen/Maintenance							
	1		Ceiling	Switched	N		Compact Fluorescent	Entry Way Light	Y	Shielded by porch	
			**Building Type:**	Guest Cabin							
	1		Pendant	Switched	N			Entry Way Light	N		Progress Cylinder fixture with amber LED
	2		Flood Light		N			General Light	N		amber LED par30

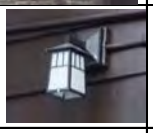
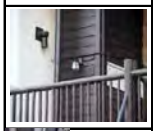
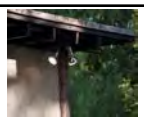
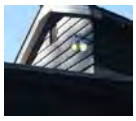
			**Building Type:**	Guest Cabin							
 	1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
 	2		Ceiling	Switched	N		LED	Porch Light	Y	Shielded by porch	Par30 amber LED bulb
			**Building Type:**	Guest Cabin							
 	1		Pendant	Switched	N			Entry Way Light	N		Par30 amber LED bulb
 	2		Single Flood	Dusk to Dawn	N			PAR	N		Par30 amber LED bulb
			**Building Type:**	Guest Cabin							
 	1		Pendant	Switched	N			Entry Way Light	N		Amber LED par30
 	2		Single Flood Light	Dusk to Dawn	N			Entry Way Light	N		Amber LED par30
			**Building Type:**	Dorm - Garden Court							
 	1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
 	2		Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
 	3		Single Flood Light	Dusk to Dawn	N			Entry Way Light	N		Amber LED par30 (aim downward)
 	4		Single Flood Light		N			Staircase Light	N		Amber LED par30 (aim downward)
 	5		Single Flood Light		N			Entry Way Light	N		Amber LED par30 (aim downward-new socket)

			**Building Type:**	Housing - Cobb							
 	1		Pendant	Switched	N			Entry Way Light	N		CLB-LED amber LED ceiling mounted fixture (RAB Designs
 	2	3	Wall Lantern	Switched	N			Walk Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
 	5	2	Post		N			Staircase Light	N		Amber LED A-lamp (if removal not possible)
	7		Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
	8	3	Solar		Y			Walk Way Light	Y		
			**Building Type:**	Snyder Hall							
 	1		Wall Lantern		Y			Entry Way Light	Y		
 	2	4	Wall Lantern	Switched	N			Entry Way Light	N		Amber LED par16
			**Building Type:**	Dispensary, Laundry							
 	1		Pendant	Switched	N			Entry Way Light	Y		
 	2	2	Wall Lantern	Switched	N			Entry Way Light	N		Amber LED par16
			**Building Type:**	Guest Cabin							
 	1		Pendant	Switched	N			Entry Way Light	Y	Under Porch	

			**Building Type:**	Maintenance							
	1		Double Flood Light		N		2 Compact Fluorescent	General Light	N		Hubbell Amber LED LNC 7L Wallpack
	2		Single Flood Light		N		Compact Fluorescent	General Light	N		Hubbell Amber LED LNC 7L Wallpack
	3		Single Flood Light		N		Compact Fluorescent	General Light	N		Amber LED par30
	4		Wall Pack		N			Entry Way Light	N		Hubbell Amber LED LNC 7L Wallpack
			**Building Type:**	Coffee Shop							
	1	5	Ceiling		N			Entry Way Light	Y	under eaves	
	6		Ceiling		N			Entry Way Light	N	under eave but visable	CLB-LED amber LED ceiling mounted fixture (RAB Designs
	7	2	Post		N			General Light	N	Light in parking lot	Beacon UrbanLED LED32-AM-DIR3-BZ
			**Building Type:**	Post Office, Restrooms							
	1		Fire Alarm		N		LED	Emergency Light	N		Not compliant but only used in emergency
	2	2	Recessed Light		N			Entry Way Light	N		Hubbell Amber LED LNC 7L Wallpack

			**Building Type:**	Sewage							
 	1		Wall Lantern	Switched	N			Entry Way Light	N		Amber LED par16
			**Building Type:**	General Store							
 	1		Ceiling		N			Entry Way Light	Y		
 	2		Vending Machine		N			Sign Illumination	N		consider FRED motion sensor vending machince device
 	3	2	Recessed Directional		Y		LED	Entry Way Light	Y		
			**Building Type:**	Condo and Dorm							
 	1	2	Wall Lantern	Switched	N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
			**Building Type:**	Caretakers Residence							
 	1	3	Ceiling	Switched	N			Entry Way Light	Y		
 	4		Wall Lantern	Switched	N			Entry Way Light	N		Amber LED par16

				**Building Type:**	Auditorium							
		1		Recessed Directional		Y		LED	Entry Way Light	Y		
		2		Vending Machine		N			Sign Illumination	N		Not compliant but motion vending
		3		Wall Lantern		N			Entry Way Light	N		Par16 amber LED bulb in Progress cylinder fixture
		4		Wall Pack		N			General Light	N		Hubbell Amber LED LNC 7L Wallpack
		5		Double Flood Light		N			General Light	N		Hubbell Amber LED LNC 7L Wallpack
		6		Double Flood Light		N			General Light	N		Amber LED par30
		7	5	Recessed Directional		Y		LED	General Light	Y		
				**Building Type:**	Lodge Side Lighting							
		1	5	Post		Y			Walk Way Light	Y		
		6		Wall Lantern		N			Task Light	N		Amber LED par16

				**Building Type:**	Lodge							
		1		Ceiling		N				Y	Under Porch	
		2	4	Ceiling		N				Y	Under Porch	
		6	8	Wall Lantern		N				N		Amber LED par16 bulb
		9		Wall Lantern		Y				Y		
		13	5	Ceiling		N				Y	Under Porch	
		18	4	Ceiling		N		No Bulb		N		If replacement made use CLB-LED ceiling mounted fixture
		20	5	Ceiling		N				Y	Under Porch	
		27		Double Flood Light		N			General Light	N		Amber LED par30
		28	6	Solar Light					Walk Way Light			na
		35	8	Low Voltage		Y			Walk Way Light	Y		na
		44		Double Flood Light		N			General Light	N		Amber LED par30 (aim downward)

Site No. 9 Lake McDonald Ranger Station:

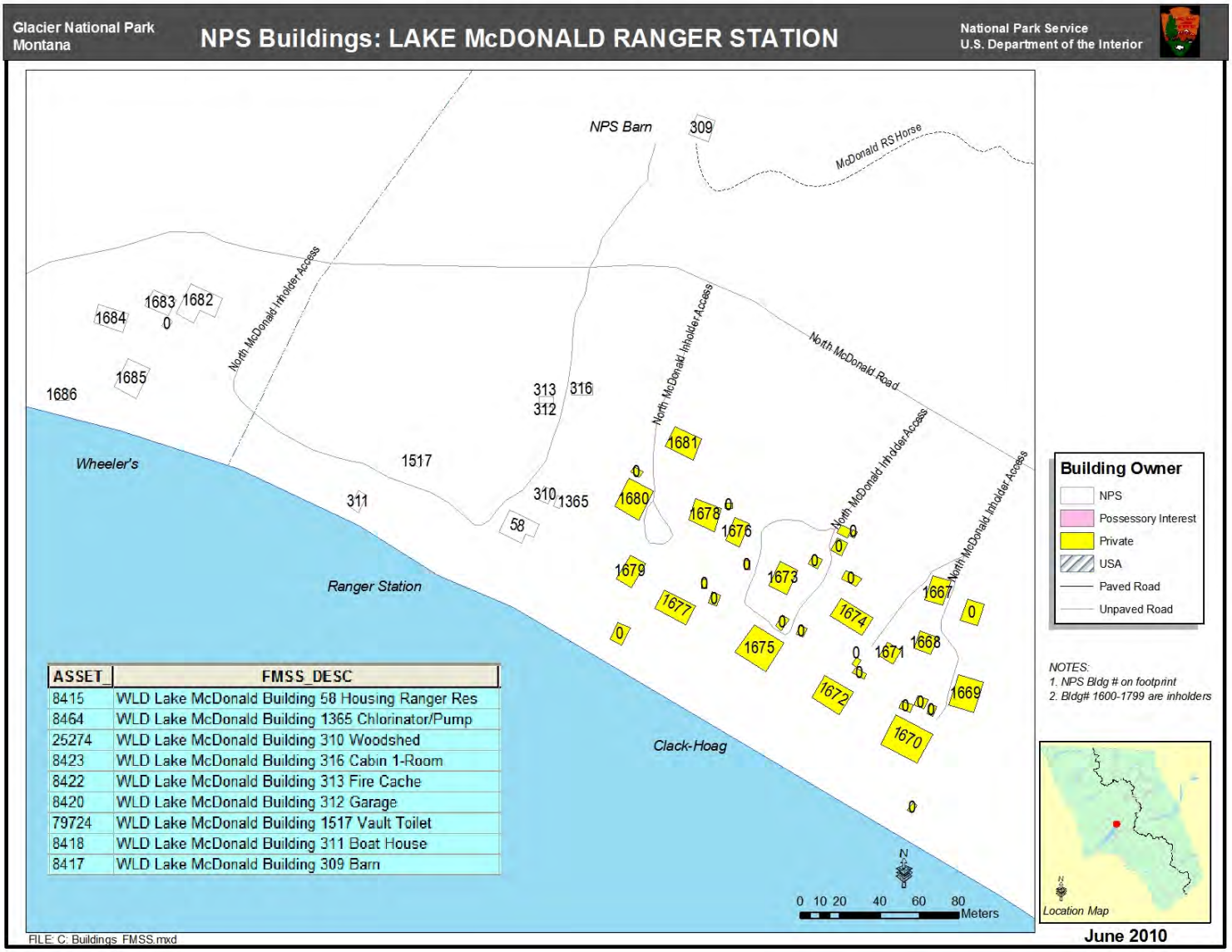
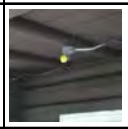


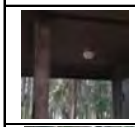
Figure 1.9

Summary of recommendations:

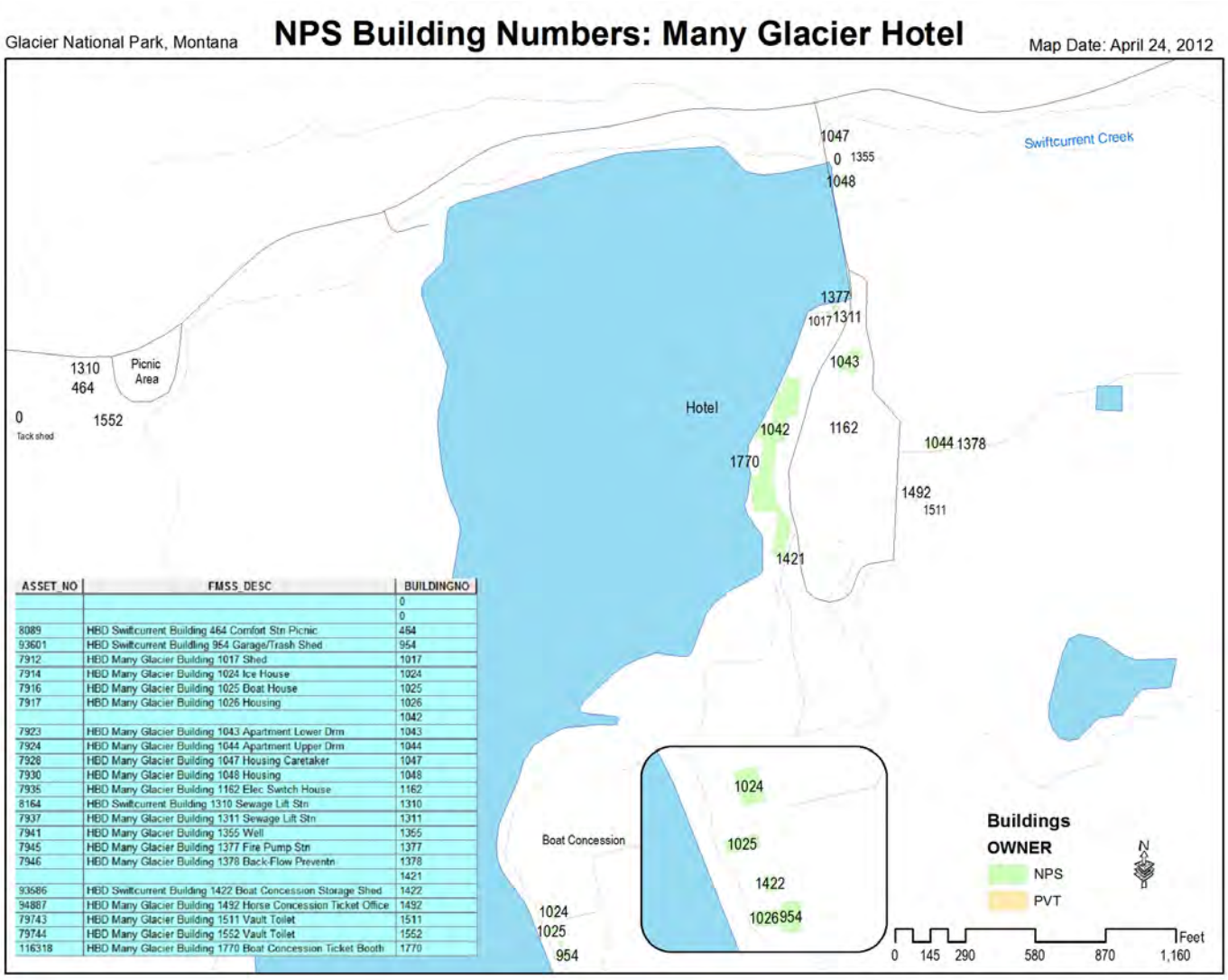
Replace wall lanterns with progress cylinder fixtures with PAR16 Amber LED bulbs. If the NPS chooses to repair currently broken wall pack on pole they should use Atlas WPS13 Amber LED Wall Paks. The lantern on the horse barn should be replaced with PAR 30 Amber LED or Wall Pak.

Responsible Party: National Park Service

Picture (Wide)	Picture (Detail)	Light No.	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec
			**Building Type:**	Cabin							
		1	Wall Lantern	Switched	N		Compact Fluorescent	Entry Way	N		Progress Cylinder fixture with amber LED bulb
			**Building Type:**	Streetlight							
		1	Post	Switched	Y			Yard Light	Y	Compliant if positioned down	
			**Building Type:**	Ranger residence							
		1	Bare Bulb	Switched	N			Porch Light	N		RAB Design CLB-LED ceiling mounted fixture
		2	Bare Bulb	Switched	N			Porch Light	N		RAB Design CLB-LED ceiling mounted fixture
			**Building Type:**	Fire Cache							
		1	Wall Lantern	Switched	N	60W		Entry way/ Bug Light	N		Progress Cylinder fixture with amber LED bulb
			**Building Type:**	Garage							
		1	Wall Lantern	Switched	N	60W		Entry Way/ Bug Light	N		Progress Cylinder fixture with amber LED bulb

			**Building type:**	Streetlight							
		1	Wallpack on Post	Motion sensored	N			Yard Light	N	No Bulb	Hubbell LNC amber LED wallpack
			**Building Type:**	Vault toilet							
		1	Ceiling	Switched	Y			Entry Light	Y		Par16 Amber LED
			**Building Type:**	Horse Barn							
		1	Wall Lantern	Switched	N			Task Light	N		Par30 Amber LED

Site No. 10 Many Glacier:



ASSET_NO	FMSS_DESC	BUILDINGNO
		0
		0
8089	HBD Swiftcurrent Building 464 Comfort Stn Picnic	464
93601	HBD Swiftcurrent Building 954 Garage/Trash Shed	954
7912	HBD Many Glacier Building 1017 Shed	1017
7914	HBD Many Glacier Building 1024 Ice House	1024
7916	HBD Many Glacier Building 1025 Boat House	1025
7917	HBD Many Glacier Building 1026 Housing	1026
		1042
7923	HBD Many Glacier Building 1043 Apartment Lower Drm	1043
7924	HBD Many Glacier Building 1044 Apartment Upper Drm	1044
7928	HBD Many Glacier Building 1047 Housing Caretaker	1047
7930	HBD Many Glacier Building 1048 Housing	1048
7935	HBD Many Glacier Building 1162 Elec Switch House	1162
8164	HBD Swiftcurrent Building 1310 Sewage Lift Stn	1310
7937	HBD Many Glacier Building 1311 Sewage Lift Stn	1311
7941	HBD Many Glacier Building 1355 Well	1355
7945	HBD Many Glacier Building 1377 Fire Pump Stn	1377
7946	HBD Many Glacier Building 1378 Back-Flow Preventn	1378
		1421
93586	HBD Swiftcurrent Building 1422 Boat Concession Storage Shed	1422
94887	HBD Many Glacier Building 1492 Horse Concession Ticket Office	1492
79743	HBD Many Glacier Building 1511 Vault Toilet	1511
79744	HBD Many Glacier Building 1552 Vault Toilet	1552
116318	HBD Many Glacier Building 1770 Boat Concession Ticket Booth	1770

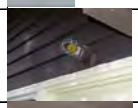
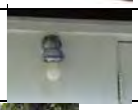
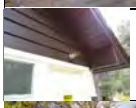
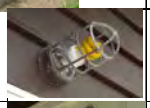
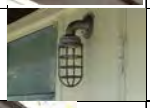
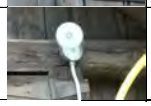
Figure 1.10

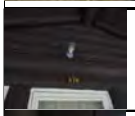
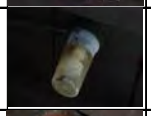
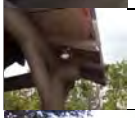
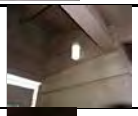
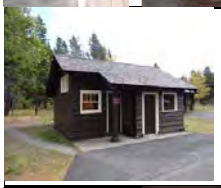
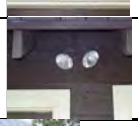
Many Glacier National Park Service Operated buildings:

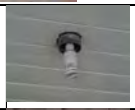
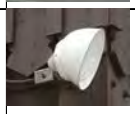
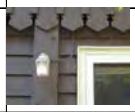
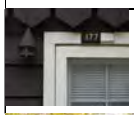
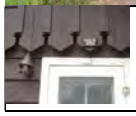
Summary of recommendations:

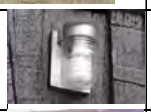
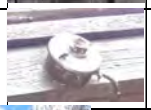
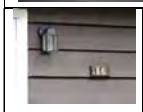
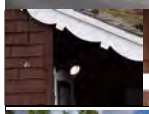
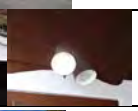
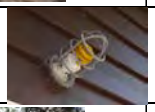
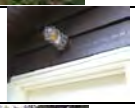
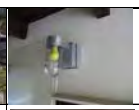
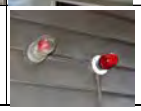
Replace non-compliant fixtures with RDA WRDS Amber LED or Progress Cylinder fixtures. Wall lanterns in comfort stations will be replaced with Atlas WPS13 LED Wall Paks in the winter of 2016.

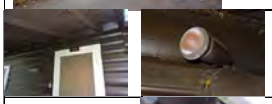
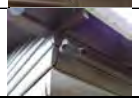
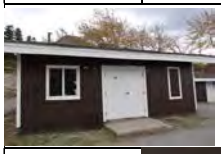
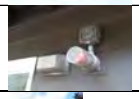
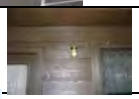
Responsible party: National Park Service

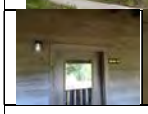
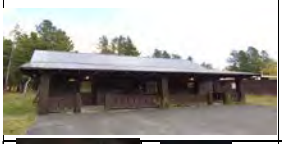
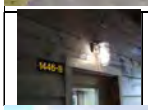
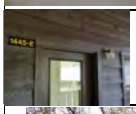
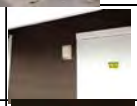
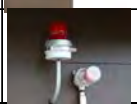
Picture (Wide)	Picture (Detail)	Light No.	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	
			**Building Type:**	Ranger Station Housing							
		1	Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	Y	Covered by roof.	Par16 Amber LED
		2	Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Par 16 Amber LED in progress cylinder fixture
			**Building Type:**	Restroom							
		1	Wall Lantern	Timer	N		Incandescent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
		2	3	Wall Lantern	Timer	N		Compact Fluorescent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
		3	Wall Lantern	Timer	Y		Incandescent	Entry Way Light	Y	Under roof.	Atlas WPS13 LED Wall Pak
		1	Wall Lantern	Timer	N		Incandescent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
			**Building Type:**	Restroom							
		1	3	Wall Lantern	Timer	N		Compact Fluorescent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
			**Building Type:**	Restroom							
		1	2	Wall Lantern	Timer	N		Compact Fluorescent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
		2	Wall Lantern	Timer	N		No Bulb	Entry Way Light	N		Atlas WPS13 LED Wall Pak
			**Building Type:**								
		1	Bare Bulb	Switched	N		Incandescent	Entry Way Light	N	Bug Light	Par16 Amber LED
		2	Flood Light	Switched	N		Halogen	Security	N		Hubbell Amber LED LNC Wallpack

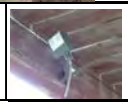
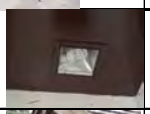
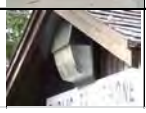
			**Building Type:**	Entry Station							
 	1	2	Wall Lantern		N		Compact Fluorescent	Entry Way Light	Y	Fixture covered by roof.	
 	2	6	Ceiling	Switched	N		Compact Fluorescent	Walk Way Light	Y	Fixture covered by roof.	
 	3		Flood Light - Double		N		Compact Fluorescent / No Bulb	Walk Way Light	Y	Fixture covered by roof.	
 	7		Flood Light - Double		N		Compact Fluorescent / No Bulb		Y	Fixture covered by roof.	
			**Building Type:**								
	1	2	Wall Lantern	Switched	N	60	Incandescent	Entry Way Light	N		RDA WRDS Amber LED fixture
	2		Wall Lantern	Switched	N			Entry Way Light	N		RDA WRDS Amber LED fixture
			**Building Type:**	Shed							
 	1		Wall Lantern	Switched	N	60	Incandescent	Entry Way Light	N		Par16 Amber LED
			**Building Type:**	Rescue Cache							
	1		Wall Lantern	Switched	N			Entry Way Light	N		RDA WRDS Amber LED fixture
	2		Double Flood Light		N		PAR x 2	Security Light	N		Par30 Amber LED
			**Building Type:**								
	1		Wall Lantern - Bare Bulb	Switched	N		Compact Fluorescent	Entry Way Light	N		Par 16 Amber LED

			**Building Type:**	Residential							
	1		Ceiling	Switched	N		Compact Fluorescent	Entry Way Light	N		
 	2		Flood Light	Dusk to Dawn	Y		Compact Fluorescent	Security	N	Would be compliant if positioned down.	Par30 Amber LED
	3		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 Amber LED
	4		Bare Bulb	Switched	N	60	Incandescent	Entry Way Light	N		Progress cylinder fixture with Par16 Amber LED
			**Building Type:**	Residential							
 	1		Wall Lantern	Switched	N	150	Incandescent	Entry Way Light	N		Par16 Amber LED
			**Building Type:**	Residential							
	1		Wall Lantern	Switched	N	75	Incandescent	Entry Way Light	N		Par16 Amber LED
			**Building Type:**	Residential							
	1		Wall Lantern	Switched	N	60	Incandescent	Entry Way Light	N		Par16 Amber LED
			**Building Type:**	Residential							
 	1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 Amber LED
			**Building Type:**	Residential							
 	1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Par16 Amber LED

			**Building Type:**	Cabin							
 	1		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		RDA CLB LED amber fixture
 	2		Bare Bulb - No Bulb		N				N	Not in use	Remove
			**Building Type:**	Residential							
 	1		Wall Lantern	Switched	N		No Bulb	Entry Way Light	N		Par16 amber LED
 	2		Wall Lantern	Switched	N	60	Incandescent	Entry Way Light	N		Par16 amber LED
			**Building Type:**	Residential							
 			Flood Light x 2	Switched	N		Compact Fluorescent / PAR	General Light	N		Par30 Amber LED
			**Building Type:**	Restroom							
 	1	3	Wall Lantern	Dusk to Dawn	N		Compact Fluorescent	Entry Way Light	N	Bug Light	Atlas WPS13 LED Wall Pak
			**Building Type:**	Restroom							
	1	3	Wall Lantern	Dusk to Dawn	N		Compact Fluorescent	Entry Way Light	N	Bug Light	Atlas WPS13 LED Wall Pak
			**Building Type:**	Lift Station							
 	1		Wall Lantern	Dusk to Dawn	N		Incandescent	Entry Way Light	Y	Bug Light	
	2		Wall Lantern		N		Incandescent	Security	N	Alert? Red.	Not compliant but only used in emergency

			**Building Type:**	Well							
	1	2	Wall Lantern	Switched	N			Entry Way Light	N		Progress cylinder fixter with PAR16 amber LED bulb
			**Building Type:**								
	1		Flood Light - Single	Switched	N		PAR	Entry Way Light	N		PAr30 amber LED
	2	2	Flood Light - Double		N		No Bulb		N		PAr30 amber LED
			**Building Type:**								
	1		Wall Lantern	Switched	N		No Bulb	Entry Way Light	N		Progress Cylinder with Par16 Amber LED
			**Building Type:**	Lift Station							
	1		Wall Lantern		N			Entry Way Light	N		Hubbell Amber LED LNC wall pack
	2		Wall Lantern		N		Incandescent	Security	N	Alert - Red	Not compliant but only used for emergency
			**Building Type:**								
	1	2	Wall Lantern	Switched	N		Incandescent	Entry Way Light	Y		
			**Building Type:**	Street Light							
 		2	Post		Y		Incandescent	General Light	Y	Bug Light	
			**Building Type:**								
	1		Wall Lantern	Switched	Y		Incandescent	Entry Way Light	Y		
	2		Wall Lantern	Switched	Y		Incandescent	Entry Way Light	Y	Bug Light	

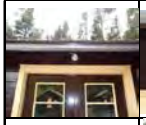
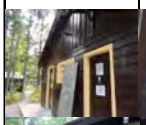
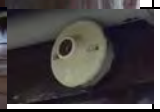
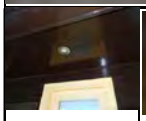
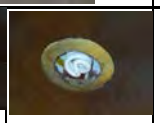
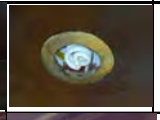
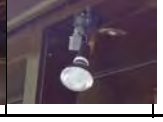
			**Building Type:**	Residential							
 	2	4	Wall Lantern	Switched	Y	50	Incandescent	Entry Way Light	Y		
			**Building Type:**								
 	1	3	Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		RDA WRDS amber LED
			**Building Type:**	Residential							
 	5	8	Wall Lantern	Switched	Y		Compact Fluorescent	Entry Way Light	Y		
			**Building Type:**	Sewage							
	1		Wall Lantern	Switched	N			Entry Way Light	N		RDA WRDS Amber LED
	2		Wall Lantern		N		Incandescent	Security	N	Alert? Red.	Not compliant only used in emergency
			**Building Type:**								
 	1	2	Wall Lantern	Switched	N		Incandescent	Entry Way Light	N		Progress Cylinder fixture with Par16 amber LED
			**Building Type:**	Fire Station							
	1		Wall Lantern	Switched	N		Incandescent	Walk Way Light	N		Par16 Amber LED
			**Building Type:**	Info Desk							
	1		Wall Lantern	Switched	Y		Compact Fluorescent	Task Light	Y		

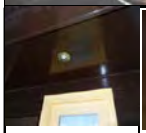
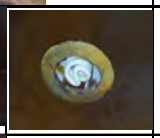
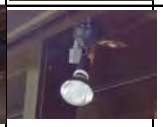
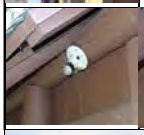
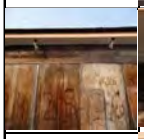
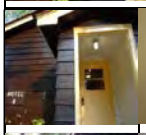
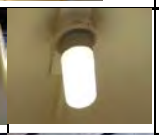
			**Building Type:**	Bridge							
	1	2	Flood Light		Y		Halogen	Security	Y	Compliant if positioned down.	
			**Building Type:**	Campground Street Light							
	1	2	Pole	Dusk to Dawn	N			Street Light	N		Beacon Urban LED
			**Building Type:**	Phone Booth							
	1			Dusk to Dawn	N			Task Light	N		NA
			**Building Type:**	Phone							
	2	5	Recessed Light	Dusk to Dawn	Y		Compact Fluorescent	Task Lighting	Y		
	7		Wall Pack	Dusk to Dawn	N		Mercury	Security	N		Hubbell Amber LED LNC Wall pack

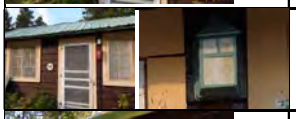
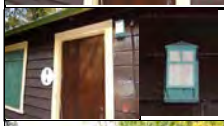
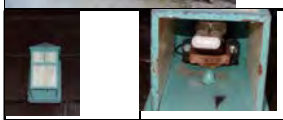
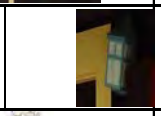
Concessions operated buildings:

Summary of recommendations: Replace wall fixtures with IDA compliant wall packs, such as the Hubbell Amber LED LNC wall pack or Atlas WPS13 LED Wall Pak. Flood lights should be replaced with PAR30 Amber LED bulbs. Shielded bare bulbs, ceiling lights, and wall lanterns should be retrofitted with PAR16 Amber LED bulbs.

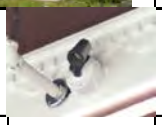
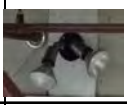
Responsible party: Xanterra

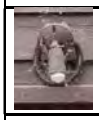
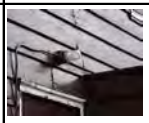
Picture (Wide)	Picture (Detail)	Light No.	# of light type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Recs
				**Building Type:**	Laundry							
		1		Bare Bulb	Switched	N		Compact Fluorescent	Entry Way Light	N		RDA WRDS amber LED fixture
		2		Wall Pack	Dusk to Dawn	N		Mercury	Entry Way Light	N		Hubbell Amber LED LNC wall pack
		3		Wall Lantern	Switched	Y		LED	Entry Way Light	Y		Hubbell Amber LED LNC wall pack
		4		Bare Bulb		N		No Bulb	Entry Way Light	N		Par16 Amber LED
				**Building Type:**	Motel							
		1	16	Recessed Light		Y		Compact Fluorescent	Entry Way Light	Y		
		9	4	Flood Light - Single	Dusk to Dawn	N		Compact Fluorescent	Security	N		Par30 Amber LED
				**Building Type:**	Motel							
		1	16	Recessed Light		Y		Compact Fluorescent	Entry Way Light	Y		
		9	4	Flood Light - Single	Dusk to Dawn	N		Compact Fluorescent	Security	N		Par30 Amber LED

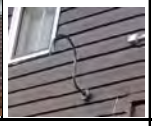
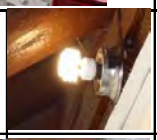
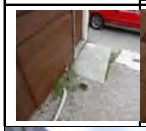
			**Building Type:**	Motel							
		1	16	Recessed Light		Y		Compact Fluorescent	Entry Way Light	Y		
		9	4	Flood Light - Single	Dusk to Dawn	N		Compact Fluorescent	Security	N		Par30 Amber LED
		1		Bare Bulb	Switched	N		LED	Entry Way Light	N		Par16 Amber LED
			**Building Type:**	Camp Store							
		1	2	Flood Light - Single	Switched	N		Compact Fluorescent	Walk Way Light	N		Par30 Amber LED
		3	5	Recessed Light	Switched	Y		Compact Fluorescent	Walk Way Light	Y		
		9	3	Flood Light - Single	Switched	N		Compact Fluorescent	Security	N		Par30 Amber LED
		10		Flood Light - Single	Switched	N		PAR	Security	N		Par30 Amber LED
		13	5	Wall Pack	Dusk to Dawn	N				N		Hubbell Amber LED LNC Wallpack
			**Building Type:**	Motel 4							
		1		Ceiling	Switched	N			Entry Way Light	N	On all day - Completely enclosed by porch	Par16 Amber LED
		2		Wall Pack	Dusk to Dawn	N		Mercury	Entry Way Light	N		Hubbell Amber LED LNC Wallpack

			**Building Type:**	Cabin Loop A							
	1	9	Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		PAR16 Amber LED
			**Building Type:**	Cabin Loop B							
	1	6	Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		PAR16 Amber LED
			**Building Type:**	Cabin Loop C							
	1	9	Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		PAR16 Amber LED
			**Building Type:**	Cabin Loop D							
	1	9	Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		PAR16 Amber LED
			**Building Type:**	Cabin Loop I							
	1	2	Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		PAR16 Amber LED
			**Building Type:**	Cabin Loop E							
	1	9	Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		PAR16 Amber LED

				**Building Type:**	Street Lights - Motor Inn Complex							
		1	10	Pole	Dusk to Dawn	Y		Mercury	Street Light	Y		
				**Building Type:**	Walkway							
		1	10	Bollard	Dusk to Dawn	Y		LED	Walk Way Light	Y	Walk from restaurant to lower dorm.	
				Building Type:	Shower							
		1	2	Wall Pack		N		Mercury	Entry Way Light	N		Hubbell Amber LED LNC wall pack
		2	2	Flood Light		N			Entry Way Light	N		Par30 Amber LED

				**Building Type:**	Hotel							
		1		Flood Light - Single	Switched	N		No Bulb	Entry Way Light	N	South Side	
		2		Flood Light	Switched	N		Incandescent	Entry Way Light	N		
		3		Flood Light - Double	Switched	N		PAR x 2	Entry Way Light	N		
		4		Flood Light - Double	Switched	N		PAR / No Bulb	Entry Way Light	N		Par30 Amber LED
		5		Flood Light - Double	Switched	N		Incandescent x 2	Entry Way Light	N		Par30 Amber LED
		6		Flood Light - Double	Switched	N		PAR / No Bulb	Security	N		Par30 Amber LED
		7		Bare bulb		N		No Bulb	Walkway Light	N		Par16 Amber LED
		8	25	Flood Light - Double	Switched	N	12	Halogen x 2	Entry Way Light	N	Lakeside West	Hubbell Amber LED LNC Wallpack
		17	10	Wall Pack	Switched	Y		Compact Fluorescent	Entry Way Light	Y		
		43	20	Recessed Light		Y		Compact Fluorescent	Entry Way Light	Y		
		63		Flood Light		N		Halogen	Security	N		Hubbell Amber LED LNC Wallpack
				**Building Type:**	Walkway Stairs							
		1	15	Bollard	Dusk to Dawn	Y			Walk Way Light	Y		

				**Building Type:**	Boat House							
		1		Wall Lantern	Switched	N		LED	Entry Way Light	N		RDA WRDS Amber LED fixture
				**Building Type:**	Shed							
		1		Flood Light		N		Halogen	Entry Way Light	N		Par30 Amber LED
 **1043**				**Building Type:**	Lower Dorm							
		1		Flood Light - Double	Switched	N		Halogen / Compact Fluorescent	Walkway Light	N		Par30 Amber LED
		2		Flood Light - Single	Switched	N		Compact Fluorescent	Walkway Light	N		Par30 Amber LED
		3		Flood Light - Single	Switched	N		PAR	General Light	N		Par30 Amber LED
		4		Ceiling	Switched	N			Entry Way Light	N		RDA WRDS amber LED fixture
		5		Wall Lantern	Switched	N		Compact Fluorescent	Entry Way Light	N		Hubbell Amber LED LNC Wallpack
		6		Flood Light - Double	Switched	N		PAR/No Bulb	Entry Way Light	N		Par30 Amber LED
				**Building Type:**	Walkway							
		1	8	Bollard	Dusk to Dawn	Y		LED	Walk Way Light	Y	Solar. Walk from parking to upper	

				**Building Type:**	Hotel Parking							
		1	3	Pole	Dusk to Dawn	N			Street Light	N		Beacon Urban LED
				**Building Type:**	Upper Dorm							
		1	3	Wall Lantern	Switched	Y		Compact Fluorescent	Entry Way Light	Y		
		4		Wall Lantern	Switched	N		No Bulb	Entry Way Light		No Fixture	
				**Building Type:**	Residential							
		1		Bare Bulb	Switched	N		Compact Fluorescent	Entry Way Light	N		RDA WRDS amber LED fixture
		2		Low Voltage Light		N			Walk Way Light	N		NA
				**Building Type:**	Residential							
		1		Bare Bulb	Switched	N		LED	Entry Way Light	N		PAR16 amber LED
		2		Bare Bulb	Switched	N		Incandescent	Entry Way Light	N		PAR16 amber LED

Site No. 11 Polebridge:

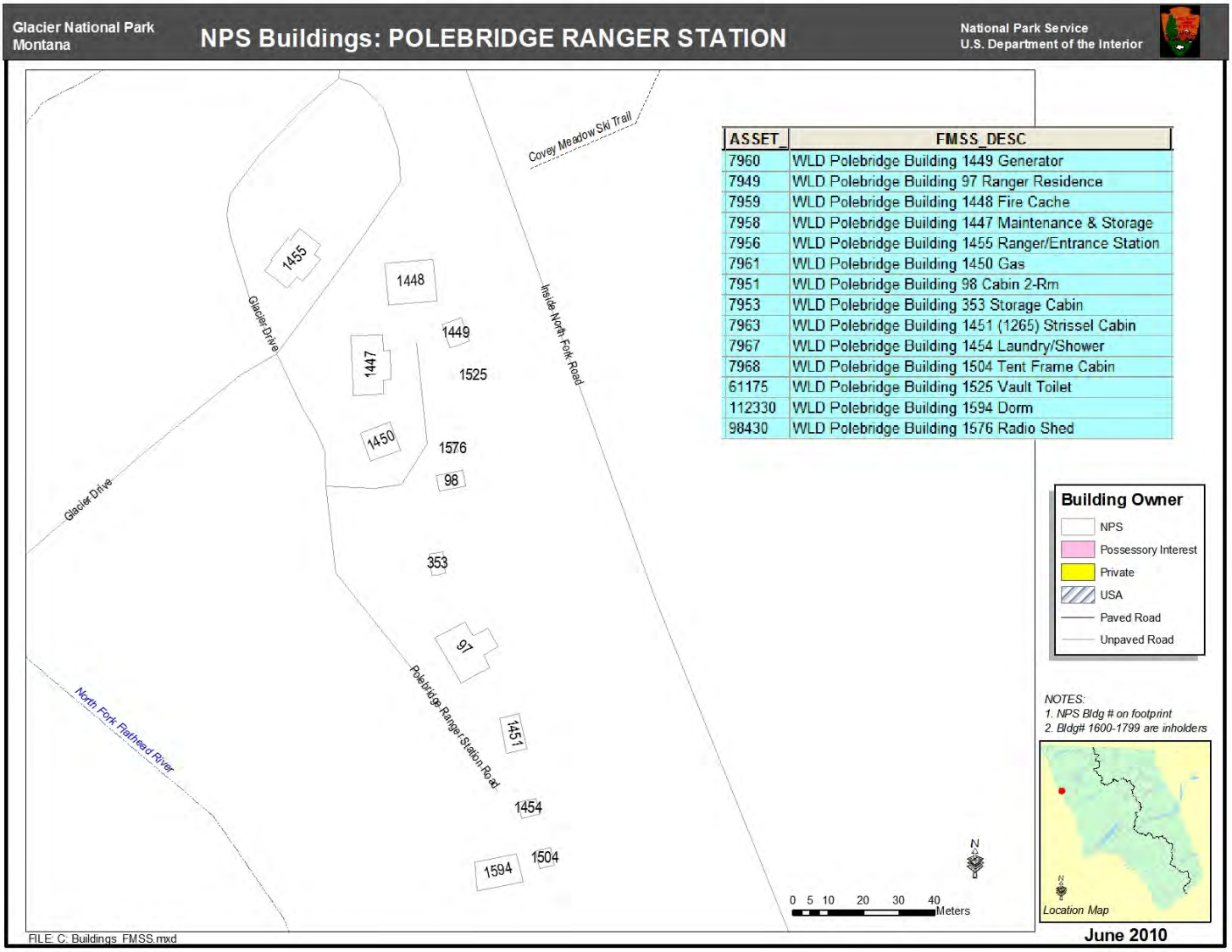
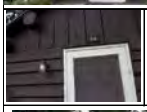
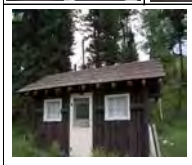
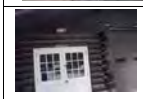


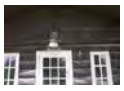
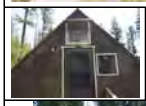
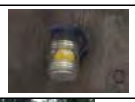
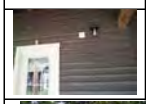
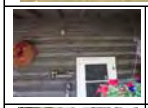
Figure 1.11

Summary of recommendations:

Replace wall fixtures with Hubbell Amber LED Wall packs. Replace unshielded porch lights with PAR16 Amber LED bulbs. Wall lanterns should be replaced with Progress Cylinder fixtures with PAR16 Amber LED bulbs.

Responsible Party: National Park Service

Picture (Wide)	Picture (Detail)	Light No.	# of light type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant ?	Notes	Rec.
				**Building Type:**	Cabin - 2 room							
		1		Wall Lantern	Switched	N	40	Incandesce	Entry Way Light	N		Progress cylinder fixture with Par 16 amber LED
				**Building Type:**								
		1		Bare Bulb	Switched	N	40	Incandesce	Entry Way Light	Y	Under Overhang 1 foot	
				**Building Type:**	Maintenance and Storage							
		1	5	Wall Pack		N			Entry Way Light	N		Hubbell LNC 7L Amber LED wallpack
				**Building Type:**	Fire Cache							
		1	4	Wall Pack		N			Entry Way Light	N		Hubbell LNC 7L Amber LED wallpack
				**Building Type:**	Generator							
		1		Wall Pack		N			Entry Way Light	N		Hubbell LNC 7L Amber LED wallpack
				**Building Type:**	Gas							
		1		Wall Pack		N			Entry Way Light	N		Hubbell LNC 7L Amber LED wallpack
				**Building Type:**	Cabin						Was Building Number 1265	
		1	2	Wall Lantern	Switched	N		Incandesce	Entry Way Light	N		Par16 amber LED bulb

			**Building Type:**	Laundry / Shower							
 	1		Wall Lantern	Switched	N	40	Incandesce	Entry Way Light	N	Bug Light	par16 amber led bulb - Prefered: in progress cylinder fixture
			**Building Type:**	Entrance Station							
 	1	5	Pendant		N	40	Incandesce	Entry Way Light	N	Bug Light	Amber LED par30 bulb
			**Building Type:**	Cabin							
 	1		Wall Lantern	Switched	N	40	Incandscen	Entry Way Light	N	Bug Light	Amber LED par16 bulb or Hubbell LNC 7-L amber LED fixture
			**Building Type:**								
 	1	2	Wall Lantern	Switched	N		Incandesce	Entry Way Light	N		WRDS amber LED fixture or Hubbell LNC 7L amber LED fixture
 	2		Wall Lantern - Bare Bulb	Switched	N		Incandesce	Entry Way Light	N		WRDS amber LED fixture or Hubbell LNC 7L amber LED fixture
			**Building Type:**	Residence							
 	1		Wall Lantern	Switched	N	40	Incandesce	Entry Way Light	N	Bug Light	Hubbell LNC 7L Amber LED wallpack
 	2		Flood Light / Single		N		PAR	Entry Way Light	N		Hubbell LNC 7L Amber LED wallpack

Site No. 12 Rising Sun:

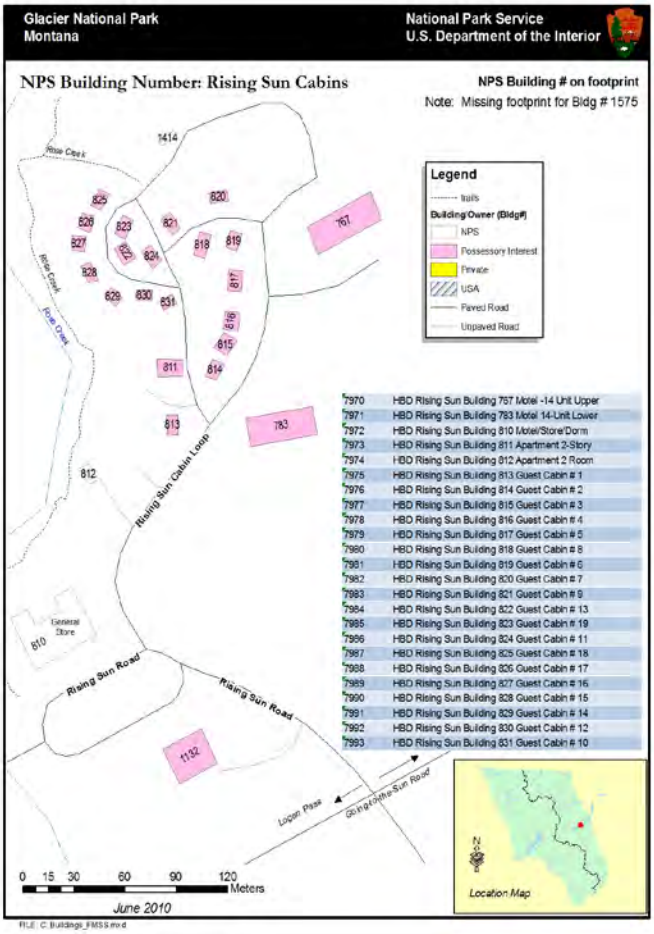


Figure 1.12

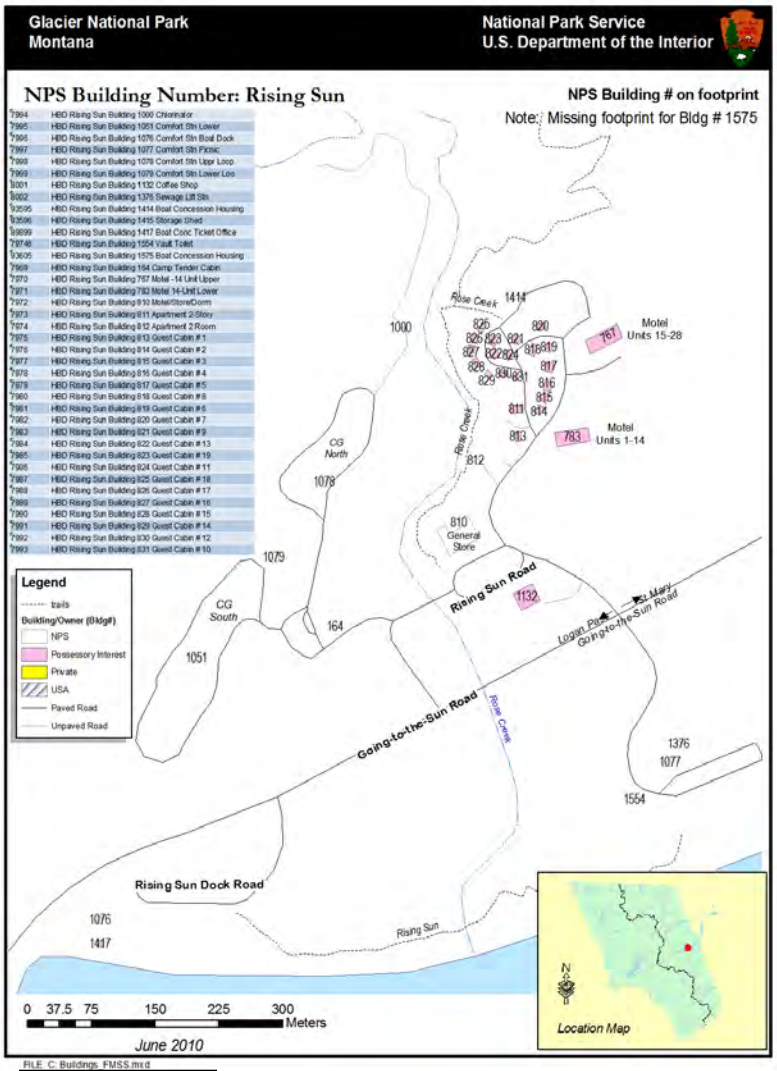
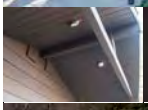
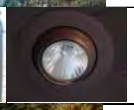
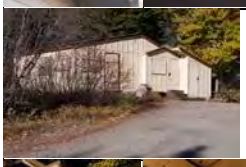
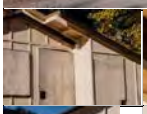
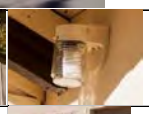
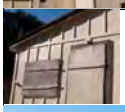
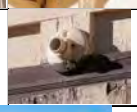
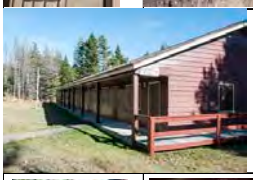
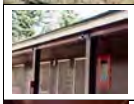
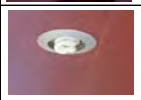
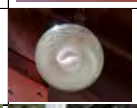
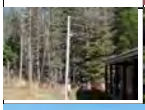
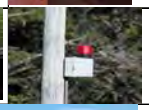
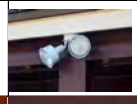


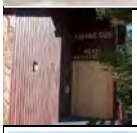
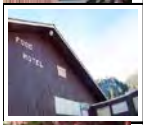
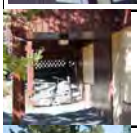
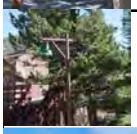
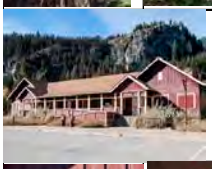
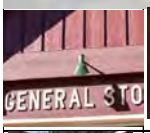
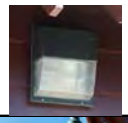
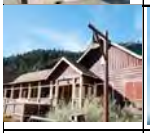
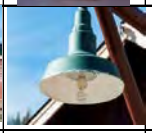
Figure 1.13

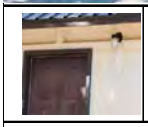
Concessions operated buildings:

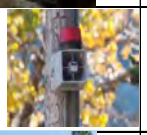
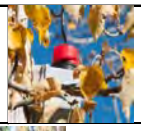
Summary of recommendations: Replace wall lanterns with RDA WRDS Amber LED fixtures. Position flood lights down and retrofit with PAR30 bulbs. Ceiling lights should be replaced with RAB Design CLB-Amber LED fixtures.

Responsible Party: Light replacement on these buildings will be conducted by concessioner

Picture (Wide)	Picture (Detail)	Light No.	# of light type	Type of Luminaire	Light Control Mechanism	Shielded ?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec
				**Building Type:** Boat Conc Ticket Office								
		1	2	Recessed Light		Y			General Light	Y		
				**Building Type:** Boat Conc Housing								
		1		Wall Lantern		N		Compact Fluorescent	Entry Way Light	N		RDA WRDS Amber LED fixture
		2	2	Wall Lantern		N		No Bulb	Entry Way Light	N		RDA WRDS Amber LED fixture
				**Building Type:** Upper Motel								
		1	2	Flood Light		N		PAR Compact Fluorescent	General Light	N		par30 amber LED bulb
		3	14	Recessed Light		Y		Compact Fluorescent	Entry Way Light	Y		
		17	2	Flood Light		N		PAR Compact Fluorescent	General Light	N		par30 amber LED bulb
		19	2	Emergency Light		N			Emergency Light	N	Not Compliant but only used in emergency.	
				**Building Type:** Lower Motel								
		1		Flood Light		N		PAR	General Light	N		RDA WRDS Amber LED fixture
		2		Double Flood Light		N		PAR Compact Fluorescent	General Light	N		RDA WRDS Amber LED fixture
		3	14	Recessed Light		Y		Compact Fluorescent	Entry Way Light	Y		
		17	2	Flood Light		N		PAR Compact Fluorescent	General Light	N		par30 amber LED fixture
		19	2	Emergency Light		N			Emergency Light	N	Not Compliant but only used in emergency.	

				**Building Type:** Coffee Shop								
		1	4	Wall Pack		N			Entry Way Light	N		RDA WRDS Amber LED fixture
		4		Yard Light		N			General Light	N		RDA WRDS Amber LED fixture
		6		Ceiling Light		N			General Light	N		CLB-Amber LED fixture
		7		Post		Y			Walk Way Light	Y		
				**Building Type:** General Store								
		1	2	Wall Lantern		Y		PAR Compact Fluorescent	Entry Way Light	Y		
		2		Flood Light		N		PAR Compact Fluorescent	Entry Way Light	N		par30 amber LED bulb
		4	5	Ceiling Light		N		Compact Fluorescent	Walk Way Light	N		Par16 amber LED bulb
		9		Vending Machine		N			Sign Illumination	N		Not compliant but motion sensored vending
		10	4	Wall Lantern		N			Entry Way Light	N		RDA WRDS Amber LED fixture
		14		Wall Pack		N			Entry Way Light	N		RDA WRDS Amber LED fixture
		15	2	Post		Y		Compact Fluorescent	Walk Way Light	Y		
		17	4	Recessed Light		Y		Compact Fluorescent	Task Light	Y		

			**Building Type:**	Apartment 2 Story							
 	1	3	Wall Lantern		Y			Entry Way Light	Y	Compliant if directed down.	
	2	4	Recessed Directional		Y			Entry Way Light	Y		
 	8		Emergency Light		N			Emergency Light	N		Not Compliant but only used in emergency.
			**Building Type:**	Housing?							
 	1	2	Wall Lantern		N		Compact Fluorescent	Entry Way Light	N		RDA WRDS Amber LED fixture
			**Building Type:**	Apartment 2 Room							
 	1		Wall Lantern		Y		Compact Fluorescent	Entry Way Light	Y		
 	2		Emergency Light		N			Emergency Light	N		Not Compliant but only used in emergency.
			**Building Type:**	Guest Cabin # 1							
 	1		Recessed Directional		Y		LED	Entry Way Light	Y		
			**Building Type:**	Guest Cabin # 2							
	1		Emergency Light		N			Emergency Light	N		Not Compliant but only used in emergency.

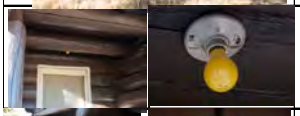
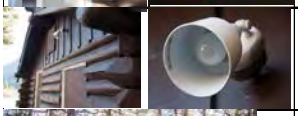
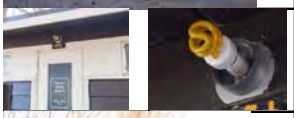
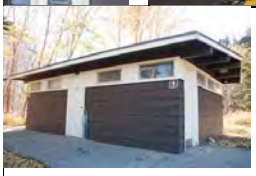
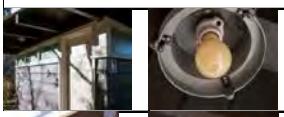
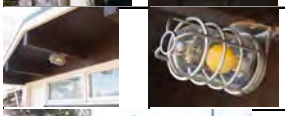
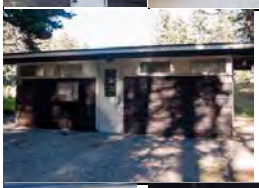
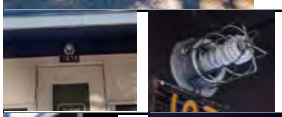
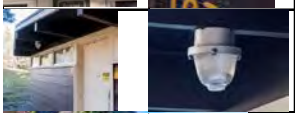
			**Building Type:**	Guest Cabin # 5							
 	1		Emergency Light		N			Emergency Light	N		Not Compliant but only used in emergency.
			**Building Type:**	Guest Cabin # 9							
 	1		Emergency Light		N			Emergency Light	N		Not Compliant but only used in emergency.
			**Building Type:**	Guest Cabin # 12							
	1		Emergency Light		N			Emergency Light	N		Not Compliant but only used in emergency.
			**Building Type:**	Guest Cabin # 16							
 	1		Emergency Light		N			Emergency Light	N		Not Compliant but only used in emergency.

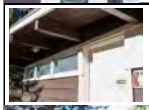
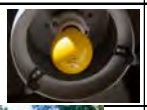
Park Operated Buildings:

Summary of recommendations:

The first priority is the replacement of all wall mounted fixtures in comfort stations with Atlas WPS13 LED fixtures. The remaining lights in comfort stations will be changed to PAR16 Amber LED bulbs. The remaining non complaint fixtures in this developed area are located on the sewage lift station and should be replaced with RDA WRDS Amber LED fixtures.

Responsible party: National Park Service

			**Building Type:**	Camp Tender Cabin							
	1		Bare Bulb		Y	60W	Incandescent Yellow	Entry Way Light	Y	Bare bulb but under porch and shielded by a log.	Amber LED par30 bulb
	2		Flood Light		Y	200W	Incandescent	General Light	Y	Compliant if turned down.	RDA WRDS Amber LED fixture
			**Building Type:**	Comfort Station							
	1	3	Bare Bulb		N		Compact Fluorescent Yellow	Entry Way Light	N		Atlas WPS13 LED Wall Pak
			**Building Type:**	Comfort Station Boat Dock							
	1		Bare Bulb		N	60W	Incandescent	Entry Way Light	N		Par16 Amber LED
	3	2	Ceiling Light		N		Incandescent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
			**Building Type:**	Sewage Lift Station							
	1		Wall Lantern		N			General Light	N		RDA WRDS Amber LED fixture
	2		Wall Lantern		N			Entry Way Light	N		RDA WRDS Amber LED fixture
			**Building Type:**	Comfort Station Lower Loop							
	1		Ceiling Light		N		Compact Fluorescent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
	2	2	Ceiling Light		N			Entry Way Light	N		Par16 Amber LED

			**Building Type:**	Comfort Station Upper Loop							
		1		Ceiling Light		N		Compact Fluorescent Yellow	Entry Way Light	N		Atlas WPS13 LED Wall Pak
		2	2	Bare Bulb		N	60W	Incandescent Yellow	Entry Way Light	N		Par16 Amber LED
			**Building Type:**	Comfort Station Picnic							
		1		Wall Lantern		N		Compact Fluorescent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
		2	2	Wall Lantern		N			Entry Way Light	N		Atlas WPS13 LED Wall Pak
			**Building Type:**	Chlorinator							
		1		Emergency Light		N			Emergency Light	N		Not compliant but only used in emergency

Site No. 13 Sprague Creek Campground:

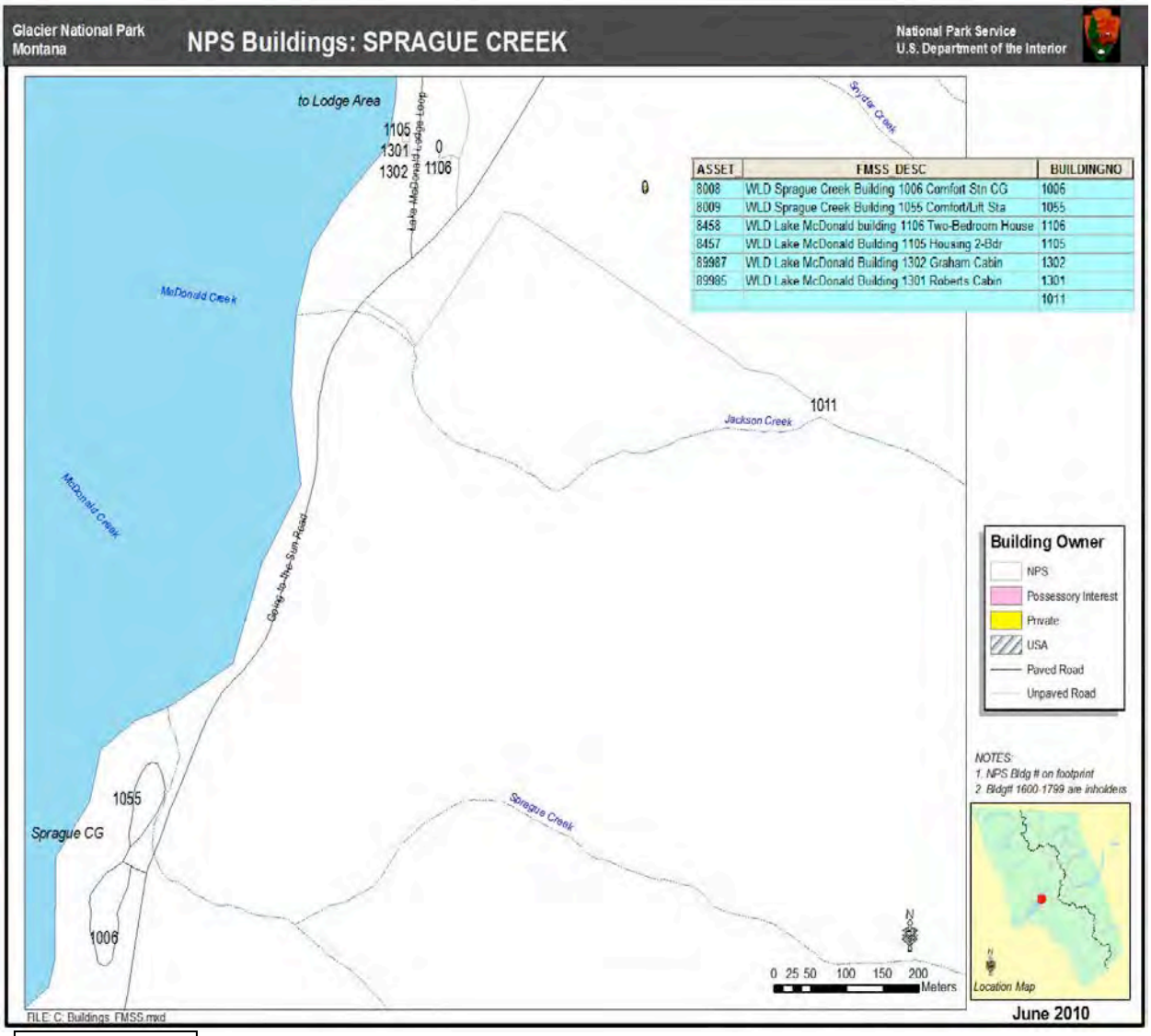
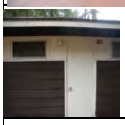
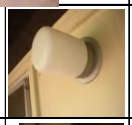


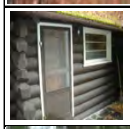
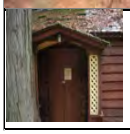
Figure 1.14

Summary of recommendations:

Replace wall fixtures in comfort stations with Atlas WPS13 LED Wall Paks. The remaining lights in the comfort stations should be replaced with PAR30 Amber LED Bulbs. The remaining exterior lights should be replaced with RDA WRDS Amber LED fixtures.

Responsible Party: National Park Service

Picture (Wide)	Picture (Detail)	Light No.		Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec
				**Building Type:**	Restroom							
		1				N			Entry			Atlas WPS13 LED Wall Pak
		2		Wall Lantern		N			Entry	N		Atlas WPS13 LED Wall Pak
		3		Wall Lantern		N	130V Bug bulb	Bug Bulb	Entry	N		Atlas WPS13 LED Wall Pak
		4		Wall Lantern		N		Compact Fluorescant	Entry	N		Atlas WPS13 LED Wall Pak
				**Building Type:**	Restroom							
		1	2	Wall Lantern		N			Entry	N		Atlas WPS13 LED Wall Pak
		4		Flood		N		CF PAR	Security	N		PAR30 Amber LED Bulb
		5		Wall Lantern		N		Compact Fluorescent	Entry, Walk Way	N		Atlas WPS13 LED Wall Pak
		6		Wall Lantern		N			Entry, Walk Way	N		Atlas WPS13 LED Wall Pak

				**Building Type:**	Cabin							
		1		Wall Lantern	Switch	N		Incandescent	Entry	N		RDA WRDS Amber LED fixture
				**Building Type:**	Cabin							
		1		Wall Lantern	Switch	N			Entry	N		RDA WRDS Amber LED fixture
		2		Ceiling	Switch	N		Compact Fluorescant	Entry	N		amber LED par30 bulb
				**Building Type:**	Cabin							
		1		Wall Lantern	Switch	N		Incandescent	Entry	N		RDA WRDS Amber LED fixture

Site No. 14 St. Mary VC and Campground:

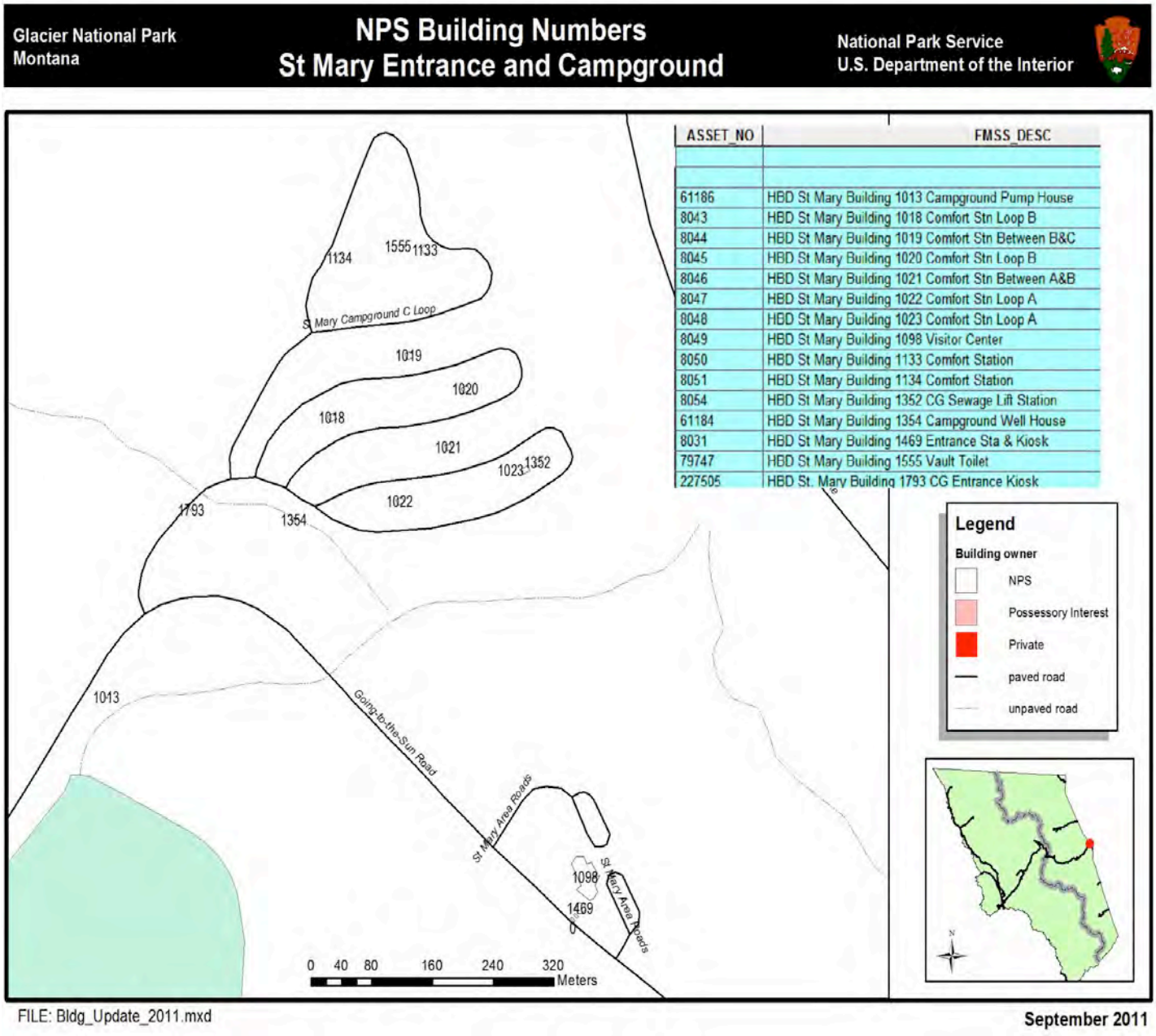
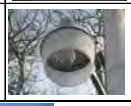
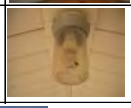
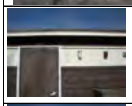
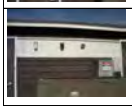


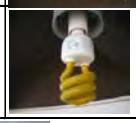
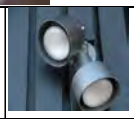
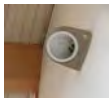
Figure 1.15

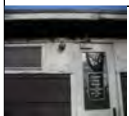
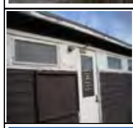
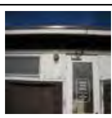
Summary of recommendations:

Atlas WPS13 LED Wall Pak fixtures will replace comfort station wall lanterns. The emergency lights will be left non-compliant because they are only used in case of emergency. The wall lanterns on other park services buildings such as the visitor center should be replaced with Atlas WPS13 Wall Paks. The ceiling lights should be replaced with CLB-LED Amber LED ceiling mounted fixtures.

Responsible party: National Park Service

Picture (Wide)	Picture (Detail)	Light No.	# of light	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec
				**Building Type:**	Park Services - Kiosk							
		1	2	Flood		N	45W	CF PAR	Entry, Task	N	45° angle	CLB-LED amber LED ceiling mounted fixture (RAB Designs Canada)
		2		Recessed		Y			Entry	Y		Par30 amber LED bulb
		4		Post		N			Street	N	Next to Kiosk	Par38 amber LED bulb with mogul to medium base adapter (bypass ballast)
				**Building Type:**	Park Services - Kiosk and entrance station							
		1		Ceiling		N			Security, General	N	On at time of inspection	CLB-LED amber LED ceiling mounted fixture (RAB Designs Canada)
		2	8	Bare Bulb				F	General	Y		
		4	3	Ceiling		N			Security, General	N		CLB-LED amber LED ceiling mounted fixture (RAB Designs Canada)
		13	3	Ceiling				CF	Walk Way	Y		
				**Building Type:**	Park Services - Sewage Lift Station							
		1		Wall Lantern		N			Entry	N		RDA WRDS Amber LED fixture
		2		Emergency		N			Emergency	N		Not compliant but only used in emergency
				**Building Type:**	Restroom							
		1	5	Wall Pack		Y		Mercury	Entry	Y		
		2		Wall Pack		Y		Mercury	Walk Way, Security	Y		
		7		Wall Pack		Y		Mercury	Entry, Walk Way	Y		

			**Building Type:**	Restroom							
		1		Wall Lantern		N			Entry	N		Atlas WPS13 LED Wall pak
		2		Bare Bulb		N		Incandescent	Walk Way	N		CLB-LED amber LED ceiling mounted fixture (RAB Designs Canada)
		3		Bare Bulb		N	15W	CF	Entry, Walk Way	N		CLB-LED amber LED ceiling mounted fixture (RAB Designs Canada)
			**Building Type:**	Park Services - Visitor Center							
		1		Double Flood		N		PAR	General, Security, Walk Way	N		Par30 Amber LED bulb
		2	15	Wall Lantern		N			Walk Way	N		CLB-LED amber ceiling mounted fixture
		8		Wall Lantern, No Lamp		N			Walk Way	N		Remove
			**Building Type:**	Restroom							
		1	3	Wall Pack		Y		Mercury	Entry	Y		
			**Building Type:**	Restroom							
		1	3	Wall Lantern		N	15W	CF	Entry	N		Atlas WPS13 LED Wall Pak

				**Building Type:**	Restroom							
		1	3	Wall Lantern		N	15W	CF	Entry	N		Atlas WPS13 LED Wall Pak
				**Building Type:**	Restroom							
		1	3	Wall Lantern		N	15W	CF	Entry	N		Atlas WPS13 LED Wall Pak
				**Building Type:**	Restroom							
		1	3	Wall Lantern		N	15W	CF	Entry	N		Atlas WPS13 LED Wall Pak
				**Building Type:**	Restroom							
		1	3	Wall Lantern		N	15W	CF	Entry	N		Atlas WPS13 LED Wall Pak

Site No. 15 St. Mary- Hudson Bay:

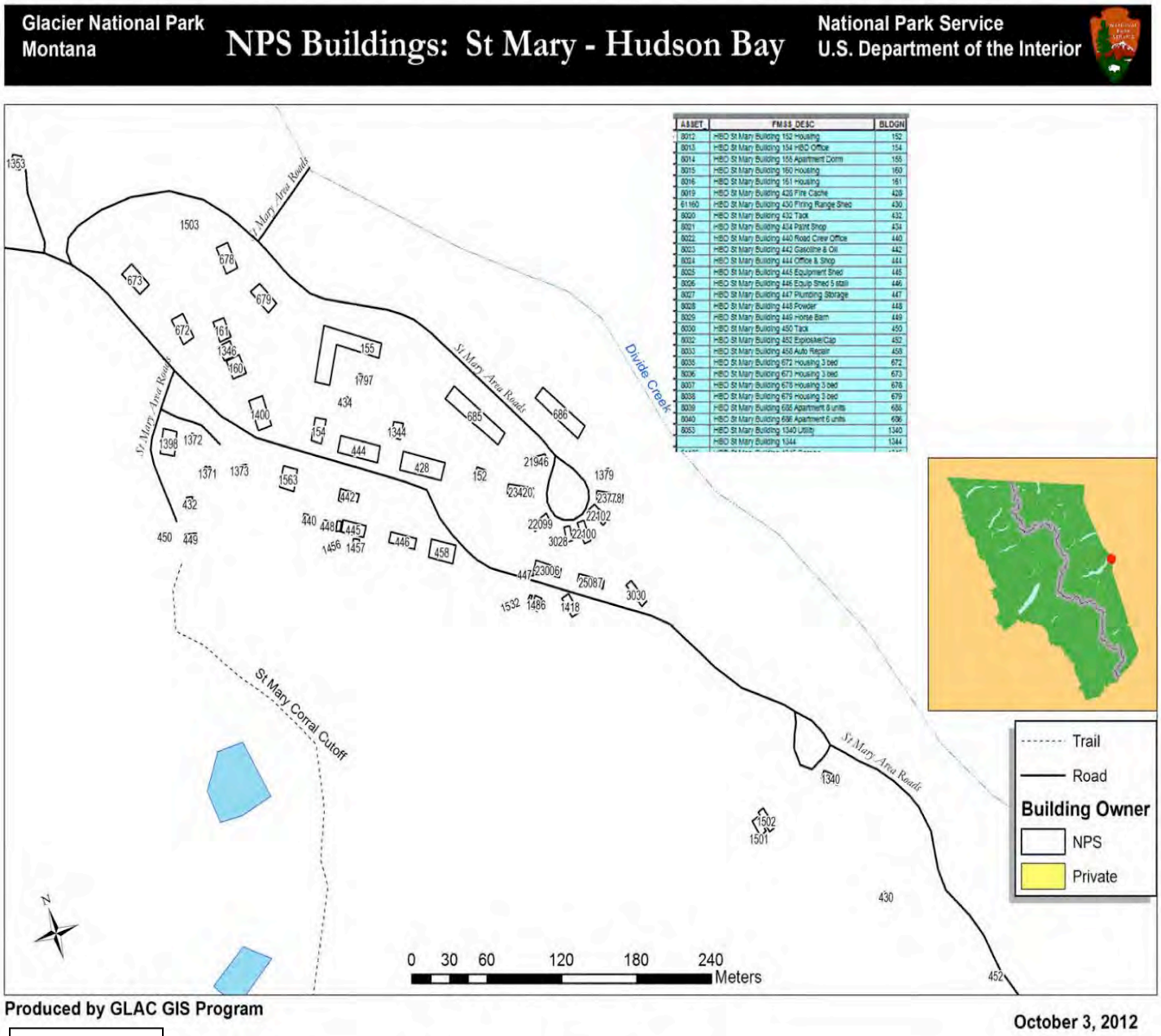
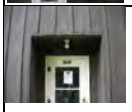


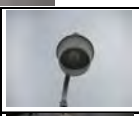
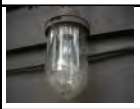
Figure 1.16

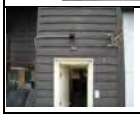
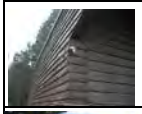
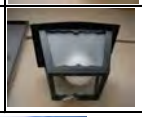
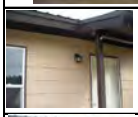
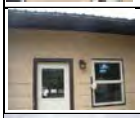
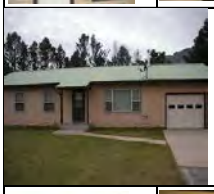
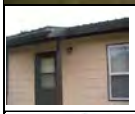
Summary of recommendations:

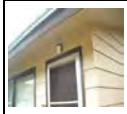
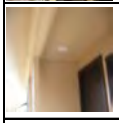
The wall lanterns in the St. Mary—Hudson developed area should be replaced with RDA WRDS Amber LED fixtures. The ceiling mounted fixtures should be replaced by CLB LED ceiling mounted fixtures. Streetlamps should be replaced with Beacon Urban LED lamps. The emergency lights will not be replaced as they are only used in the case of an emergency.

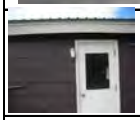
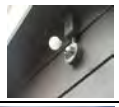
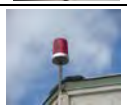
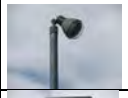
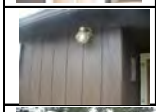
Responsible party: National Park Service

Picture (Wide)	Picture (Detail)	Light No.		Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec
				**Building Type:**	Cabin							
		1		Wall Lantern		N		CF	Entry	N		Amber par16 bulb
				**Building Type:**	Park Services - office							
		1		Wall Lantern		N			Entry	N		ceiling mounted fixture (RAB Designs Canada)
				**Building Type:**	Cabin - dorms							
		1		Bare Bulb		N			Entry	N		CLB-LED amber LED ceiling mounted fixture (RAB Designs Canada)
		2		Bare Bulb		N		CF	Entry	N		CLB-LED amber LED ceiling mounted fixture (RAB Designs Canada)
		3		Post		N			Street	N	Sticks out above/beyond building ~ 10ft	
		4		Wall Lantern		N			Entry	N		RDA WRDS Amber LED fixture
		5		Ceiling		N			Entry	N		CLB-LED amber LED ceiling mounted fixture (RAB Designs Canada)
				**Building Type:**	Cabin							
		1	5	Ceiling	Switch			Double CF	Entry, Patio			ceiling mounted fixture (RAB Designs Canada)
		1		Double Flood		N			Security	N		RDA WRDS Amber LED fixture w/motion sensor

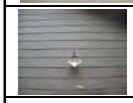
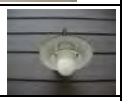
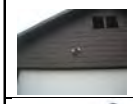
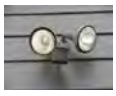
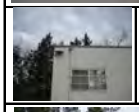
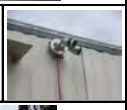
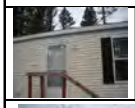
				**Building Type:**	Fire Cache							
		1		Wall Lantern		N			Entry	N		RDA WRDS Amber LED fixture
		1		Double Flood		N		CF PAR	Entry, Security	N	Look straight out	RDA WRDS Amber LED fixture
		2		Emergency		N		Incandescent	Emergency	N		no change
				**Building Type:**	Gas							
		1		Wall Lantern		N		CF	Entry	N	On at time of inspection	RDA WRDS Amber LED fixture
		2		Wall Lantern		N		CF	Task	N	On at time of inspection	RDA WRDS Amber LED fixture
				**Building Type:**	Maintenance - office & shop							
		1			Post						Above Building	Amber LED par38 with mogul to medium base adapter (bypass
		2			Wall Lantern	N			Entry, Walk Way	N		RDA WRDS Amber LED fixture
		3			Wall Lantern	N	15W	CF	Entry	N		RDA WRDS Amber LED fixture
		1	2	Ceiling		N			Entry	N		Par30 amber LED bulb
				**Building Type:**	Storage							
		1		Ceiling		N			Entry	N		par30 amber LED bulb
		2	2	Wall Pack		Y			Security, General	N	45° tilt	Hubbell LNC amber LED wallpack

			**Building Type:**	Maintenance - garage							
		1		Wall Pack, Wall Lantern				Entry	Y		
		2		Double Flood		N		Security	N	45° tilt	RDA WRDS Amber LED fixture w/motion sensor
			**Building Type:**	Cabin							
		1		Wall Lantern		N		CF	Entry	N	Bulb sticking out	Par16 amber LED bulb
		2		Wall Lantern		N	100W	Incandescent	Entry	N		Par16 amber LED bulb
			**Building Type:**	Cabin							
		1		Wall Lantern		N		CF	Entry	N		Par16 amber LED bulb
		2		Wall Lantern		N		Incandescent	Entry	N		Par16 amber LED bulb
			**Building Type:**	Cabin							
		1	2	Wall Lantern		N		Incandescent	Entry	N		Par16 amber LED bulb
			**Building Type:**	Cabin							
		1		Wall Lantern		N		Incandescent	Entry	N		Par16 amber LED bulb
		2		Wall Lantern		N		CF	Entry	N		Par16 amber LED bulb

				**Building Type:**	Cabin - apartments							
		1	13	Wall Lantern	Switch	N			Entry	N		RDA WRDS Amber LED fixture
		3	2	Wall Lantern	Switch	N		CF	Entry	N		RDA WRDS Amber LED fixture
		16		Bare Bulb	Switch	N		CF	Entry	N	On at time of inspection	RDA WRDS Amber LED fixture
		17		Bare Bulb	Switch	N			Entry	N		RDA WRDS Amber LED fixture
				**Building Type:**	Cabin - apartments							
		1		Ceiling, partially recessed, bare bulb		N		CF	Entry	N		RDA CLB-LED ceiling fixture
		2	4	Wall Lantern		N			Entry	N		RDA WRDS amber LED fixture
		4	2	Wall Lantern		N		Incandescent	Entry	N		RDA WRDS amber LED fixture
		8	4	Recessed		Y			Entry	Y		
		12		Recessed		N		CF	Entry	N		Par30 amber LED bulb

				**Building Type:**	Maintenance - water treatment							
		1		Wall Lantern		N			Entry	N		Par16 amber LED in Progress Cylinder fixture
		2		Wall Lantern		N			Security	N		Par16 amber LED in Progress Cylinder fixture
		3		Emergency		N			Emergency	N		Not compliant-- only used in emergency
		4		Wall Lantern		N			Entry	N		Par16 amber LED in Progress Cylinder fixture
		6	4	Post		Y			Task	N	30° angle	Beacon UrbanLED LED32-AM-DIR3-BZ
		9		Post		N			Task	Y	Straight down	
		10		Post		N			Task	N		Beacon UrbanLED LED32-AM-DIR3-BZ
				**Building Type:**	Cabin							
		1		Bare Bulb, Ceiling		N	60W	CF	Entry	N		Par30 Amber LED Bulb
		2		Wall Lantern		N		CF	Security, Walk Way	N		RDA WRDS Amber LED fixture
				**Building Type:**	Cabin							
		1		Wall Lantern		N			Entry	N		RDA WRDS Amber LED fixture
				**Building Type:**	Cabin							
		1	2	Wall Lantern		N	60W		Entry	N		RDA WRDS Amber LED fixture

			**Building Type:**	Storage							
 	1		Wall Pack		N			General	N		RDA WRDS Amber LED fixture
			**Building Type:**	Cabin							
 	1		Wall Lantern, Bare Buld		N		CF	Entry	N		RDA WRDS Amber LED fixture
 	2		Wall Lantern		N			Entry	N		RDA WRDS Amber LED fixture
			**Building Type:**	Cabin/residential(?)							
 	1	2	Wall Lantern	Switch	N		CF	Entry	N		RDA WRDS Amber LED fixture

			**Building Type:**	Maintenance							
 	1		Wall Lantern, Emergency		N			Emergency	N		Not compliant but only used in emergency
			**Building Type:**	Storage & Maintenance - garage							
 	1		Wall Lantern		N			Entry	N		Par30 amber LED bulb
 	2		Double Flood		N		CF PAR	Entry, Security	N		RDA WRDS Amber LED fixture
			**Building Type:**	Communications							
 	1		Wall Pack		N			Entr	N	Looks sraight out	RDA WRDS Amber LED fixture
			**Building Type:**	Unknown							
 	1		Double Flood	Motion	N			Security	N		RDA WRDS Amber LED fixture
			**Building Type:**	Cabin							
 	1	2	Wall Lantern		N			Entry	N		RDA WRDS Amber LED fixture
			**Building Type:**								
 	1	2	Wall Lantern	Switch	N			Entry	N		RDA WRDS Amber LED fixture
 	6	3	Post	DD				Street			Beacon UrbanLED LED32-AM-DIR3-BZ

Site No. 16 Two Medicine:

Figure 1.17

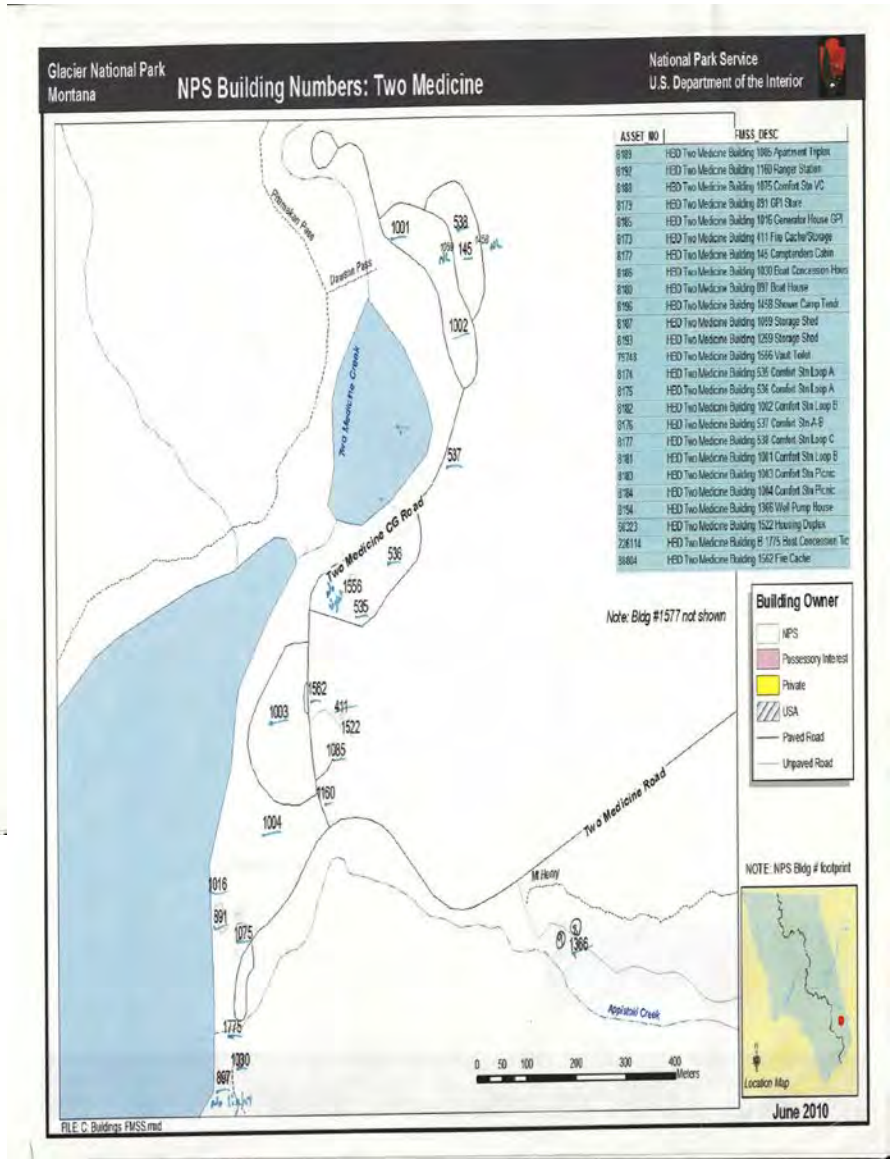


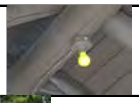
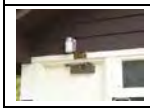
Figure 1.18

NPS operated Buildings:

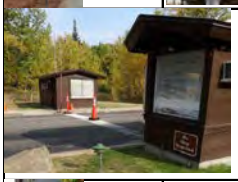
Summary of recommendations:

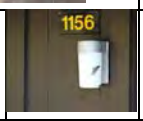
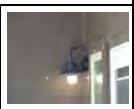
The first priority for light fixture replacement in this developed area is the wall lanterns in the comfort stations. They will be replaced with Atlas WPS13 LED Wall Paks. The other wall lanterns on housing and park services buildings should be replaced with Progress Cylinder fixtures with PAR16 Amber LED bulbs. Streetlamps should be replaced with Beacon Urban LED fixtures. The emergency lights may remain non-compliant because they are only used in case of an emergency.

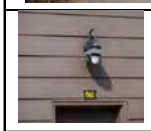
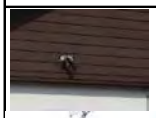
Responsible party: National Park Service

Picture (Wide)	Picture (Detail)	Light No.	# of Light Type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	REC
				**Building Type:**	Ranger Residence B Loop							
		1		Bare Bulb	Switched	N	60	Incandescent	Entry Way Light	N	Bug Light	Amber LED par30 bulb
				**Building Type:**	Storage Shed							
		1		Wall Lantern	Switched	N		No Bulb	Entry Way Light	N		amber LED par16 bulb
				**Building Type:**	Comfort Station Loop A							
		1	3	Wall Lantern	Timer	N			Entry Way Light	N		Atlas WPS13 LED Wall Pak
				**Building Type:**	Comfort Station Loop A							
		1		Wall Lantern	Timer	N	60	Incandescent	Entry Way Light	N	Bug Light	Atlas WPS13 LED Wall Pak
		2		Wall Lantern	Timer	N		Compact Fluorescent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
		3		Wall Lantern / Bare Bulb	Timer	N		Compact Fluorescent	Entry Way Light	N	Bug Light	Atlas WPS13 LED Wall Pak
				**Building Type:**	Comfort Station Loop A							
		1	2	Wall Lantern	Timer	N		Compact Fluorescent	Entry Way Light	N	Bug Light	Atlas WPS13 LED Wall Pak
		2		Wall Lantern	Timer	N	60	Incandescent	Entry Way Light	N	Bug Light	Atlas WPS13 LED Wall Pak

			**Building Type:**	Comfort Station							
		1		Wall Lantern	Timer	N			Entry Way Light	N		Atlas WPS13 LED Wall Pak
		2	2	Wall Lantern / Bare Bulb	Timer	N		Compact Fluorescent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
			**Building Type:**	Comfort Station Loop B							
		1	2	Wall Lantern	Timer	N	60	Incandscent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
		3		Wall Lantern	Timer	N		Compact Fluorescent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
			**Building Type:**	Comfort Station							
		1		Wall Lantern	Timer	N	60	Incandscent	Entry Way Light	N	Bug Light	Atlas WPS13 LED Wall Pak
		3	2	Wall Lantern	Timer	N		Compact Fluorescent	Entry Way Light	N	Bug Light	Atlas WPS13 LED Wall Pak
			**Building Type:**	Comfort Station							
		1		Wall Lantern	Timer	N			Entry Way Light	N		Atlas WPS13 LED Wall Pak
		2	2	Wall Lantern	Timer	N		Compact Fluorescent	Entry Way Light	N		Atlas WPS13 LED Wall Pak
			**Building Type:**	Comfort Station							
		1	2	Wall Lantern	Timer	N			Entry Way Light	N		Atlas WPS13 LED Wall Pak
		3		Wall Lantern - No Bulb	Timer	N			Entry Way Light	N		Atlas WPS13 LED Wall Pak

				**Building Type:**	Housing							
		1		Wall Lantern		N		Compact Fluorescent	Entry Way Light	N		Amber LED par16 in progress cylinder fixture
				**Building Type:**	Comfort Station							
		1	2	Wall Lantern	Timer	N			Entry Way Light	N		Atlas WPS13 LED Wall Pak
		2	2	Wall Lantern	Timer	N			Security Light	N		Atlas WPS13 LED Wall Pak
				**Building Type:**	Residential - Triplex							
		1	7	Wall Lantern	Switched	N			Entry Way Light	N		Amber LED par16 in progress cylinder fixture
				**Building Type:**								
		1		Post - No Bulb		N			Street Light	N	ID lamp to confirm base	Amber LED A-lamp
				**Building Type:**	Entrance							
		1		Bollard		Y			Walk Way Light	Y		NA
		2			Switched	Y		Mercury	Security	Y		
		3			Switched	Y		Compact Fluorescent	Task Light	Y		amber LED par30 bulb
		4			Switched	Y		Mercury	Security	Y	On All Day	
		5			Switched	Y		Incandescent	Entry Way Light	Y		amber LED par30 bulb

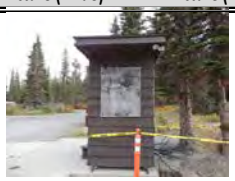
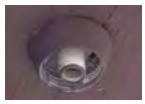
			**Building Type:**	Entrance								
		1		Wall Lantern	Switched	N			Entry Way Light	N		Amber LED par16 in progress cylinder fixture
		2		Recessed Light	Switched	Y			Sign Illumination	Y		2700k bulb
			**Building Type:**	Park Service - Ranger Station								
		1		Flood Light - Double	Motion Sensor	N		PAR	Entry Way Light	N	On During Day	amber LED par30 - aim down or replace with Hubbell LNC amber
			**Building Type:**	Entrance								
		1		Post	Dusk to Dawn	N			Street Light	N		remove - install Beacon Viper amber LED 22E-29 type 3 - possible
			**Building Type:**	Entrance								
		1				N			Task Light	N		NA
			**Building Type:**	Well Pump House								
		1		Wall Lantern		N		Compact Fluorescent	Security	N	Red Globe	NA
			**Building Type:**									
		1	4	Wall Lantern	Switched	N			Entry Way Light	N		Amber LED par16 in progress cylinder fixture

			**Building Type:**								
 	1		Wall Lantern	Switched	N			Entry Way Light	N		Amber LED par30L in progress cylinder fixture
 	2		Flood Light - Double	Motion Sensor	N			Security	N		Hubbell LNC 9L wallpack amber LED
			**Building Type:**	Communication							
	1		Wall Lantern		N			Entry Way Light	N		Hubbell LNC amber LED 9L Fixture
			**Building Type:**	Entrance							
 	1	2	Post	Dusk to Dawn	Y	100	Mercury	Street Light	Y		if HPS/ no change
			**Building Type:**	Parking Lot							
 	1	2			N			Street Light	N		Amber LED beacon Urban fixture

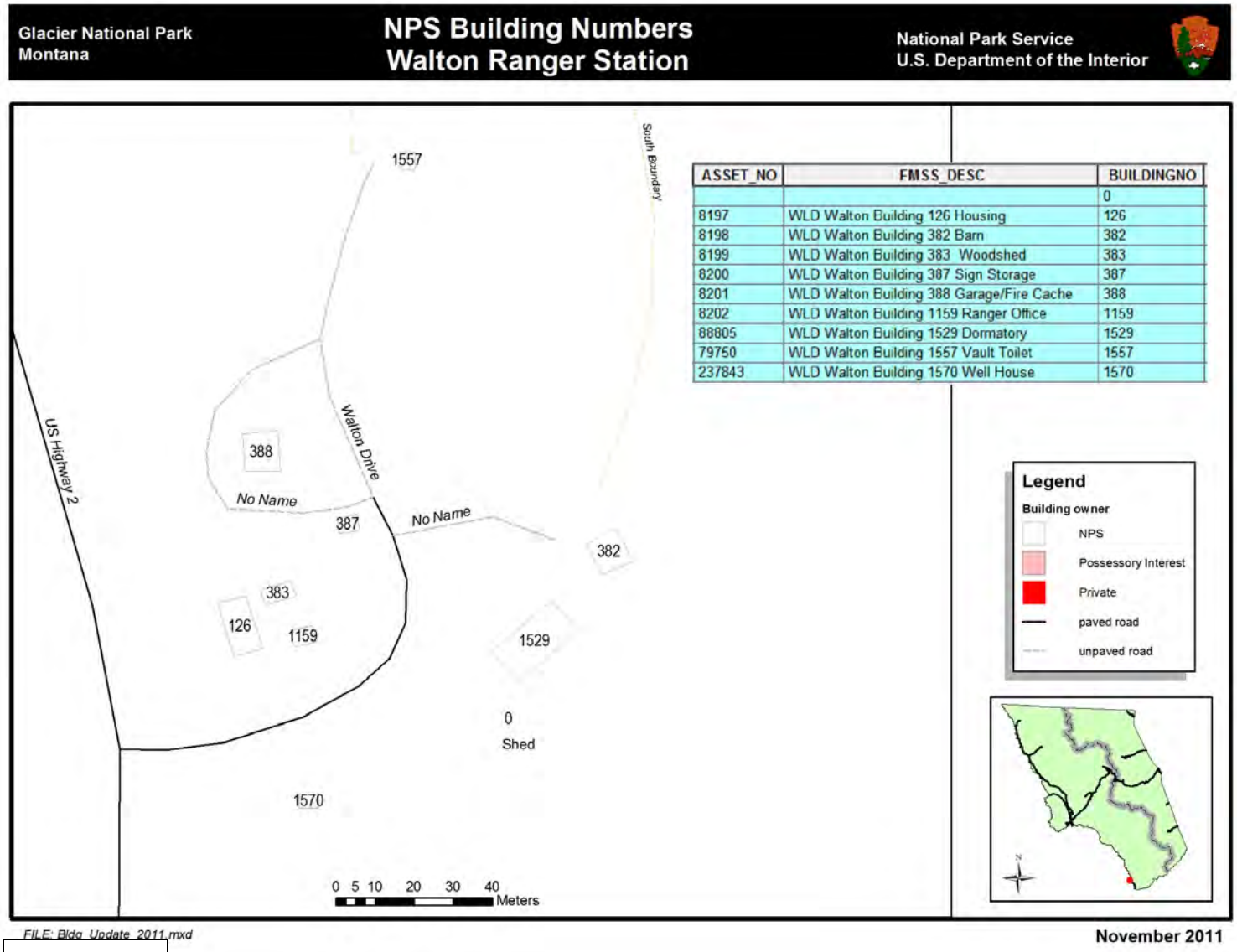
Concession operated buildings:

Summary of recommendations: Retrofit Flood lights and ceiling lights with PAR30 Amber LED Bulbs. Replace wall lantern on generator house with Hubbell LNC Amber LED Wall Pack.

Responsible party: Concessioner (Xanterra)

Picture (Wide)	Picture (Detail)	Light No.	# of Light Type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	REC
				**Building Type:**	Boat Concession Ticket							
		1		Flood Light - Double		N			Security	N		remove - install CLB-LED amber ceiling mount fixture if light warrented
		2	2	Ceiling - No bulb		N				N		par30 amber LED bulb
				**Building Type:**	Camp Store							
		1		Flood Light	Switched	N		PAR	General Light	N		Amber LED par30- aim downward
		2		Bare Bulb	Switched	N		Compact Fluorescent	Entry Way Light	N		Amber LED par30- aim downward
		3		Recessed Light					Task Light	Y		
		4		Flood Light	Switched	N		Compact Fluorescent	Entry Way Light	N		Amber LED par30 - aim downward
		5		Flood Light - Double		N		PAR	Security	N		Amber LED par30 - aim downward
				**Building Type:**	Generator House							
		1		Wall Lantern		N		Mercury	Security	N	On During Day	Hubbell LNC amber LED wallpack 7L

Site No. 17 Walton ranger station:



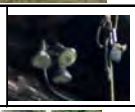
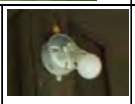
ASSET_NO	FMSS_DESC	BUILDINGNO
		0
8197	WLD Walton Building 126 Housing	126
8198	WLD Walton Building 382 Barn	382
8199	WLD Walton Building 383 Woodshed	383
8200	WLD Walton Building 387 Sign Storage	387
8201	WLD Walton Building 388 Garage/Fire Cache	388
8202	WLD Walton Building 1159 Ranger Office	1159
88805	WLD Walton Building 1529 Dormatory	1529
79750	WLD Walton Building 1557 Vault Toilet	1557
237843	WLD Walton Building 1570 Well House	1570

Figure 1.19

Summary of recommendations:

Wall lanterns at Walton Ranger Station should be replaced with Progress Cylinder fixtures with PAR16 Amber LED bulbs. The ceiling fixtures should be replaced with CLB-LED Ceiling mounted fixtures. The remaining non-compliant light is a streetlamp that should be replaced with a Beacon Streetlight fixture.

Responsible Party: National Park Service

Picture (Wide)	Picture (Detail)	Light No.	# of light type	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Recommendation
				**Building Type:** Barn								
		1		Triple Flood Light		N			General Light	N		(1) Amber LED par30 bulb - aim down, cap other sockets
				**Building Type:** Woodshed								
		1		Bare Bulb		N		Incandescent		N		PAR30 Amber LED
				**Building Type:** Garage								
		1		Wall Lantern		N		Incandescent	General Light	N		Amber LED par16 bulb w/ progress cylinders fixture
				**Building Type:** Ranger Station								
		1		Wall Lantern		N			Entry Way Light	N		Amber LED par16 bulb with progress cylinder fixture
				**Building Type:** Dorm								
		1		Ceiling		N			Patio Light	N		CLB-LED Ceiling mounted fixture
		2	3	Wall Lantern		N			Entry Way Light	N		Amber LED PAR16 Bulb with Progress Cylinder fixture
				**Building Type:**								
		1	3	Post		N				N		Beacon Viper-S 30E-40 type 3

Site No. 18 East Glacier Ranger Station:

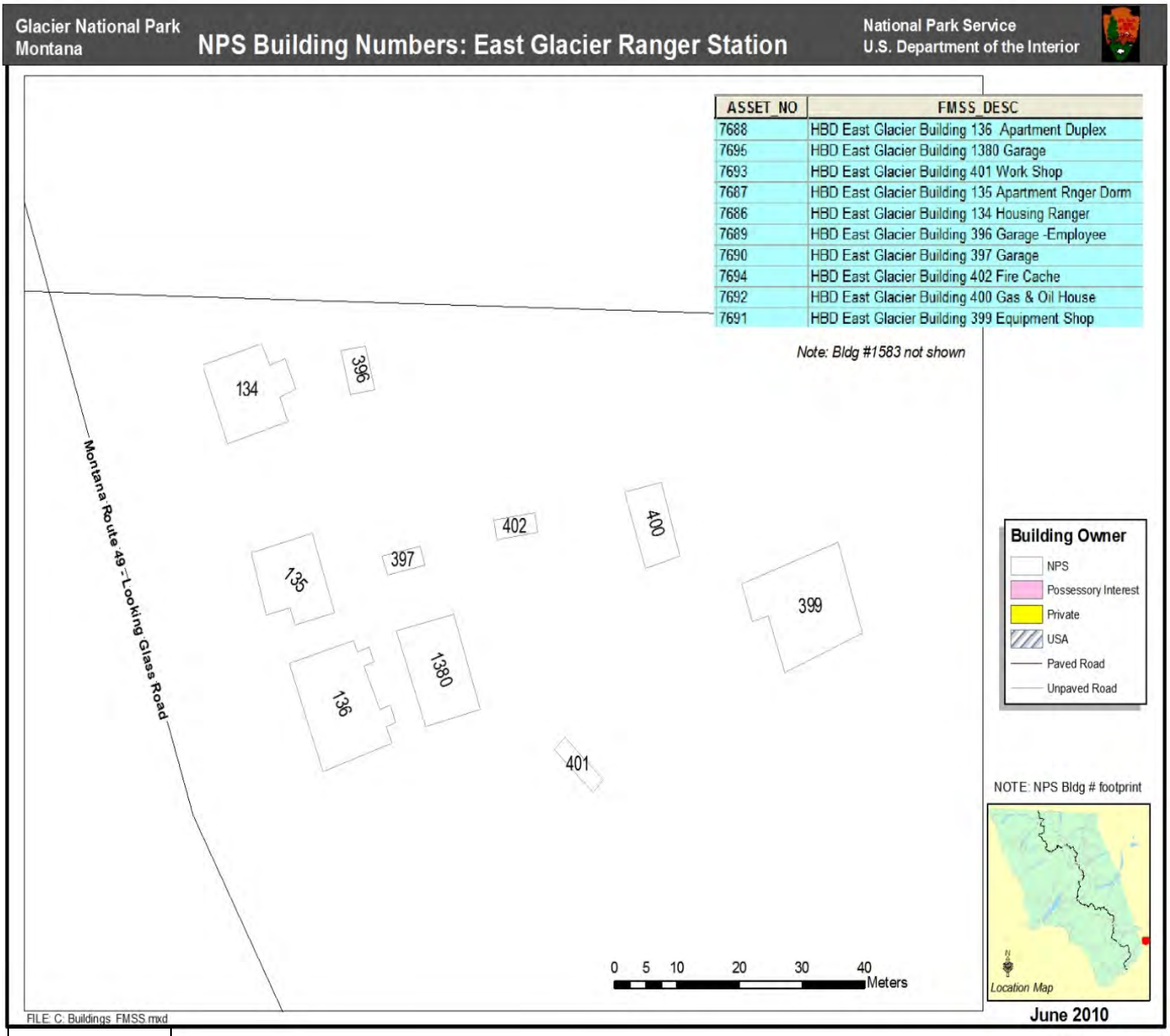
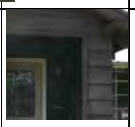


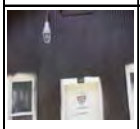
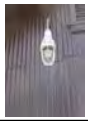
Figure 1.20

Summary of recommendations:

Replace unshielded bulbs with PAR16 or PAR30 Amber LED bulbs. Replace yard lights with Hubbell Amber LED LNC Wall pack. The wall lanterns in residences should be replaced with RDA WRDS Amber LED fixtures.

Responsible party: Naional Park Service

Picture (Wide)	Picture (Detail)	Light No.	Type of Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec
			**Building Type:**	Ranger Dorm							
		1	Wall Lantern	switched	N			Entry	N		RDA WRDS Amber LED fixture
			**Building Type:**	Ranger Housing							
		1	2 Wall Lantern	Switched	N		Compact Fluorescent	Entry	Y	Light compliant because shielded by roof	Par16 Amber LED
		3	2 Wall Lantern	Switched	N		Compact Fluorescent	Entry	N		RDA WRDS Amber LED fixture
			**Building Type:**	Garage							
		1	Wall Lantern	Switched	N			Entry	N		Par16 Amber LED
			**Building Type:**	Ranger Residence							
		1	Wall Lantern	switched	N			Entry	Y	Covered by porch	Par16 Amber LED
		2	Double Flood Light	switched	N			Security	N		Hubbell Amber LED LNC 7L wallpack
			**Building type:**	Garage							
		1	Double Flood Light	motion sensored	N			Security	N		Par30 Amber LED

				**Building Type:**	Maintenance							
		1		Wall Lantern	Switched	N		Compact Fluorescent	Entry way light	N		Par16 Amber LED
		2		Wall Lantern	Switched	N			Entry way light	N		Par16 amber LED
				**Building type:**	Equipment shop							
		1		Wall Lantern	Switched	N			Yard Light	N		Hubbell Amber LED LNC 9L Wallpack

Site No. 19 West Glacier Entrance station:

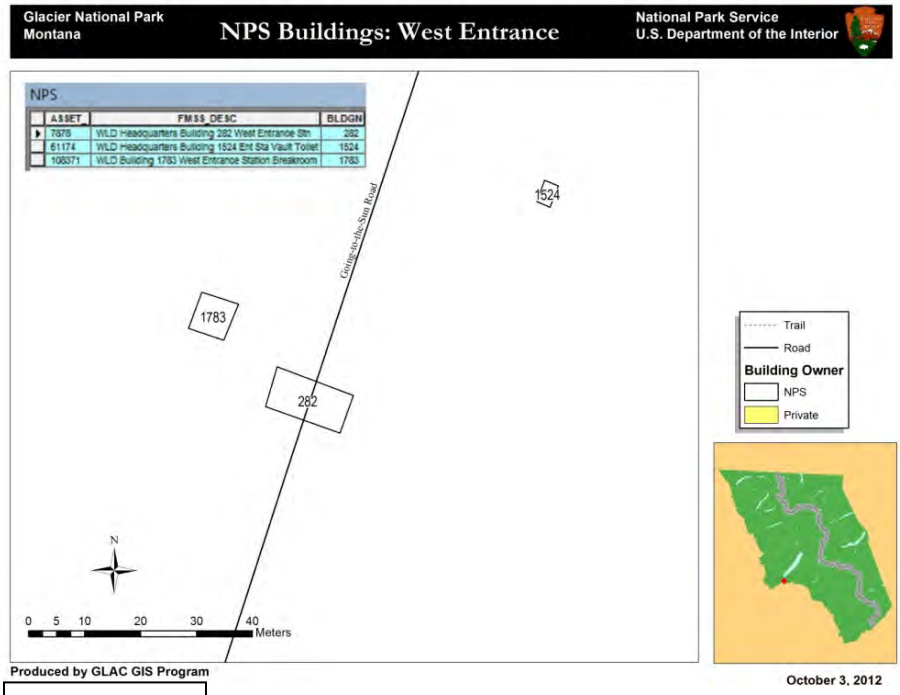
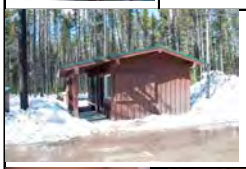
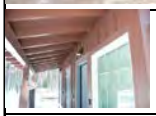
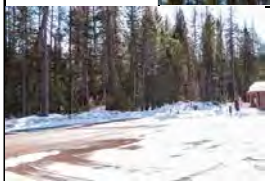


Figure 1.21

All lights in this developed area are in compliance.

Picture (Wide)	Picture (Detail)	Light No.	# of light type	Luminaire	Light Control Mechanism	Shielded?	Wattage	Bulb Type	Purpose / Application	Compliant?	Notes	Rec
		1	3	Wall Pack		Y			Entry Way Light	Y	ID lamp type	2700k lamp or warmer
				**Building Type:**	Restrooms							
		1	3	Wall Pack		Y			Entry Way Light	Y	ID Lamp type	2700K lamp or warmer
				**Building Type:**	Light Posts							
		1	2	Post		Y			Street Light	Y		Par38 Amber LED bulb
				**Building Type:**	Light Posts							
		1		Post		Y			Street Light	Y		par38 amber led bulb

2014 GLACIER NATIONAL PARK LODGES DRAFT EXTERIOR LIGHTING PLAN

Overview

There are two key components to a successful Exterior Lighting Plan. The first is to only use light when it is needed, where it is needed and in the appropriate amount for the specific task it is needed for. The second is fully shielding the exterior lighting fixtures and incorporating timers and motion sensors on them to minimize the time that they are on. This will not only minimize light pollution but will also result in a decrease in electricity usage and thereby a reduction in utility costs.

The Exterior Lighting Plan is designed to address directed lighting systems to provide minimum necessary lighting for safe nighttime walking in and around Glacier National Park Lodges' (GNPL) land assignments, but that is sensitive to night sky pollution. This plan follows the procedures and protocols outlined in the International Dark-Sky Association (IDSA) "Dark Sky Park Program Guidelines" (October 2014) as well as "Guidelines for Outdoor Lighting" written by Robert Dick of the Royal Astronomical Society of Canada (RASC) and adopted by the IDSA in November 2012. In these documents the Exterior Lighting Plan will be referred to as a Lightscape Management Plan (LMP) in alignment with the language utilized in the Dark Sky Guidelines.

Implementation of Dark Sky Program

Implementation

The following steps will be taken to develop and implement the LMP following the Dark Sky Program:

- Create a Lightscape Management Plan (LMP) – this document
- Conduct a lighting inventory
- Determine the applicability of implementing "Dark Time"
- Develop guest and employee education and interpretive programs
- Work with NPS to achieve Dark Sky Certification

Lighting Inventory

Lighting Inventory

To determine how to mitigate light pollution in the GNPL land assignment an exterior lighting audit and inventory will be conducted. This audit will identify the location, type, quantity and lumen output of the fixtures around each of the GNPL facilities and land assignments.

The initial lighting inventory will focus on GNPL land assignments and divide the locations based upon the "Guidelines for Outdoor Lighting" standard as listed below:

- Buildings: Administrative, Public, Retail, Vending, Toilet & Washroom Facilities
- Parking Lots
- Pathways
- Historic Sites

Guidelines for illumination levels for each of these categories can be found in the "Guidelines for Outdoor Lighting" document. The maximum illumination levels are to be used to determine if the lighting conforms with the Dark Sky Program.

The lighting inventory should note whether the fixture is fully shielded, if the fixture is a special purpose fixture (i.e. historic preservation) under 500 initial lumens, and the application for the fixture.

A sample table provided by the "Dark Sky Park Program Guidelines"

Location	Fixture	Fully-Shielded	Special Purpose <500	Application	Conformity with LMP
Visitor Center	12 fixtures on 14' pole, 70 W HPS	YES	NO	Parking log, timer off at 10pm	YES
	2 door lights,	YES	NO	Building egress	YES
	6 bollard (post) lights, 32 W CFL	NO	NO	Walkway	NO – see plan
Historic Cabin	2 carriage style lights at doorways,	NO	YES	Historic Preservation, egress	YES
Maintenance Yard	6 wall packs, 250 W MH	NO	NO	Occasional night operations	NO – see plan
	8 Glarebusters, 11 W CFL	YES	NO	Egress, security	YES

Lamps of 500 lumens output and less include: 33 watt incandescent and less; 25 watt tungsten (quartz) halogen and less; 8 watt linear fluorescent and less; 10 watt compact fluorescent and less.

As part of the lighting inventory a plan will be submitted with recommendations on improving exterior lighting and to create a plan to ultimately achieve IDSA Dark Sky certification. These measures will include lighting retro-

fits, de-lamping and the installation of motion sensors and timers. The action plan and timetable for these operations will be incorporated into the annual report on Energy Conservation Measures submitted to NPS in January of each year.

"Dark Time" Implementation

"Dark Time"

The phrase "Dark Time" is used to represent a period after dusk when significant activity has ended within an area. If an area is identified as a candidate for "Dark Time" status, GNPL will work with NPS to implement the program for the specific area.

Examples of "Dark Time" principles are listed below:

- Offices that are closed during the evening should ensure that all lighting visible from the outside be turned off or covered.
- Lighted pathways should only be illuminated when there is a reasonable expectation of pedestrian traffic.
- Provide the minimum light level required for safe transitions from lighted to unlighted areas.
- Areas of illumination should be limited to the minimum necessary and should be fully shielded where applicable.
- Utilize timers and motion sensors to minimize unnecessary illumination.
- In areas of low speeds or infrequent traffic, retro-reflective signage should be utilized in lieu of lighting fixtures.

Education and Outreach

In-Room Guest Outreach

To ensure that the guest understands the importance of the "Dark Sky Program" and why GNPL strives to minimize exterior lighting, guest education documents will be created and placed throughout the operations including the guest room directories. GNPL will also work with NPS on language to be added to the Park Newsletter as well as during night programs to inform the guest of the activities both GNPL and NPS are taking and the importance of those efforts.

Employee Training

The Director of Sustainability will work with the Human Resources and Risk departments to develop training for employees related to "Dark Sky" management. Departmental policies and procedures will be implemented to ensure that each department on property understands their role in the "Dark Sky" Program.

IDSA Dark Sky Certification

Certification

Currently the IDSA Dark Sky Certification is divided into three categories (Gold, Silver, and Bronze). GNPL will coordinate with NPS and through our partnership work to achieve one of the certification levels.

The table below from the IDSA Guidelines outlines the different levels and the requirements of each.

Indicator	Gold	Silver	Bronze
Philosophy	Nighttime environments that have negligible to minor impacts from light pollution and other artificial light disturbance, yet still display outstanding quality night skies and have superior nighttime lightscapes.	Nighttime environments that have minor impacts from light pollution and other artificial light disturbance, yet still display good quality night skies and have exemplary nighttime lightscapes.	Areas not meeting the requirements of *Silver*, yet still offering people, plants, and animals a respite from a degraded nocturnal environment and suitable for communicating the issue of light pollution and connecting people with the many aspects of the night sky.
Artificial Light and Skyglow	Typical observer is not distracted by glary light sources. Light domes are only dim and restricted to sky close to horizon.	Point light sources and glary lights do not dominate nighttime scene. Light domes present around horizon but do not stretch to zenith.	Areas with greater artificial light and skyglow than *Silver*, but where aspects of the natural sky are still visible.
Observable Sky Phenomena	The full array of visible sky phenomena can be viewed— e.g. aurora, airglow, Milky Way, zodiacal light, and faint	Brighter sky phenomena can be regularly viewed, with fainter ones sometimes visible. Milky Way is visible in summer and winter.	Many sky phenomena cannot be seen. Milky Way is seen when pointed out to the average person, as is the Andromeda Galaxy.
Nocturnal Environment	Area is devoid of obvious lights that can cause wildlife disorientation. Artificial light levels are thought to be below the threshold for plant and animal impact. Ecological processes related to nocturnality are unaltered. No lighting atop towers or buildings within Park	Areas that have minor to moderate ground illumination from artificial skyglow. Lights that may cause disorientation to wildlife are distant. Disruption of ecological processes is minor with no impairment to plants or wildlife.	Areas with greater nocturnal impact than *Silver*, but where ecosystems are still functional.
Visual Limiting Magnitude	Equal or greater than 6.8 under clear skies and good seeing conditions	6.0 to 6.7 under clear skies and good conditions	5.0 to 5.9 under clear skies and good seeing conditions
Bortle Sky Class			
Unihedron Sky Quality Meter			

Summary

This document along with the procedures and protocols outlined in the International Dark-Sky Association (IDSA) “Dark Sky Park Program Guidelines” (October 2014) as well as RASC/IDSA “Guidelines for Outdoor Lighting”, will be utilized to create an effective LMP Program that not only meets the necessary safety standards for the guests of Glacier National Park, but will also allow them the opportunity to enjoy the beauty and wonder that the Park has to offer at night free of unnecessary light pollution.

REPORT ON CURRENT LIGHTING WITHIN WATERTON LAKES NATIONAL PARK, SPECIFICALLY THE TOWN SITE OF WATERTON

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December 4, 2014

EXECUTIVE SUMMARY

This Report reviews the existing lighting in and around the Town Site of Waterton Lakes National Park. It is not an exhaustive study of all luminaires and lighting situations, however based on the information provided to us, these comments and recommendations can be generalized to other luminaires and lighting situations within the park.

It is apparent from the images that the current state of lighting within the park has grown over many years, with very old luminaires and new luminaires within the same area. This suggests there has been an increase of outdoor lighting in the park over the past few decades. The various types of luminaires indicate they were selected prior to the current knowledge of the impact of artificial light at night (ALAN) on wildlife and human vision and before the Parks Canada Guidelines for Outdoor Lighting (PC-GOL).

The PC-GOL specifically addresses this situation and provides luminaire recommendations and passive alternatives to outdoor lighting. Some of these are mentioned in this Report.

Based on the light fixture designs and lamp wattages, current luminaires provide high levels of illumination over relatively small isolated areas with collateral glare and light trespass. These “bright spots” and glare from unshielded fixtures reduce visibility into the less illuminated areas, which gives the impression of insufficient illumination. Reducing glare and providing more uniform illumination over high-traffic areas might reduce the demand for more light and allows the removal of some existing light fixtures. These actions should improve the visitor camping experience and enjoyment of the night environment while minimizing the impact of ALAN on the ecology of the region. This will also reduce the energy and maintenance costs of the WLNP.

There are three main areas that require the reduction and control of ALAN.

Compound
Most/all of the luminaires in the Compound are non-compliant to the PC-GOL. Although it is not open to the public, the light trespass beyond the Compound will impact the wildlife in the area. Some of the luminaires are “architectural” and do not provide sufficient illumination to warrant the amount of glare and light trespass they produce. There are a few inexpensive actions that can be taken to get quick results for Wall Packs (mounting of fabricated shields). These can then be followed up with more permanent solutions (luminaire replacement) without wasting too much effort and materials.

Fabricating shields for Pole-Mounted luminaires is more difficult than for Wall Packs. Activity and machinery in the Compound requires more illumination than the Campground. Therefore current excessively bright FCO fixtures from the Campground areas (100-150W HPS) may be re-purposed for use in the Compound. This effort will allow the removal of some existing Wall Packs, thereby avoiding the need for them to be shielded. Low wattage Wall Packs may be re-purposed indoors to complement shop lighting.

Campgrounds
All the Wall Packs in the Campground areas are non-compliant, and in the short term a few will benefit from fabricated shields. However this will not improve the existing ground illumination. The shields will not correct for overly bright spots under the fixtures and poor uniformity. More useful “quality illumination” requires better Wall-Mounted fixtures.

Visitor experience is undermined by the illumination throughout the Campground. There are both shielded and un-shielded Pole-Mounted luminaires in the Campgrounds. Both varieties provide illumination that is too bright for the pedestrian-dominated activity. Putting the existing lighting on timers will delay the "experience" until late in the evening during "Dark Time[1]". Removing all un-shielded Post Top fixtures and sag-lens cobra lights will improve visibility across the Campground and improve the visitor experience. Incorporating a few amber sharp cut-off LED Pole-Mounted or Wall-Mounted fixtures at the car entrance and toilet/shower facilities (only) will ensure visitor orientation at night.

Navigation across the campground will be improved with white painted bollards with reflective tape placed at bends and intersections along the vehicle access paths. Vehicle headlights and flashlights will provide the necessary illumination when needed. The current FCO Campground Pole-Mounted luminaires should be removed and re-purposed – perhaps in the Compound.

Town Site

All Town Site luminaires are non-compliant to the GOL (they are not FCO). The luminaires appear to be quite old - based on the clarity of their lenses. These should be replaced with compliant amber LED luminaires or low wattage FCO HPS. The current pole separation does not produce uniform illumination along the roads. Since uniformity has not been reported as an issue, the shorter 6-7 meter poles can be used to limit the extent of the illumination. Modern FCO luminaires can provide much better uniformity than older fixtures further permitting the use of shorter poles.

Recommended Luminaires and Poles

Compliant poles are available from Fortis and others. The light output from the Fortis luminaires is too bright for use within the campground and other pedestrian sites within the Park. FCO HPS luminaires with low-wattage bulbs (35W and 50W) can be supplied by all major luminaire manufacturers and may be available from Fortis with negotiation.

We recommend the use of CSbG Luminaires. CSbG Eco-Light is suitable for most sites and mounting arrangements. Although the Eco-Light is more expensive than the commercial FCO HPS luminaires, the Eco-Light minimizes the number of different luminaires that must be serviced by the WLNP. A single style of luminaire also provides a more consistent lighting. Its relatively uniform illumination and Sharp Cut-off shielding improves visibility allowing fewer luminaires within the Park. The amber LEDs do not emit disruptive blue-light components so they have significantly less ecological impact than the HPS lamps.

The CSbG Mounted Path-Light (MPL) can be used where subtle illumination is needed with no overspill of light. This is suitable for pedestrian navigation and to illuminate the location of toilets, showers and kiosks. Their very low power requirements make them suitable for small solar arrays in remote locations. This alleviates the need for buried power cable and overhead wiring that impacts the visitors' wilderness experience.

[1] Approximately after 2 hours following sunset.

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1.0 SCOPE

This Report assesses the current lighting conditions within and around the Town Site of Waterton Lakes National Park (WLNP). The lighting is reviewed with respect to the requirements of the Parks Canada Guidelines for Outdoor Lighting (PC-GOL) and is based on information supplied by Christy Gustavision of WLNP. Our comments and recommendations are subject to the limitations of Section 6.0.

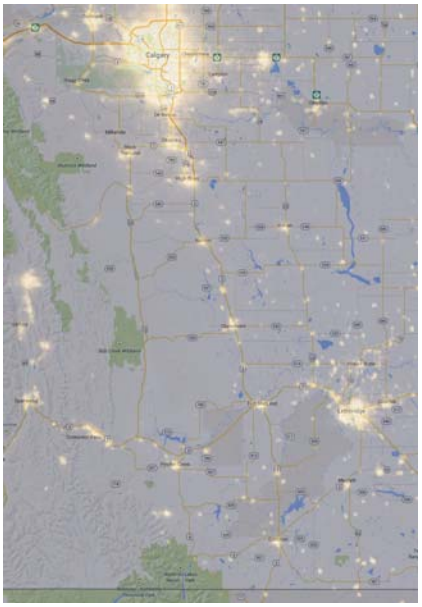
The recommendations are based on the varied land uses and available techniques and luminaires that are available at this time. The emphasis is to minimize the ecological impact of the Artificial Light at Night (ALAN) and improve the visitor experience in the Park. This is achieved by reducing glare and light trespass from the Town Site, Compound and Campgrounds. This will reduce the visual impact of ALAN on the surrounding landscape and wildlife and will improve pedestrian navigation.

2.0 DEFINITIONS

Amber Light	Colour of light that has no blue light components (spectrum is only >500 nm)
CFL	Compact Florescent lights
Cobra Head	Cobra Head – descriptive term used for relatively standard HID fixtures
Full Cut-Off (FCO)	No light is emitted above a horizontal plane that passes through the bottom of the fixture, AND <10% of the light is emitted within 10° below this plane.
Florescent	A lamp that uses glowing gas within a phosphor coated ampoule as a light source
Glare	Bright light within an otherwise relatively dim field of view that reduces our night vision
Glare Zone	Vertical sector between 80 and 90 degrees from nadir (within 10 degrees below the horizon)
HID	High intensity discharge lamps (HPS, Metal Halide)
HPS	High-Pressure Sodium HID light source (amber colour but emits light <500 nm)
Incandescent	Light emitted by a glowing metallic filament
LEDs	Light emitting diodes, the emitting component in solid-state lighting (SSL)
Light Fixture	The enclosure and optics of an light
Light Trespass	Light that shines beyond the target area
Luminaire	The enclosure, optics, electrical circuitry and lamp of a light
Mesopic Vision	The intermediate illumination with contributions from both the night and day vision
MH	Metal Halide HID light source that gives a white coloured light.
Nadir	Point directly below the light source.
Photopic Vision	Day vision that relies on our relatively insensitive retinal cone cells to see.
Post Top	Circular fixture that mounts on the top of a post (“Oriental Style”).
Scotopic Vision	Night vision that relies on our sensitive retinal rod cells.
Sharp Cut-Off (S/CO)	No light is emitted above a horizontal plane that passes through the bottom of the fixture, AND, <1% of the light is emitted within 10° below this plane.
Shoe Box	Rectangular shaped enclosure for a light fixture
Wall Pack	Luminaire mounted on wall or vertical surface
Wall Washer	Luminaire mounted under an eve and oriented to illuminate a vertical surface.

3.0 ASSESSMENTS

The Town of Waterton Lakes has a year-round population of about 88 (2011) and about 400,000 visitors per year (2012/2013)[2]. It is approximately 0.8 km west-east and 1.5 km north-south (about 1 km^2). The north side of the town is primarily residential with town services. There are Parks Canada (PC) facilities along the NE shoreline (Marina and Dock facilities), Campground sites and Park Compounds.



The region around Waterton Lakes National Park (WLNP) is relatively free of sky glow, which makes this a good time and place to begin protecting the region. Within the Park, the Town Site and Compound are the largest contributors to light pollution. Most of this is contained within the hills around the Town, however the public that camp within the Town Site Campgrounds or boat on the lake will have their night vision and appreciation of the natural night compromised by the glare and light trespass.

This ALAN also affects the local ecology. Wildlife takes advantage of starlight to help navigate and avoid predation, and aquatic life use the anonymity of darkness as they feed on near-surface plants.

Our view of the night sky is severely degraded by the illumination as low as the full Moon, which is 1/10 the level permitted by the DSP-GOL, therefore, every effort must be made to limit the extent of even the PC-GOL compliant artificial light.

The type of luminaire and illumination level depends on the use of the area that is to be illuminated. WLNP have a number of areas requiring different types of lighting. These areas are:

Town Site	Marina
Compound	Other Areas
Campgrounds	

We will review the characteristics of these areas as they pertain to lighting and compliance with the PC-GOL. When applicable, this lighting is assessed for its contribution to:

1) Visibility,
2) Visitor navigation,
3) Visitor outdoor experience, and
4) Its impact on the flora and fauna of the region.

This Report is organized into two main sections. Section 3 describes the Pole-Mounted lighting styles and Wall Packs used in WLNP. Section 4 contains the recommendations to minimize the ecological impact of the illumination while increasing the effectiveness of the ALAN for visitor experience and safety.

[2] http://en.wikipedia.org/wiki/Waterton_Lakes_National_Park

We assess the luminaires by first reviewing the characteristics of available Fortis fixtures (Section 3.1). In the second sub-section we identify the four general types of luminaires found in the Waterton Lakes area, which is based on information provided by WLNP. In sub-section 3.3 we assess the application and performance of the four types of Pole-Mounted luminaires.

In sub-section 3.4 we review the general types of Wall-Mounted fixtures (Wall-Packs) and in sub-section 3.5 we assess the application and performance of these luminaires.

3.1 GENERAL ASSESSSMENT OF FORTIS LIGHTING INVENTORY

We reviewed the Fortis 2009 and 2014 catalogues because the 2009 edition provided more information about their standard luminaires than the 2014 publication. Two of their luminaires that were labelled as "Dark Sky Friendly" are in fact NOT Dark Sky Friendly since they are not FCO (they produce "up-light"). It is apparent from this catalogue that care must be exercised in interpreting their products since the "essence" of "Dark Sky Friendly" was not understood by Fortis.

Fortis provides roadway lighting for the Town Site and charge rent for the luminaires, and for service and power. Although Fortis does not own all the Pole-Mounted fixtures, they seem to have been drawn from their suite of products. Therefore we assessed the attributes of all Pole-Mounted luminaires in their catalogue.

Style (HPS)	BUG	Style (LED, 4000K)	BUG
70W Cobra Head Flat Glass	U=0, G=2	70We Cobra Head	U=0, G=2
70W Cobra Head Sag Lens	U=1, G=2		
70W Post Top [PM-2]	U=4, G=4		
70W Shoebox [PM-4]	U=0, G=1	70We Galleon	U=0, G=1
100W Domus	U=1 (!), G=1	100We Domus	U=1, G=2
100W Crystal Ridge	U=3, G=3	70We Pendant	U=2, G=2
70W Coach	U=3, G=1	70We Traditionaire	U=0(?) G=1
70W Contemporary Coach	U=2 G=2	70We Contemporary Coach	U=3 G=1
70W Acorn	U=5 G=3	70We Acorn	U=4, G=4
100W Yard Light	U=3, G=1 (?)	50We Yard Light	U=5, G=4

Luminaires in the Fortis Catalogue are for street lighting. Using the Fortis roadway definitions, we judge the roads in the Town of Waterton to be "local" and pedestrian traffic as "medium to high".

The standard Fortis lamps are HPS, which are acceptable in a DSP. However they must be mounted in FCO fixtures. Fortis LEDs fixtures have a Coordinated Colour Temperature (CCT) of 4000K, which emit unacceptable amounts of blue light (20-40% depending on the LED manufacturer).

Fortis rate their luminaires using the "BUG System" - Backlight, Up-Light, Glare APPENDIX B. The "B" refers to the amount of light that shines behind the fixture – or Backlight, "U" is the light that shines above the horizon – or up-light and "G" is the glare. The BUG Rating refers to the amount of light that is emitted in various directions and clarifies the amount of shielding the fixture provides.

The Fortis "BUG" Ratings are listed in the following table. This system generally reflects the characteristics of the illumination. In the case of the 100W Domus: although there should be no up-light, the BUG system recognizes that excessive light just below the horizon will scatter to produce up-

light. Therefore it has a U=1, and not U=0. We feel there may be an error in the Fortis 2014 Catalogue for the 100W Yard Light. Its relatively low Glare rating may be due to a similar quirk of the BUG Rating, and not because it has low glare.

The cost of power from Fortis is relatively low (40 cents/month/light[3]). In 2010, Fortis estimated the cost of replacing existing luminaires with flat-glass (FCO) fixtures was $340 per unit, which includes labour and the fixture[2]. Fortis estimates the cost of replacing a HPS luminaire with an LED fixture is between $800-$1000[4]. In 2012 a 100W HPS fixture cost about $130[5] so the labour to replace the fixture is about $200. Therefore the estimated cost of the Fortis' alternate LED luminaires are about $600-$800.

There are no luminaire photometrics presented in the Fortis Catalogues. However, by inspection, there do not appear to be any with Sharp Cut-Off optics. The FCO shielding limits the emission of light between 90-80 degrees from nadir to 10%. Sharp CO shielding reduces this glare to <1% and significantly reduces light trespass.

3.2 POLE-MOUNTED LUMINAIRES

The figure on the next page plots the distribution of existing Pole-Mounting luminaires in Waterton Lakes. The south side of the Town Site, roughly south of Vimy Avenue, is almost treeless (open) with PC camping areas and service buildings. The open camping area west of Cameron Creek is about 150m square and the eastern open camping area is about 130m square. South and east of the eastern field and south of the western field have campsites amid brush.

The Town Site lighting north of Vimy seems to consist of three types of luminaires: Right-of-Way (ROW), Marker Lighting and Area Lighting.

ROW lighting seeks to achieve continuous illumination along the road for pedestrian visibility and navigation. Marker lighting provides information about the location of intersections for automobiles. (Drivers can see ahead where the next intersection is located.) A few short un-labelled roads[1] may have lights between intersections, but they are too widely spaced to provide continuous illumination.

We suggest the ROW lighting is along Mount View Road, Waterton Avenue, Windflower Avenue (north end), and Cameron Falls Drive. Marker lighting is found along Evergreen, Fountain and Clematis Avenues. Area lighting covers non-specific uses.
The different styles of luminaires have been documented with images provided by C. Gustavision. The Park Luminaire database (APPENDIX A: Light_Inventory.xls) indicates their wattage and whether they are owned by Fortis or Parks Canada. We have plotted in the image on the left[6] the location of all the lights that were provided in a sketch by WLNP. They are differentiated as:

Parks Canada (PC) Seasonal
PC Metered
PC Metered 150LU
Fortis Flat Rate

[3] Ref. Email from Sean LeMoine 2010
[4] Fortis 2014 Catalogue
[5] Ref. Audit of Jasper NP 2012
[6] Google Maps

Pole-mounted luminaires within Waterton belong to both Fortis and Parks Canada (PC), with the PC lights, very approximately, on the bordering roads. We have also marked various structures in and around the campground areas (kiosks, toilets and showers, and other buildings).

Plots of Pole-Mounted Fixtures across the Town Site and Campground areas.

The locations of the Pole-Mounted fixtures in and around the Campgrounds do not seem to be based on a coherent plan. The glare from some fixtures competes with the visibility provided by others.

Based on images from WLNP, we have identified four general styles of Pole-Mounted (PM) lights.

PM-1 PM-2 PM-3 PM-4

PM-1 – Non Cut-off Luminaire **PM-3** - "Shoebox" with a sag refractor

PM-2 - Pole-top (Oriental Style) **PM-4** - "Shoebox" with Full Cut-off (FCO) shielding

The different types of luminaires suggest they were purchased at different times from stock available at that time. We suggest PM-1 may be the oldest luminaires and are reported to be 150W HPS. These are found at the Cameron Falls Bridge and we have been told they are also used throughout the Town Site.

PM-1 and PM-3 have similar light distribution patterns caused by the 'sag-type" lens, or "refractor". The lens scatters the light to expand the illuminated area - permitting wide pole spacing while improving uniformity between poles, but this produces increased glare and light trespass. The brightest illumination is under the lamp and it rapidly decreases with distance from nadir. This results in poor illumination in the periphery.

The PM-3 lenses (primarily in the Town Site) have significant discolouration that may have been caused by time-in-service, accumulation of brackish water and degradation from the heat of the bulb. The lens is angled to throw light across the road. This produces light trespass onto private properties. The Fortis 9-meter high poles will shine this light into second story windows.

PM-2 luminaires are used in all campgrounds along with the other fixtures. The PM-2 luminaires are not shielded so these lights will make the campground "look dark" because the glare undermines the campers' night vision. Their view of the night from their tents and RVs will be compromised. To see the night sky, they must leave the Campground, or shield their eyes from these lights, and wait for their eyes to recover from the glare. Although PM-2 has a "cap" on the top, this does not limit the light from shining across the grounds (BUG G=4). Relatively little of this light illuminates the ground, so it provides relatively little illumination for the amount of emitted light.

Based on the Lighting Inventory (APPENDIX A), the Fortis PM-1 and PM-3 luminaires in the Town Site are typically 100-150W HPS. The campground PM-2 and PM-4 luminaires also have 70W HPS bulbs.

3.3 POLE ASSESSMENT BY AREA

We assess the current lighting in WLNP by the area in which they are used in order to differentiate the needs for the illumination characteristics. We refer to the plots of luminaires in the figure at the beginning of Section 3.1, the Lighting Inventory (APPENDIX A) and communications with C. Gustavision.

There are about forty-six 100W HPS luminaires throughout the **Town Site** and there are 14 unshielded

150W HPS luminaires along **Waterton Avenue**. The illumination level on the ground will be about 12 lux. The 100W HPS unshielded luminaires on 9-meter poles along the streets provide a ground illumination of about 8-lux or about 3X the PC-GOL limit. The unshielded fixtures will create glare down the roads and light trespass into homes and beyond the Town Site.

South of Vimy Avenue, there seems to be four Fortis luminaires (150LU) followed by three more PC 150LU luminaires near the Camp Kitchen. These appear to be on the west side of Waterton Avenue, and tilted up towards the water. These lights will create glare across Upper Waterton Lake since there are few trees for shielding. The illumination level is estimated to be over 10-lux – three times the maximum illumination level (PC-GOL).

The **Campground** has about 17 streetlight-type luminaires. They are primarily PM-2 and PM-3 luminaires on 9-meter poles. These illuminate the area to urban-levels. Even if they are turned off at "Dark Time" they will make the visitor experience of the early night impossible for younger visitors since they will have already gone to bed by the time they are turned off.

The **Bridges** over Cameron Creek and Cameron Falls have railings to delineate the width of the bridge.

At the Cameron Creek Bridge, here are two Pole-Mounted luminaires of unknown wattage. Glare from the unshielded foreground luminaire will compromise visibility of hazards further down the road.

Cameron Fall Bridge has 2 Pole-Mounted luminaires that are reported to be not working. They should be removed if they are not required in order to avoid future electrical hazards.

The **Marina** has 19 Pole-Mounted PM-3 50-70W and 150W HPS lights that are not shielded. The

Dock facility is a potentially hazardous area. Careful illumination may be needed at the wharf and in places where there may be machinery. Glare and shadows should be avoided to improve visibility of hazards.

The light fixtures are mounted on relatively short poles so the ground and water illumination is quite high (12-26-lux) - about 10X higher than permitted by the PC-GOL. The glare from the direct view of the lights, and the light that reflects off the water reduces the ability of

late-night boaters to navigate and avoid floating hazards. Pictures from the north looking towards Waterton[7] indicate the extent of the glare. The brightest area may be from the 150W HPS lights.

Waterton Lights (top) and a similar view (below) during a power failure.

The nighttime image used time exposures, however it demonstrates the extent of the contamination when shielded luminaires are not used, and the glare they create across the water. This glare is made worse by wave action that tilts the water surface and exacerbates both surface reflection and the penetration of the light into the water column. This reflected light from the Marina and the rest of the Town Site undermines the wilderness experience within the Park.

Since the lights on the wharf shine directly down into the water, they illuminate sub-surface vegetation and suppress the deil vertical migration of zooplankton that feed on the vegetation. As a result, the shoreline may become overgrown with plants. We did not visit the dock so we cannot confirm excessive growth of aquatic plants and there may be other phenomena that are at work to counteract plant growth.

It is difficult to see from the WLNP map and Google Maps, but the lights in one of the Marina parking lots, may be reducing the vision of motorists as they drive north on Waterton Drive and approach the left turn onto Mountain View Road..

The **Gate Kiosk** area is currently illuminated by fixtures on five poles. Cars will be approaching the Kiosk from both directions, so motorists' vision will be compromised more by the glare from the approaching cars than the Gate Kiosk lighting.

Roadway illumination may be governed by Alberta Traffic regulations. However, the light should be contained to the immediate area (estimated to be 35m x 100m). The vegetation in the area cannot provide natural shielding for the light. The light from these luminaires can be seen out to the tree line.

[7] Alan Dyer images used with permission

The Pole-Mounted fixtures at the Gate are a mix of “flat glass” and angled lens. This demonstrates that selecting luminaires for PC-GOL compliance must be done with care. The right hand luminaire in this figure has a level flat glass window, however the glass is projected below the metal box, which compromises its FCO performance. To be classified as FCO, the window must be flush with, or recessed inside the bottom of the fixture. The luminaire on the left side of the pole has the flat glass angled away from the pole. Although these two luminaires look similar, the right hand fixture can be easily made to be FCO but the left one cannot.

There is no record of what wattage lamps are used in these fixtures, however the left luminaire could probably be seen for many kilometres whereas the right luminaire would be visible for a few hundred meters. Both exceed the area of the Park Entrance, so there is light trespass beyond the gate facilities.

3.4 GENERAL ASSESSMENT OF WALL-MOUNTED LUMIANIRES (WALL PACKS)

We generally interpret “Wall Packs’ (WPs) to include building-mounted luminaires. The image files we have been provided show there are about 25 different WP styles with a variety of light sources (incandescent, fluorescent and HPS) (see the montage on the next page). These are shown in the montage below. The wide range of styles suggests they were purchased and installed over a long period of time. A few of the WP luminaires have discoloured lenses due to extended time-in-service or high temperature bulbs, which may have baked the plastic lenses.

Some of these luminaires seem to have been installed in response to a perceived need at that time. Their selection was based on availability and purchase cost. Some are mounted simply and others have a more elaborate mounting scheme.

We arbitrarily classify these wall packs as “Standard WP” (WP-Std) and “Random WP” (WP-Random). The WP-Random units are WP-5, WP-6, WP-9, WP-12, WP-13, WP-15, WP-16 and WP-19. Based on the tilt of the lamps in WP-6, WP-12 and WP-13 these lights are meant to illuminate a large ground area or act as marker lights.

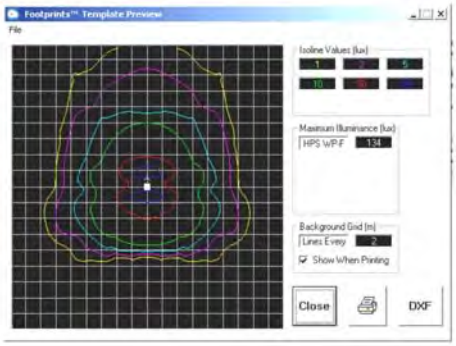
Generally, WPs are not designed for area lighting – they illuminate the area beneath the fixture (nadir). Very few of these fixtures are designed to project the light uniformly over an extended area. Most WPs create so much glare as to severally limit the extent of the "visible area". This can lead to unfortunate illumination properties: small area coverage, bright spots at nadir, brightly illuminated mounting surfaces and glare visible over a wide area with light trespass.

Bright glare (especially from white light) "bleaches" our night vision cells in our retina - blinding us to areas of low illumination. It takes several minutes for our eyes to recover after being exposed to bright lights.

We could not assess from the provided pictures, the photometrics for most of these WPs. However, we can provide representative photometrics for four fixtures with which we are familiar.

We use the following figure to illustrate some characteristics of typical WPs. It is a Cooper Wall Pack (Wally), which is used extensively in Jasper NP. It's both relatively inexpensive ($100) and accommodates a range of light sources (incandescent and HSP up at least 150W).

Cooper 150W HPS Wall Pack



The right image is the light distribution for the Wally and it is typical of "scattering-type optics". The graph shows lines of constant illumination on the ground. The brightest point is 135-lux and the teal-coloured line is 5-lux – a factor of 25 fainter than the nadir point. Although the light is scattered over a wide area (9-meter from the nadir – 1 1/2 mounting-height away) that light is only 4% the brightness at nadir, and is overwhelmed by the bright "Hot Spot" at nadir. Roughly 30-40% of the light is scattered backwards towards the mounting wall instead of illuminating the ground.

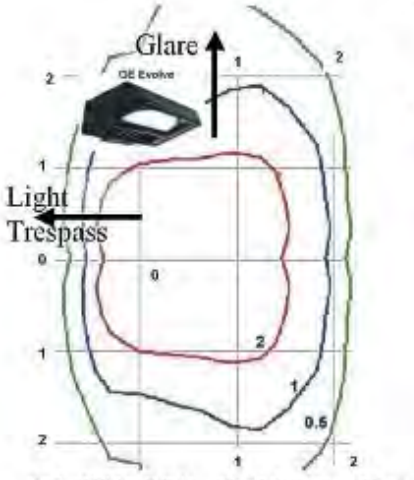
To put the illumination brightness into a practical context - at 1-lux you can read a map.

The figure on the next page compares three very different "LED" Wall Packs. This comparison makes the point that even some "modern" WPs may cause the same problems as older cheaper ones unless they are designed to specifically avoid the problems.

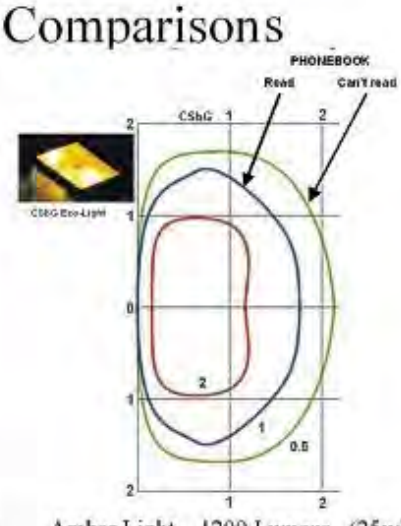
The GE Evolve fixture (left) uniformly illuminates a wide area. However, about ¼ of this light is backlight that will brightly illuminate the mounting surface. People will see the ground where it is illuminated, but not to the side because their night vision is compromised by the brightness of the wall and light emitted in the "glare zone". This GE fixture is only available with white LEDs.

Almost all LED Luminaires expose the individual LEDs to the public. The intense points of light leave temporary blind spots on the retina that can take a minute or more to fade. Large extended sources such as incandescent bulbs or low wattage HPS lamps reduce this effect because of the large apparent size of the light-emitting region.

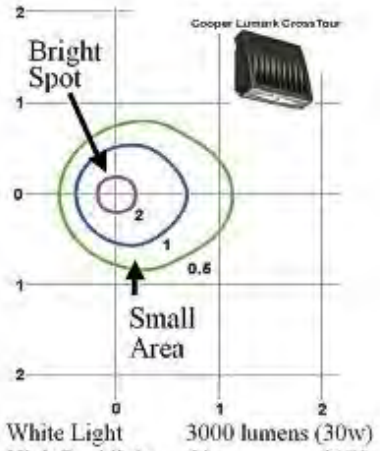
Comparisons



Only White Light 5200 lumens (52w)
High Backlight Glare $1466



Amber Light 1200 Lumens (25w)
Low backlight No glare $500



White Light 3000 lumens (30w)
High Backlight Glare $279

The Cooper light on the right (the least expensive) only illuminates a very small area – a few meters around a door. About 1/3 of the light illuminates the wall, which will reduce the ability of those in the area to see to the side of the door. It is also only available with white LEDs.

The CSbG light (middle) was designed specifically to comply with the PC-GOL. It illuminates almost the same the target area as the more expensive GE luminaire, but without the backlight, and it uses half the power. The Sharp Cut-off shielding reduces the glare to virtually zero. It is baffled so that the public cannot see the LED emitters It is available with amber LEDs or “incandescent white” if necessary, and its brightness is field-adjustable so its light output can be tailored to the application. If this Wall Pack is to illuminate the perimeter of a building, you need only one unit for every three Cooper Wall Packs.

In these examples we can see that you generally get what you pay for. However you may not need all that the luminaire provides. An otherwise good luminaire (GE Wall Pack) may leave out attributes that are critical to your application. And, an inexpensive luminaire may undermine the visibility you wish to create. It is better to purchase the light fixture that satisfies your needs than to purchase one that is the cheapest or emits the most light per watt.

3.5 WALL PACK ASSESSMENT BY AREA

The Wall Packs in the **Compound** are not shielded so they create considerable glare and light trespass across the area and beyond the Compound - they will “illuminate the hillside”. The light should illuminate only the working area rather than shine above the ground where it does not contribute to visibility. The high wattage of the luminaires on the Operations Building (70-150W HPS) will brightly illuminate the immediate area but at the cost of reduced general visibility over the site.

There are no trees within the Compound so the only shields capable of reducing light trespass off the site are the buildings. The unshielded Compound lighting may also contribute to glare along Hwy 5 as nighttime traffic approaches the town of Waterton. The building-mounted WPs at the sewage lagoons and stables in the upper Compound are also problematic.

Although floodlights (garage and bunkhouses) are meant to illuminate large areas, they are only effective if the viewer is behind the light. People in front of them are subject to their glare.

Although the **Town Site** has few Park-managed WPs, we expect that most residential and commercial buildings have building-mounted lighting to illuminate doors and outdoor property. We have assessed the outdoor lighting in other parks and municipalities and found that outdoor lighting of private property can be a major contributor to glare along residential streets. In major cities it can account for a significant amount of sky glow (15%-40%) and can undermine the effectiveness of otherwise good ROW lighting.

Most "door lights" are inexpensive and are purchased based on their day-time appeal. Most are not shielded, and in many cases they consist of "bare bulbs". After the promotion a few years ago to use Compact Florescent Lights, many incandescent bulbs were replaced with white CFLs. Home owners replaced 60W incandescent bulbs with higher than the equivalent wattage CFL. The light pollution from the average home increased, and the white light and lack of shielding increased the glare along the roads.

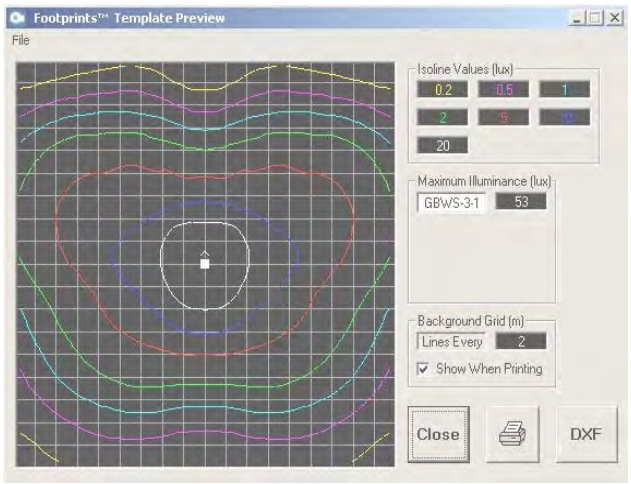
The increase in glare on a street makes the road seem under-illuminated. Adding shields and reducing the wattage of the door and curb lights will help.

Most of the WPs in WLNP use HPS lamps. Although HPS lamps are compliant with the PC-GOL, if mounted less than 6-meters high they produce too much illumination for compliance. Due to the high light output of HPS (even 35W lamps), the WPs with HPS bulbs must be mounted at least 6-meters high, and have sufficient shielding to prevent light trespass off the site.

The **Campgrounds** are primarily illuminated by Pole-Mounted fixtures. However, there are WPs on the buildings that seem to be used to help locate and identify the structures after dark. Images of these have been provided by the WLNP in the "Campground" path on the image CD.

Pedestrian traffic requires only 1-lux illumination. Steps leading up to the doors should be illuminated, however inspection of APPENDIX C reveals that when mounted as a door light even a low wattage 35W HPS fixture will illuminate the area to about 100X this level.

It is even more instructive to consider the brightness as the person walks by the light (left photograph of WP-3). At this distance (about ¼ m), the brightness is thousands of lux.



Only WP-3 in the Town site **Campground** is FCO but its illumination is much too bright to be compliant to the PC-GOL. The HPS bulb seems to be a 100-watts (the lowest HPS wattage for this product). The light distribution pattern in the right hand figure is typical of most wall packs. The grid spacing in the accompanying figure is 2-meters. This WP provides extremely bright illumination below the fixture (53-lux at nadir if mounted 6-meters high!). The lens does not "throw" the light forward, so the mounting wall is very brightly illuminated – effectively preventing the use of night vision across the field in front of the building.

In most of the cases documented in the images of the Campground buildings, the glare from wall packs will be so bright as to bleach the visitor's night vision as they walk by them. Most light fixtures should be located where people will typically remain at a distance.

The **Administration Building** on Mountain View Road has a "token" light near the peak of the roofline. It is not shielded and is too high to provide enough illumination to warrant the glare it creates.

If a light is to identify a building, it should illuminate a sign that identifies the building, otherwise it only serves as a marker light that will distract from the overall navigation along the road.

The **Gate Kiosk** uses light to welcome visitors and to provide safety around vehicles. The building currently has WPs with generally low impact, however the fixtures being used do not provide very much illumination. Recessed lighting provides sufficient light only within a distance of 1-mounting height from nadir. The one for which we have an image seems to be an incandescent bulb of perhaps 60-100 watts. This will produce a bright circular spot on the porch.

The caged fixture seems to have a discoloured lens. However it is not known if it is due to the use of high wattage bulbs, time-in-service or a filter material was added to produce amber light.

These recessed fixtures will provide some illumination for personnel but will add little awareness for motorists as to the presence of pedestrians.

4.0 RECOMMENDATIONS FOR PC-GOL COMPLIANCE AND RATIONALE

When adapting existing lighting to comply with the PC-GOL (and by similarity the Dark Sky Preserve Guidelines for Outdoor Lighting), we recommend reworking and re-purposing existing equipment into less light-sensitive locations rather than purchasing new equipment.

For example we suggest re-purposing wall packs as “indoor high-bay lighting” and relocating Pole-Mounted fixtures. Although labour costs may exceed the cost of new luminaires, the funds are spent locally and can be scheduled to level out the use of human resources. These will add more lasting value to the local economy.

Appendix D has a revised list of the luminaires with the suggested changes to their type and wattage. When replacing Wall Packs with FCO Amber LEDs, fewer fixtures may be required, however the number and placement will depend on more detailed information as to the location. Also, the power of the amber LEDs will depend on the final height and acceptable illumination level. It is estimated the typical power setting will be between 4 and 17 watts per amber LED luminaire.

The IESNA guidelines were primarily developed for cities. The relatively small towns in Parks and DSPs, rarely see road traffic density as high as in large urban areas. The IESNA suggest “minimum” illumination levels whereas the PC-GOL specifies “maximum” levels. Maximum illumination generally occurs under the luminaire (nadir). This is relatively easy to calculate without the need for photometric engineering software to “design” street illumination. Limiting the maximum illumination also discourages relatively bright spots at nadir and encourages more uniform illumination, which permits visibility into the less illuminated periphery.

The PC-GOL requires lower illumination levels than promoted by the IESNA (Illumination Engineering Society of North America). Fortis may require a “waiver” from the Township before installing PC-GOL compliant lighting (i.e. non-standard luminaires and wattage). It must be pointed out that large municipalities have adopted ½ IESNA illumination levels[8]. WLNP should take advantage of this opportunity to reduce the level of existing illumination and energy use.

The permanent population for Waterton Lakes is about 88 persons, of whom 50 are park employees. So, visitors are the main contributor to vehicle traffic density. During spring, summer and autumn, daylight persists well into the late evening so illumination is not needed for most high-density traffic periods. Only in winter will the late afternoon and early evening traffic require roadway lighting during peak traffic hours. However the winter season has only 10% the visitors of spring to autumn.

Although “liability” is used as an argument to increase illumination levels, we have not found any successful litigation based on lower lighting levels. And, studies show that street lighting has no significant effect on crime rates. Crime is a social phenomenon that is not easily addressed by technical solutions (artificial lighting).

[8] Ottawa ROW Lighting Policy 2008

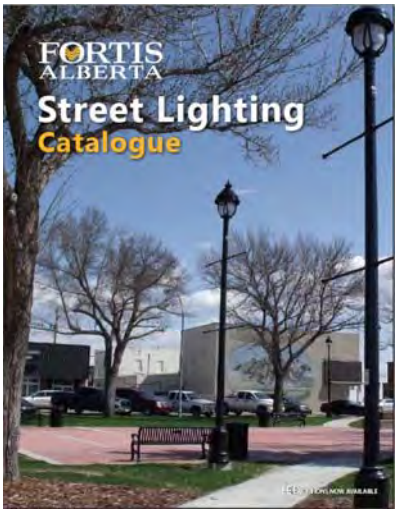
4.1 RECOMMENDATION OF FORTIS ROADWAY AND CAMPGROUND FIXTURES

Non-Fortis Equipment

Most luminaire manufacturers can provide low power (35W and 50W) FCO HPS light fixtures. These can be mounted on 6-meter poles to comply with the PC-GOL. However as with most commercially available luminaires, their light output cannot be adjusted in the field, which limits where they can be re-purposed.

PC-GOL compliant amber LED luminaires are commercially available and maybe used where low maintenance and low power usage is desirable. Their brightness can be adjusted in the field to allow the luminaire to be re-purposed (i.e. they are NOT application-specific).

Fortis Products



The Fortis Pole-Mount information in the following table has been taken from the 2014 Catalogue. It includes the Fortis products that can be used in the Compound and Town Site of the WLNP. This data is compared to the Requirements of the PC-GOL.

There is insufficient information in the 2009 and 2014 catalogues to assess the light distribution of the luminaires. The roadway lighting should have a Type III illumination pattern, which extends along the roadway with reduced backlight and glare across the street. The illumination pattern should be relatively uniform to maximize the length of road that is illuminated to avoid the need for additional poles and reduced pole spacing.

PC-GOL	CHARACTERISTIC	FORTIS CATALOGUE
6m maximum	Pole Height	5, 6, 7.5, 8 m (Structures Rd. Steel - 1427, 1428, 1492, Sq. Steel - 1432)
HPS, Amber LED	Spectrum (colour)	HPS (70W)
FCO (BUG – U=0, G=0 (for BVH=FVH=0)	Shielding	Shoebox, Cobra (U=0, G=0)
3-Lux	Roadway Illumination	IESNA
1-Lux	Pedestrian/Pathway Illumination	IESNA
1-Lux	Office Building outdoor illumination	-
3-Lux	Illumination around machinery	-

4.2 POLE-MOUNTED LUMINAIRES

All luminaires in the WLNP used along the roadways and in the Campgrounds are not FCO. The lack of clarity of the lens in the PM-1, PM-3 luminaires suggests they have reached close to the end of their useful life unless extensive work is done to improve their optics. This work would include changing the lens for a “flat glass” and altering the reflector properties. The Town of Tobermory in the Bruce Peninsula NP have used retrofit kits for many of the Town Site luminaires. These kits are product-specific but the manufacturer of the Waterton Lakes luminaires may also have retrofit kits.

We do not believe the PM-1 and PM-2 can be retrofitted to become FCO. The “sloped base” of the PM-3 luminaire prevents retrofitting for FCO performance. These should be removed or replaced with FCO fixtures.

Town Site

All roadway luminaires have HPS lamps between 70W and 150W on 9-meter poles. These will produce ground illumination levels of 5-lux (70W) to 12-lux (150W), which exceed the PC-GOL illumination levels. None of the roadway fixtures are FCO. Also, the lights along the southern half of Waterton Avenue exhibit light trespass into the Campgrounds and over the lake.

The accompanying image shows the revised luminaire distribution and is based on our recommended re-lamping and removal of Pole-Mounted luminaires. There are only three remaining types of luminaires: 50W FCO HPS or Amber LED (22), 35W HPS Post Top marker lights (13), and 35W HPS FCO or Amber LED (10)

> *1) Along the Town Site roads we recommend replacing existing luminaires with 50W HPS in FCO fixtures or amber FCO LED luminaires that will produce a maximum ground illumination of about 3-lux.*

FCO luminaires are not usually suitable for marker lighting because they cannot be seen at a distance.

> *2) We recommend the marker lighting, if deemed necessary, use existing (re-purposed) post-top luminaires (PM-2) as long as their power output is reduced to no more than 35W HPS.*

The height of the Town Site Pole-Mounted fixtures should be no more than roughly 6-meters to take advantage of the tree canopy to limit the extent of the illumination. Current poles in use are 9-meters high, however Fortis can provide poles as short as 6-meters. This will also reduce the light that enters second-story windows.

> *3) We recommend replacing the current 9-meter poles with 6-meter poles unless there are higher foliage and buildings to provide sufficient shielding.*

The HPS bulb and its ballast in luminaires set the light output of the fixtures, so these components must be retrofitted to reduce the brightness. Since HPS lamps cannot be easily dimmed, it is difficult to re-purpose existing HPS luminaires without re-lamping.

> *4) We recommend adopting amber LED luminaires that are dimmable in the field in order to tailor the illumination level to the application and to take advantage of re-purposing luminaires in the future.*

Fortis only supplies white (4000K) LED luminaires affect the ecosystem and exacerbates the effects of glare on animal and human vision so they are non-compliant to the PC-GOL. The brightness of most LED luminaires is set in the factory and cannot be dimmed without expensive control systems. To the best of our knowledge, only two LED luminaires can be dimmed in the field (CSbG Eco-Light and MPL) and it is available with amber LEDs.

> *5) We recommend that white LEDs not be used within WLNP.*

Glare from the luminaires on each end of the bridges reduce the visibility of pedestrians crossing the bridges. The spans of the bridges are short enough (about 20 meters) to allow the illumination with FCO fixtures.

6) If ROW luminaires are deemed necessary on the bridges, we recommend 50W HPS luminaires on 9-meter poles on each end of the bridges, which will illuminate the full span. We also recommend using reflective tape/paint along the railings.

Marina

The PC-GOL refers to shoreline lighting[9]. Light that penetrates into the water column should be avoided or at least minimized to reduce the impact of ALAN on plant growth and altering the vertical migration of aquatic species. Although shoreline luminaires should be set back from the shore by about 10 m, the marina lighting may be needed to illuminate the dock equipment and to facilitate its safe operation.

The Pole-Mounted fixtures at the Marina appear to be old with discoloured lens. This suggests they are due for refurbishment or replacement. Roadway traffic along Waterton Avenue and perhaps Mount View Road would benefit from FCO shielded lights (or better) in the Marina parking lots to prevent glare down the road. Illumination and glare from the existing 150W HPS is excessive for PC-GOL Parking Lot limit of about 3-lux. (See APPENDIX C - Light Output from Typical Bulbs for Comparison Purposes.)

7) We recommend the Marina luminaires (14) be replaced with 35W HPS, or amber LED luminaires on 6-meter poles. The location of these luminaires should be as to minimize the number that is necessary. Where practical, shoreline luminaires should be mounted close to the water's edge and aimed inland.

Cross-water glare is caused by luminaires close to the water's edge and light from unshielded luminaires inland that reflect and scatter off the surface. Therefore low intensity FCO luminaires should be used around the dock facilities when machinery is not in use. When machinery is needed, shielded and directed task lighting should be used, and only while work is being done. Once complete, the task lighting should be turned off. Alternatively, a curfew on the dock lighting should be invoked, perhaps by timers set for less than 2-hours after sunset.

8) We recommend low level lighting may be used if dock machinery is not used during the night, and the wharf is only used by personal boat traffic, otherwise the lighting should comply with the Park's "dark time" curfew.

Campground

The illumination is currently shared between building-mounted Wall Packs (17) and Pole-Mounted lights (12). These are not shielded. This lack of shielding and their high 70W HPS and 100-150W incandescent lamps produce glare across the site. Even though Waterton should have very little sky glow, it is likely campers will not be able to see many stars within direct view of these lights. This undermines their outdoor experience.

9) We recommend all Pole-Mounted luminaires in the Campground be removed and passive techniques adopted to help visitor navigation.

The entrance road to the Campgrounds will be a confluence of pedestrian and vehicle traffic.

[9] PC-GOL, Section 4.5

10) We recommend the Pole-Mounted luminaires at the roadway entrance to the Campgrounds be re-lamped with 35W HPS FCO (2).

Compound

Unshielded Wall Packs (44) predominate in the Compound. These create relatively small brightly illumination areas with considerable glare across the site. This area will benefit from using FCO Pole-Mounted luminaires to improve the uniformity of illumination and reduce the number of luminaires around the Compound.

The Compound is about 120 x 160m, however the main travelled area is within 20m of the central building. This allows the use of Pole-Mounted lights as shown in the accompanying figure. The light distribution pattern for these Pole-Mounted fixtures should be a Type III – typical of a streetlight, and oriented as shown in the figure.

The poles could be placed adjacent to the buildings to minimize interference with vehicle traffic. Using multiple poles will reduce the dark shadows that will result from using only one high luminaire. FCO WPs can be used on the shadowed walls that have access doors (estimate five WPs).

The 11-13 meter poles from Fortis and modern FCO 100W HPS luminaires with tenons (mounting arms) will place the nadir for the fixture away from the side of the building. This will take advantage of the backlight of typical streetlights to help illuminate the approach to the building and any stairs and doorways. The current WPs that illuminate these areas can be removed.

The Pole-Mounted fixtures will be above the line-of-sight so glare will be reduced for drivers. The FCO shielding will limit the amount of light that shines out of the Compound.

The 11-13 meter pole height exceeds the limit for a DSP, however it has been reported that the Compound sees 24-hour activity, which will repel foraging wildlife. The proposed luminaires generally point towards the centre of the Compound, which will limit the light off-site. Modern FCO luminaires can provide a relatively wide uniform illumination over an area of 3-4 x 2 times their mounting height.

11) We recommend the Campground Pole-Mounted FCO luminaires be moved to the Compound and installed on new 10-13 meter poles to reduce the need for Wall Packs currently mounted on the buildings.

Gate Kiosk

The roads by the Gate Kiosk may experience relatively high traffic densities and with people entering the kiosk buildings. Car headlights produce glare for the on-coming traffic, which reduces the visibility of pedestrians in the area. Therefore this is a relatively hazardous area.

The Fortis FCO HPS shoebox or cobra luminaires can be used to provide 6-lux average[10] illumination. This site may involve non-Parks Canada regulations, Fortis should advise on the necessary wattage.

12) We recommend replacing the current non-cut-off lighting with FCO 70W (to be confirmed by Fortis) HPS luminaires.

13) We recommend placing a 1-meter high light barrier between the two opposing lanes of traffic to reduce glare from on-coming traffic.

4.3 WALL PACKS

This section provides general recommendations for the 89 Wall Pack luminaires in WLNP. About half of these are used in the Compound, but these recommendations are valid for WPs used in other areas as well. The locations of the WPs were listed by-building in the Lighting Inventory, not by location on the map. Therefore we have inferred their general location.

All WLNP Wall Packs that we are aware of are not compliant to the PC-GOL because they produce considerable light trespass and glare, which significantly reduces night vision and the visitor wilderness experience in and around the Campground. The pedestrian-way illumination levels should not exceed about 1-lux to preserve the character of the night environment, whereas areas with late night vehicle activity may require about 3-lux.

The lighting in the Park and Upper Compound will impact wildlife in the surrounding areas.

Campground

There are seventeen 70W HPS Wall Packs mounted on buildings within the Campground. If WPs are used on buildings that will be closed in the late evening, they should be automatically turned off about 30-minutes after closing. HPS lamps require several minutes to warm up for proper operation, so they are not suitable for motion detection. White CFLs are not permitted.

The improved light distribution from modern WPs may allow fewer luminaires than are currently used. Depending on the distance between doorways on the buildings and the number of outside walls with doorways, a single modern WP may be sufficient. This may permit the removal of some current WPs. For example, if mounted under the eve of a building, an amber LED WP will illuminate the ground by the wall 12-meter long using 4 watts.

> *14) We recommend Wall Packs in the Campgrounds be replaced with amber LED FCO luminaires.*

Town Site

Private and commercial outdoor lighting can significantly impact visibility in the Town Site. Although we have not seen images of the streets at night, many houses probably have front door lights that are not shielded. This was the case in the Town Jasper and even Flagstaff AZ – a Dark Sky Community. It is important to limit sources of glare that compromise visibility. Otherwise, there will be pressure to

[10] Alberta Highway Lighting Guide 2003, Table E5.1 “Design Lighting Levels” for local rural roads with potential conflict areas.

increase lighting levels in an ever-escalating spiral and at great municipal cost. An information campaign may be needed to encourage home and business owners to shield their property lights.

Property lights in the Town Site should be shielded to be approximately FCO. Shielded and low wattage incandescent bulbs (20W) or 13W (lowest practical wattage) amber CFL bulbs may be used. White CFL bulbs should not be used. Amber LEDs fixtures are also suitable but cost more than light bulbs with the standard E26 orE27 lamp sockets.

> *15) We recommend the Town promote the use of shields on all residential and commercial lighting.*

Commercial signage can also produce considerable illumination along a street, especially if back-illuminated signs are used. This can be reduced if non-white signs are used.

15) We recommend that the Town encourage commercial establishments modify their back-lit signs to use contrasting colour rather than black and white and to turn off outdoor signage when business is closed.

Gate Kiosk

The illumination at the Gate Kiosk can be improved. “Wall washer” illumination over the door and its entrance would make drivers more aware that someone was leaving the building – allowing them to avoid the potentially dangerous situation of pedestrians near the traffic lanes.

Compound

The Compound is relatively compact. This provides an opportunity to use five Pole-Mounted luminaires to provide most of the area lighting within the Compound (see the previous section). If the installation of poles is not acceptable, then the current suite of WPs should be shielded or replaced as described below.

The Surveillance cameras on the **ERVE Building** will work better with uniform illumination from a source of light that is not close to the cameras. The off-axis lighting will let the illuminated surface (a person or vehicle) stand out in contrast against shaded areas – rather than “blending in” with the illuminated scene – especially if monochrome cameras are used. A single modern Amber FCO LED WP can illuminate an area of about 12 x 6 meters if mounted 4 meters above the ground. Therefore, one new WP may replace several existing fixtures.

16) We recommend that the Wall Packs be shielded or replaced with FCO Amber LED Wall Packs.

There are 23 WPs on the **Bunkhouses** in the Compound. Images of some of these lights indicate that they are probably low wattage incandescent or CFLs. Some are reported to be HPS luminaires. They are not designed to project the light onto the ground. Therefore only roughly 25% of the light provides useful illumination, the rest of the light shines out across the Compound providing a "marker-light" function. Since this is an area with moving vehicles, any reduction in visibility for the drivers is a cause for concern. The vehicle lights provide better visibility if there is no competing glare from building lights.

If illumination is needed away from the wall (referencing the two flood lights in the middle figure on the bottom of the previous page) then a FCO WP can be installed near the down-pipe to preclude the need for all the ground story fixtures shown in the image.

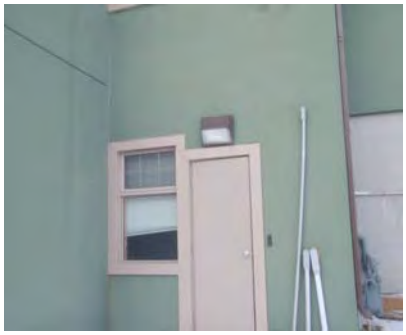
17) We recommend replacing ground story fixtures with amber FCO Wall Packs.

We presume the fixtures above the balcony illuminate the balcony surface. These can be replaced with shielded incandescent bulbs or linear lighting (reference CSbG MPL).

18) We recommend that the second story Wall Packs on the Bunkhouse Building be replaced with shielded amber LEDs or shielded incandescent bulbs to illuminate the balcony and wall perimeter for pedestrian traffic.

The **Operations Building** in the Compound has 7 HPS Wall Packs (70-150W). If not shielded, luminaires of this wattage can illuminate a vertical surface at a distance of several kilometres. (An unshielded 13W CFL can cast a shadow at 250m.) This will have both ecological impact and will limit the extent of on-site visibility over the immediate area.





Other WPs in the **Compound** are mounted just above head height and are listed as 70W HPS. These will bleach our night vision, which will require several minutes to recover. People walking by these lights probably turn their heads away to protect their eyes. Although this is a practical solution, it indicates the light is much too bright.

19) We recommend the eye-level Wall Packs on the Operations Building, and on other buildings be replaced with shielded amber LEDs or shielded incandescent bulbs to illuminate the porch and steps for pedestrian traffic.

20) Where practical, low intensity linear illumination should be used along exterior corridors (CSbG MPL) or shielded low wattage incandescent light bulbs.

The **Garage** has a 70W HPS Wall Pack and flood lights on the exterior walls.



21) We recommend the Wall Packs on the Garage Building be replaced with FCO amber LED Wall Packs to illuminate the area by the receiving doors and pedestrian doors. If mounted at the top of the wall (4-meters?), a S/CO amber LED Wall Pack will illuminate the entire area in front of the building (10 x 6 meters).

The **Garage Storage Building** has an unshielded light that will reduce the visibility of the adjacent gas tanks (propane?) at the side of the building. In this case the light from a FCO WP on an adjacent building, or a luminaire on a pole may be directed to this area. The walls or edges of the building can be painted white to increase their visibility at night.

22) We recommend the corners of the Garage Storage Building be painted with white vertical strips to make it more visible to vehicle traffic. A low intensity "wall washer" (CSbG MPL) may be mounted under the eve to highlight the face of the wall for drivers in the Compound.

Loading Bays in the Compound have unshielded Wall Packs. The Garage, Carpentry Entrance, Highway Storage Building, Operations Loading Dock, and possibly other buildings would benefit by replacing these lights with shielded "wall-washer" luminaires or FCO WPs if a larger area needs to be illuminated. This will improve driver vision and depth perception when they back up to the doors during the night.

In some situations, existing WPs may be replaced with shielded Pole-Mounted streetlights that are set away from the building wall and oriented towards the building. These should be installed about 2-times the mounting height from the wall to allow space for the passage of vehicles and to increase the illumination of the wall.

The height of the pole should be less than the height of the building roof. So, the building will act as a shield to reduce the light trespass beyond the immediate area. Therefore, this may be an opportunity to re-purpose existing 9-meter poles from the Campground.

This technique will require the installation of new footings for the pole and buried power to avoid aerial wiring that may become hooked by maintenance vehicles. The Park will benefit from the improvement in visibility and staff safety.

23) We recommend that the Wall Packs on the Loading Bays be replaced with FCO amber LED Wall Packs to illuminate the area by the receiving doors and pedestrian doors. If mounted at the top of the wall (6-meters?), a S/CO amber LED Wall Pack will illuminate the entire area in front of the building (15 x 9 meters).

The **Salt Shed** has at least two lights. These are listed in the Inventory as a 70W HPS Wall Packs. The glare from these unshielded lamps will affect visibility across the Compound.

The luminaire over the pedestrian door is serving as a marker light. It appears to be the same if not larger than the luminaire over the bay door (≥70W). Presumably it should illuminate the area in front of the door. From the limited height above a person entering the building, it may be bright enough to disrupt their vision in the dark for an extended period. Persons probably squint when passing the light, which undermines its usefulness.

24) We recommend replacing the current Wall Pack over the bay door with an amber FCO Wall Pack. A lower brightness shielded incandescent lamp (<20 watts) can be used above the pedestrian door.

Wall Packs that are mounted next to these loading bays are low wattage CFL lamps – presumably white in colour. These are non-compliant, but the white bulbs can be replaced with amber if the fixtures are shielded. If a larger area in front of the dock needs to be illuminated, a FCO amber LED Wall Pack may be used.

25) We recommend replacing the white CFL with a shielded amber bulb.

The **Sewage Lagoon** buildings are separate from the Compound and have five 70W HPS Wall Packs. Unshielded lighting in this area will extend the light-contaminated area further from the Compound. The light used around the sewage area should be all FCO or better. Doorways that are used at night may be illuminated by low brightness WPs. No area lighting should be used if it is visited infrequently at night.

26) We recommend the Wall Packs on the Sewage Lagoon Buildings be removed or replaced with FCO amber Wall Packs that are only turned on when necessary.

The **Stable** has a 70W HPS. Unless the stable is visited at night, there is no need for more than a faint marker light by the door.

27) We recommend the Wall Packs on the Stable be removed or replaced with FCO amber Wall Packs that are only turned on when necessary

Specific Problem Light

One light that looks over Waterton Avenue is a source of debilitating glare. If installed with the window horizontal to the ground, it would be considered a FCO luminaire, however since it is tilted; it "directs" the light into the eyes of approaching drivers and pedestrians. The optics of these types of lights are designed to project more light into the periphery that to nadir. Therefore a bright beam is being directed roughly horizontally and into the sky. This luminaire should be removed or properly oriented and the bulb replaced with a FCO 35W HPS – if it is still required.

28) We recommend the above Pole-Mounted luminaire be removed.

Action Priorities

The wattages of the WLNP Wall Packs are very high (high brightness). The main offenders are WP-1-4, WP-5-8, WP-10-14, WP-17 and WP-18. Only WP-5, WP-9, WP-15-16 and WP-19 seem to take low wattage bulbs. However all existing WPs should be shielded.

Replacing the WPs has a financial impact. There is a considerable range in price for Wall Packs - from around $70 to over $1500. Most non-LED fixtures are about $100-$150. LED fixtures cost about $200 and up but one well-designed WP can replace several cheep ones and will use much less electricity. The higher cost of LED fixtures must be weighed against the reduced maintenance cost. And, at least one LED WP can illuminate a large area without glare or light trespass[11].

There are three levels of action to reduce the impact of WPs and will also increase their effectiveness. We recommend the following order (with increasing level of cost).

1) Unnecessary Wall Packs should be removed.

2) To reduce the glare, WLNP Wall Packs should be shielded with wood or metal covers that extend below the lowest portion of the luminaire. The wattage of the lamps should be reduced to limit ground illumination levels to no more than 3-lux. Light bulbs should be replaced with incandescent bulbs, amber CFL bulbs. The 35W HPS lamps will be too bright for low-mounted Wall Packs.

3) Wall Packs should be replaced with amber FCO (or Sharp CO) light fixtures that are designed for wide uniform illumination. White light lamps must not be used.

[11] CSbG Eco-Light and MPL

4.4 SIGNAGE AND PASSIVE TECHNIQUES

Non-illuminated signage should be used as per the Parks Canada "*Exterior Signage: Standards and Guidelines, 2007*". The PC-GOL provides additional suggestions to improving navigation around Park facilities.

The Campgrounds have numerous water and power outlets for RVs and campers. They are currently painted dark green. This makes them very difficult to see at night – even with flashlights. These "hazards" should be painted white to reflect the natural starlight, and to make them more visible to pedestrians and motorists.

The Gate Kiosk can be made to be more visible to approaching cars with more extensive use of white or bright yellow paint on curb edges, bollards and building corners, railings and the edge of stairs.

The Bridge railings are currently painted to "blend in" with the surroundings. However this reduces their use to delineate the roadway. The railings should be painted white so they will stand out at night with car headlights. Only the inside (road side) of the top railings need be painted, so that when viewed from off-road it will not be distracting. Retro reflective paint or tape may also be applied to a sample number of vertical posts along the bridge.

Brightly painted steps, railings and doors are sufficient to allow very low wattage (<100mW) "task" lighting (CSbG MPL), which at a distance would also provide subtle navigation cues for visitors. Low wattage and shielded incandescent Christmas tree or amber LED lights can also be used as "wall washers" to help visitors identify the building at a distance without compromising their night vision. This power level can be compared to the 50-70+W HPS luminaires that are currently being used.

5.0 RECOMMENDED POLES AND LUMINAIRES

By using an integrated lighting plan the Park will benefit from considerably less power for outdoor lighting (perhaps down to ¼ of the current usage) with improved visibility in the Park. Controlling unnecessary late-night illumination can reduce this to perhaps 1/10.

Adopting a standard adjustable luminaire for most uses will avoid the current diverse inventory of light fixtures that cannot be re-purposed when needed.

Using mature HPS technologies and well-cooled LEDs, to provide long LED life, will reduce the need for maintenance.

Fortis Products

Fortis carries a number of compliant HPS luminaires and pole products, however this is not without qualification. These qualifications are mentioned below.

Poles

Fortis have 5 and 6-meter steel poles available that are compliant with the PC-GOL limit of 6-meters, which is approximate height of the tree canopies (“Structures” 1427, 1428, 1429, 1431, 1433,). Alternatively, wooden poles could be used. Other companies can provide poles with compliant heights (for example Pappi Lighting, Mississauga, ON [pappilighting.com]).

Luminaires

Only FCO HPS and amber LED luminaires can be used in a DSP. The lowest wattage HPS lamps that are listed by Fortis are 70W. These are marginally sufficient for the Compound and perhaps the Town Site. The Park should negotiate with Fortis to get 35W-50W HPS for the Town and Compound Sites. At the entrance to the campgrounds, low wattage (35W HPS or amber LED) FCO luminaires should be used to prevent light from shining and scattering into the camping area.

Fortis can provide two styles of roadway luminaires though their minimum power level is at the upper limit for a Park.

- HPS Cobra Head Flat Glass
- HPS Shoebox

Roadway light fixtures are available from most manufacturers with 50W and 35W HPS sockets.

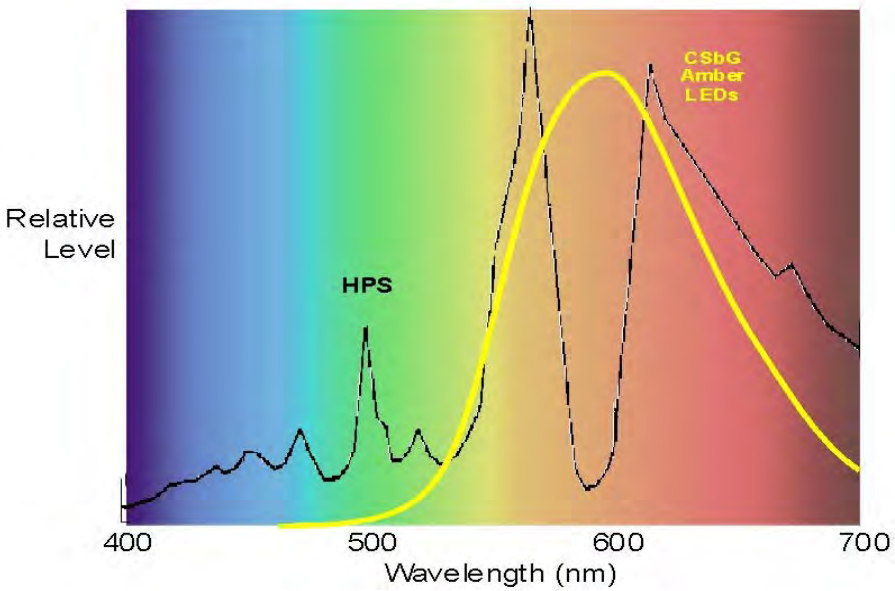
Other Recommended Luminaires

Most luminaires have been designed for urban lighting that have, arguably, high environmental impact. WLNP requires outdoor lighting with minimal impact on the environment. This requires specialized light fixtures that have been designed to provide “sufficient illumination” in a low brightness environment.

To the best of our knowledge only two luminaires by CSbG can satisfy the PC-GOL requirements.

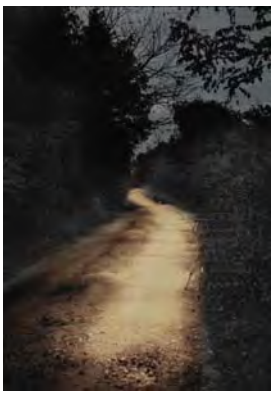
CSbG Inc Products:

CSbG products were specifically developed to comply with the PC-GOL and to address Park logistics. To the best of our knowledge there are no other fully PC-GOL compliant luminaires. All CSbG luminaires are available with amber LEDs. Their Sharp Cut-Off shielding significantly reduces light trespass and glare compared to the more common FCO fixtures or the emission from other LED fixtures. Their adjustable low-impact illumination levels require significantly lower power than typical HPS and LED light fixtures.



Although the amber colour looks similar to HPS lamps, it emits no blue light. The relatively smooth spectral curve, compared to HPS, results in a colour rendering index that is about twice as good as HPS.

The brightness of the CSbG luminaires can be adjusted over a range of 8:1 in the field at any time. Therefore they can be used as either Pole-Mounted fixtures or Wall Packs at heights from about 3 meters up to 14 meters. This reduces the number of different types of fixture in the Park inventory. Other luminaires must be replaced if the lighting situation changes.



On the left is the CSbG MPL that is designed to provide linear illumination, such as long a pathway. If mounted on the underside of a railing, it can provide a discrete path light, or it can illuminate a staircase or balcony. In all these applications the illumination is about 1-lux and the power used per fixture is about 100mW.

It can also be mounted as a low-illumination wall pack or for use as a “wall washer” to illuminate the ground and along a wall.

Attributes of all CSbG Luminaires:

Amber LEDs (no bio-active blue light),
"Sharp Cut-Off" shielding,
Uniform illumination across target area,
Field-adjustable light output to allow different mounting heights,
Low power consumption
Compatible with curfew, dusk-to-dawn and motion detector controls

Eco-Light (See Appendix E)

Can be mounted on pole or wall
110-277 vac (adjustable 4-25 watts, typ. 10W)
Illuminates 3+ x 1.5+ its mounting height
No backlight
LED emitters are not visible

Mounted Path-Light (MPL) (See Appendix F)

Can be mounted on a wall or railing
6vdc (0.5 watt max, typ. 0.1W)
Illuminates 5+ x 1.5+ times its mounting height
No backlight

6.0 LIMITIATIONS ON USE OF THIS REPORT

This report was prepared for the exclusive use of the Waterton Lakes National Park (The Client). The factual data, interpretations and recommendations pertain to the specific project as described in this report and are not applicable to any other project or site location. Any use of this document by a third party is expressly forbidden.

No assurance is made regarding the accuracy and completeness of these data. Robert Dick disclaims responsibility for consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

This document is based solely on data provided by Waterton Lakes National Park and a cursory review between September 30, 2014 and December 2, 2014 of existing luminaire products and Robert Dick's present understanding of the site conditions, information and data collected by others, and his judgment in light of such information at the time this document was written.

This document provides an opinion and, therefore, no warranty is either expressed, implied, or made as to the conclusions, advice and recommendations offered in this document. This document does not provide a legal opinion regarding compliance with applicable laws. Robert Dick will not be held responsible for the errors and omissions of work carried out by third parties.

The report, all plans, data, drawings and other documents prepared by Robert Dick are considered his professional work product and he shall retain its copyright. The Client and approved users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Robert Dick.

The findings and conclusions of the lighting assessment are valid only as of the date of the report, and are specific to the assumed land use for the Site. If the proposed land use for the Site changes, an updated assessment should be performed.

The services performed as described in this document were conducted in a manner consistent with the level of care and skill normally exercised by Robert Dick subject to the time limits and financial and physical constraints applicable to the service.

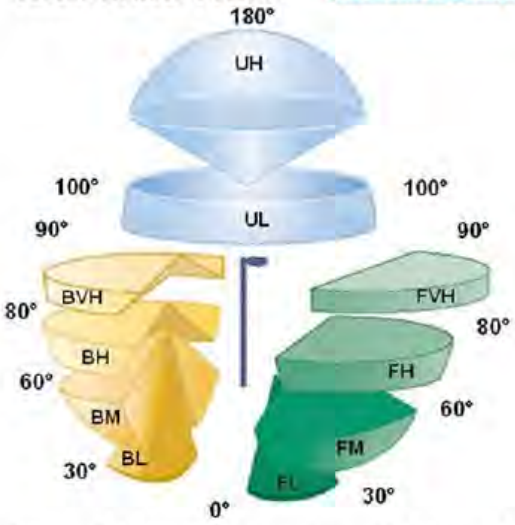
Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Robert Dick accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Site	Location/Street	Building/Pole	Number	Bulb	Comments
Townsite Campground	Section A	poles	10	Inc 100-150w	Inc=incadescent
Townsite Campground	Section A	building	3	HPS LU 70w	PT=Park Townsite
Townsite Campground	Section B	building	6	HPS LU 70w	PV=Park Visitor Centre
Townsite Campground	Section B	building	1	?	PC=Park Compound
Townsite Campground	Section B	pole	2	Inc 100-150w	PG=Park Gate
Townsite Campground	Section E	building	3	HPS LU 70w	FS=Fortis Streetlights
Townsite Campground	Section G	building	4	HPS LU 70w	
Townsite Marina	Marina	poles (8 lamps)	8	HPS LU 70 or 50w	
Townsite Marina	Parking	poles	6	HPS LU 150w	
Townsite	Waterton Ave	poles	11	HPS LU 150w	
Townsite	Waterton Ave; by camp kit.		3?	HPS LU 150w	
Townsite	Cameron Falls bridge	poles	2	HPS LU 150w	don't appear to be working
Townsite	Fortis Streetlights	poles	46	HPS 100w	
Park Compound	Res Con Building	building	2	HPS LU 150w	entrance light, main and basement entrance [from page 2]
Park Compound	Res Con Building	building	1	HPS LU 70w	small secuirity light, back entrance [from page 2]
Park Compound	Res Con Building	building	2	HPS LU 150w	Inc?, garage [from page 2]
	Res Con Building	building	2	?	front of building flood lamps; don't appear to be working
Park Compound	Operations Building	building	6	HPS LU 70w?	entrance light, restoration, carpentry, reception, back of ops, loading bay entrance
Park Compound	Operations Building	building	1	HPS LU 150w?	entrance light, IRV Entrance
Park Compound	Garage	building	1	?	small wall pack light, garage entrance
Park Compound	Garage	building	1	?	flood light, side of garage
Park Compound	Garage Storage	building	1	?	small wall pack light, entrance
Park Compound	bunkhouse	building	2	?	small wall pack light, walkway by laundry door & courtyard
Park Compound	bunkhouse	building	1	Inc	laundry door
Park Compound	bunkhouse	building	18	Inc	bunkhouse doors (18)
Park Compound	bunkhouse	building	2	?	flood lights, bunkhouse doors (2)
Park Compound	Salt Shed	building	2	?	security light, Entrance & Loading Bay (2)
Park Compound	Highways Storage Shed	building	2	Inc	loading area (2)
Upper Compound	Stables	building	1	HPS?	Entrance light small wall pack (1)
Upper Compound	Sewage lagoons	building	5	HPS?	Entrance light wall pack (5)
Upper Compound	Sewage lagoons	building	1	HPS?	Entrance light small wall pack (1)
Townsite	Administration Building	building	1	?	doorway, inc. (1)
Townsite	Cameron Creek Bridge	pole	2	?	box fixture (2)
Gate	Gate Kiosk	pole	4	?	double box fixtures (4)
Gate	Gate Kiosk	pole	1	?	box fixture (1); across from Randall's house
Gate	Gate Kiosk	building	6	?	inset fixtures (6); dark sky compliant
Gate	Gate Kiosk	building	2	?	caged drop down fixture? (1 or 2)
Townsite	Marina	pole	3	HPS LU 50 or 70	double box fixtures (3)
Townsite	Marina	pole	2	HPS LU 50 or 70	box fixture (2)
Townsite	Marina	pole	6	HPS LU 150	box fixture (6)
Townsite	Waterton Ave	pole	11	HPS LU 150	box fixture (11)

APPENDIX B – BUG Rating

Specifier Bulletin for Dark Sky Applications

VOLUME 2: ISSUE 1 : 2009 — International Dark-Sky Association



A Classification System for Lighting Zones

The BUG System—A New Way To Control Stray Light from Outdoor Luminaires

BUG STANDS FOR "**Backlight**", "**Uplight**" and "**Glare**." The acronym describes the types of stray light escaping from an outdoor lighting luminaire. "B" stands for backlight, or the light directed in back of the mounting pole. "U" stands for uplight, or the light directed above the horizontal plane of the luminaire, and "G" stands for glare, or the amount of light emitted from the luminaire at angles known to cause glare.

It is expected that BUG values will be published by luminaire manufacturers so lighting specifiers, designers or purchasers can tell at a glance how well a certain luminaire controls stray light or compares with other luminaires under consideration for an installation.

The BUG system was developed by the Illuminating Engineering Society (IES) to make comparing and evaluating outdoor luminaires fast, easy and more complete than older systems.

Work on the BUG system started in 2005 when the IES upgraded the roadway shielding classification system. The original system, which included the ratings full cutoff, cutoff, semi-cutoff and non cutoff, had been designed as a rating system solely for street lighting. However, increasing demand for control of glare and light trespass extended these terms to all types of outdoor lighting, and the IES realized that a more comprehensive system was needed.

The Lighting Research Center, acting as an IES contractor, developed a new classification concept that addresses light emitted from the luminaire in all directions, not just up into the sky. This system, released to the public as IES Technical Memorandum TM-15, technically replaced the old system. It divides the sphere around a luminaire into zones assigning values according to expected environmental impact. This rating system offers the most complete evaluation of the total light emitted from luminaires to date. A point to

The BUG System

For more information on FSA approved luminaires please visit the IDA Web site www.darksky.org.

remember, however, is that while the values assigned by the new system are good indicators, they may not in all cases directly correlate to light pollution. ***It still depends upon the site, the application and how the luminaire is installed.***

A fundamental component of the Model Lighting Ordinance (MLO), currently under public review, divides lighting requirements into lighting zones according to environmental impact. ***See Appendix A.*** The joint IDA/IES task force in charge of drafting the MLO reviewed TM-15 and realized that it could be modified to serve as a key measure of all forms of light pollution related to shielding and the direction of light, becoming an important tool to determine which luminaires are appropriate for each zone. Modifications were made, including subdividing the TM-15 uplight zone to better address artificial sky glow, and subdividing the upper downlight zone to better address glare. The IES accepted these adjustments and released TM-15-07 (revised). ***See Figure 1.***

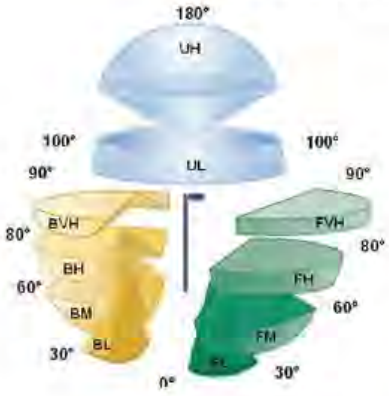


Figure 1: the revised outdoor luminaire distribution measuring system from TM-15-07 (revised)

After reviewing hundreds of candidate luminaires, the MLO task force established the three composite (BUG) ratings based on TM-15-07 (revised):

Backlight, which creates light trespass onto adjacent sites. The B rating takes into account the amount of ligwht in the BL, BM, BH and BVH zones, which are direction of the luminaire OPPOSITE from the area intended to be lighted.

Uplight, which causes artificial sky glow. Lower uplight (zone UL) causes the most sky glow and negatively affects professional and academic astronomy. Upper uplight (UH) is mostly energy waste. The U rating accounts the amount of light into the upper hemisphere with greater concern for the lower uplight angles in UL.

Glare, which can be annoying or visually disabling. The G rating takes into account the amount of frontlight in the FH and FVH zones as well as BH and BVH zones.

Appendix A:

Lighting Zone Definitions: The Lighting Zone shall define the limitations for outdoor lighting as specified in this ordinance. The policymaking body is able to designate areas according to the following descriptions, thereby creating a custom lighting plan according to local needs, functions, and geography.

LZ0: No ambient lighting 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. Little or no lighting is expected. When not needed, lighting should be extinguished.

LZ1: Low ambient lighting 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, security and/or convenience but it is not necessarily uniform or continuous. After curfew, most lighting should be extinguished or reduced as activity levels decline.

LZ2: Moderate ambient lighting 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, security and/or convenience but it is not necessarily uniform or continuous. After curfew, lighting may be extinguished or reduced as activity levels decline.

LZ3: Moderately high ambient lighting 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 curfew, lighting may be extinguished or reduced in most areas as activity levels decline.

LZ4: High ambient lighting Areas of human activity where the vision of human residents and users is adapted to high light levels. Lighting is generally considered necessary for safety, security and/or convenience and it is mostly uniform and/or continuous. After curfew, lighting may be extinguished or reduced in some areas as activity levels decline.

Figure 1: the revised (or BUG) outdoor luminaire distribution measuring system from TM-15-07 (revised)

The resulting rating system, called BUG for obvious reasons, is a comprehensive system that takes into account uplight shielding, glare shielding and backlight shielding as well as limiting lamp lumens to values appropriate for the lighting zone. BUG is a simple system consisting of a a table of consensus acceptable values against which any luminaire having photometric data can be judged. A luminaire's numerical rating is the LOWEST light zone number in which it can be used. BUG will be part of the latest IES outdoor lighting system update.

The BUG rating system is a principal component of the Model Lighting Ordinance (MLO). The MLO is also a simple system that considers BUG ratings in the context of total lumens allowed per site. which the total site lumens are restricted. Use of the BUG system as the measuring tool for the MLO creates a straightforward system of controlling light pollution that can be implemented by persons having minimal experience or education in outdoor lighting design.

BUG FAQs

Are BUG luminaire ratings better than using the old full cut off, semi cut off, non cut off, etc. designations for shielding?

Yes, because BUG ratings provide backlight and glare information as well as how well the luminaire controls uplight. These additional measurements provide a much more accurate picture of lumen distribution and the overall efficiency of a luminaire.

Does BUG allow any uplight?

BUG requires downlight only with low glare (better than full cut off) in lighting zones 0, 1 and 2, but allows a minor amount of uplight in lighting zones 3 and 4. In lighting zones 3 and 4, the amount of allowed uplight is enough to permit the use of very well shielded luminaires that have a decorative drop lens or chimney so that dark sky friendly lighting can be installed where in places that traditional-appearing fixtures are required.

Will all outdoor lighting manufacturers rate their luminaires according to BUG?

Not at first. Since BUG is designed to prevent bad lighting practices, a lot of current outdoor products won't pass BUG, so there will be no point in rating them. But it is expected that manufacturers will rate their "good" luminaires and make changes to current products to improve BUG ratings.

Will BUG apply to residential lighting?

No. BUG can't be used for residential luminaires because they generally are not photometrically tested. The IDA Fixture Seal of Approval Program can be used to rate residential outdoor luminaires.

Is BUG as strict as the toughest anti-light pollution ordinances in effect today?

BUG, by itself, is a luminaire rating tool. It can easily be applied more stringently by using the zonal factors in response to community choices of lighting zones. While lighting zone dererminents are clearly outlined in the MLO, the community decides upon zone placement. If a community adopts the MLO and chooses all lighting zones LZ0 and LZ1, the MLO with BUG is actually more restrictive than any of the toughest ordinances. However, zone assignment will always remain at the discretion of the community.

Addendum A for IES TM-15-07: Backlight, Uplight, and Glare (BUG) Ratings

Text, charts, and photograph from IES TM-15-07:
http://www.ies.org/PDF/Errata/TM-15-07BUGRatingAddendum.pdf

The following **Backlight**, **Uplight**, and **Glare** ratings may be used to evaluate luminaire optical performance related to light trespass, sky glow, and high angle brightness control. These ratings are based on a zonal lumen calculations for secondary solid angles defined in TM-15-07. The zonal lumen thresholds listed in the following three tables are based on data from photometric testing procedures approved by the Illuminating Engineering Society for outdoor luminaries (LM-31 or LM-35).

Notes to Tables ***A-1***, ***A-2***, and ***A-3***:

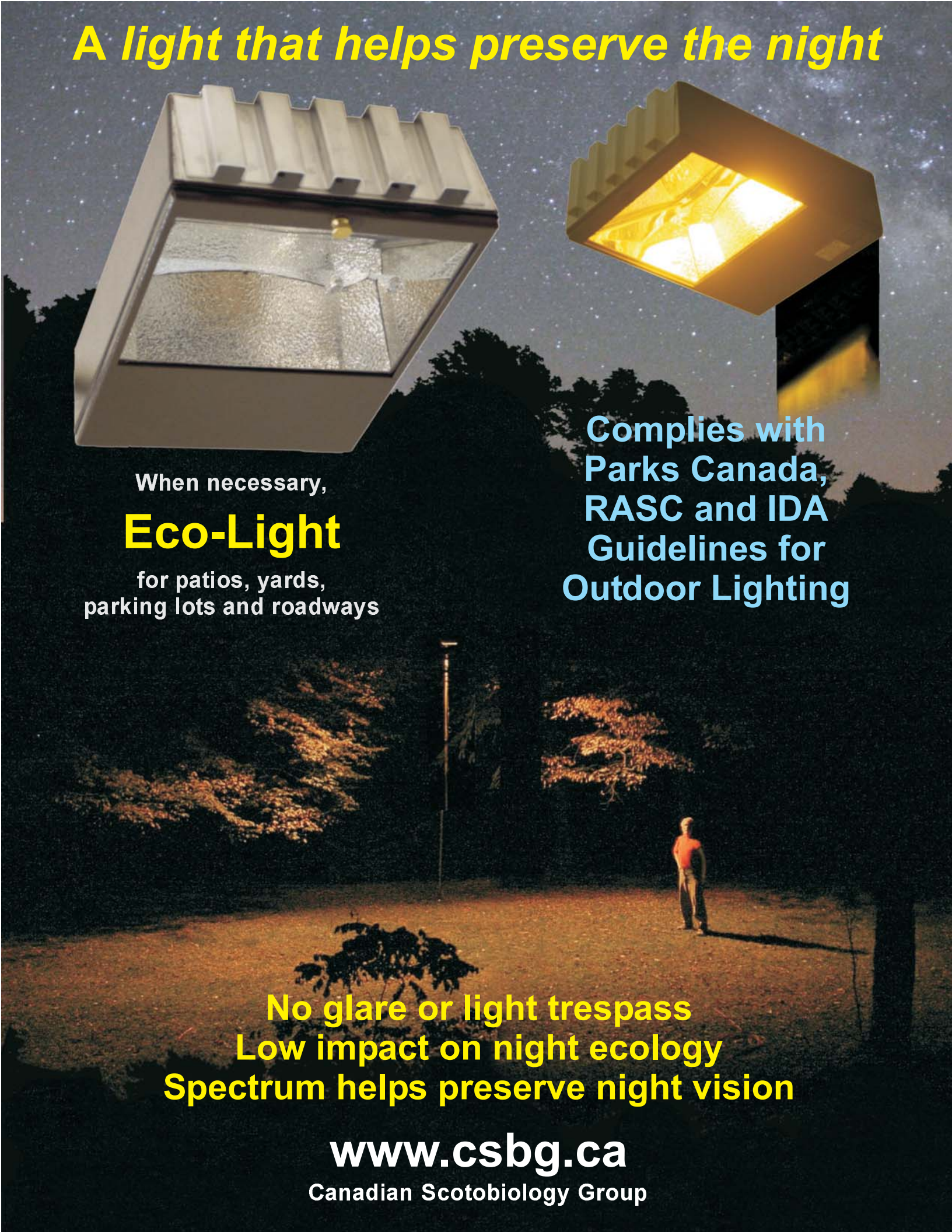
1. Any one rating is determined by the maximum rating obtained for that table. For example, if the BH zone is rated B1, the BM zone is rated B2, and the BL zone is rated B1, then the backlight rating for the luminaire is B2.
2. To determine BUG ratings, the photometric test data must include data in the upper hemisphere unless no light is emitted above 90 degrees vertical (for example, if the luminaire has a flat lens and opaque sides), per the IES Testing Procedures Committee recommendations.
3. It is recommended that the photometric test density include values at least every 2.5 degrees vertically. If a photometric test does not include data points every 2.5 degrees vertically, the BUG ratings shall be determined based on appropriate interpolation.
4. A "quadrilateral symmetric" luminaire shall meet one of the following definitions:
    a. Type V luminaire is one with a distribution that has circular symmetry, defined by the IES as being essentially the same at all lateral angles around the luminaire.
    b. Type VS luminaire is one where the zonal lumens for each of the eight horizontal octants (0-45, 45-90, 90-135, 135-180, 180-225, 225-270, 270-315, 315-315-360) are within ±10 percent of the average zonal lumens of all octants.

APPENDIX C – Light Output from Typical Bulbs for Comparison Purposes (From DSP-GOL)

Bulb Types	Lumens†	Lux†† at 6 m	Lux†† at 2 m	Lux†† at 1 m
Incandescent*				
7 watt	60	0.13	1.2	4.8
15 watt	128	0.28	2.6	10.2
40 watt	342	0.8	6.8	27.2
60 watt	513	1.1	10.2	40.8
100 watt	855	1.9	17.0	68.0
Metal Halide (MH)				
70 watt	3,000	6.6	59.7	238.7
100 watt	5,800	12.8	115.4	461.6
High Pressure Sodium (HPS)				
35 watts	2025	4.5	40.3	161.1
50 watts	3600	8.0	71.6	286.5
70 watts	5450	12.1	108.4	433.7
100 watts	8550	18.9	170.1	680.4
Low Pressure Sodium (LPS)				
18 watts	1570	3.5	31.2	124.9
35 watts	4000	8.8	79.6	318.3
55 watts	6655	14.7	132.4	529.6
Compact Florescent (CF)				
9 watt (40 w equivalent)	550	1.2	10.9	43.8
13 watt (60 w equivalent)	850	1.9	17.9	71.6
LED**				
1 watt (White) ***	100	2.8	25	100
1 watt (amber) ***	75	2.	19	75
3 watt amber A19	90	0.5	4.0	12
3 watt amber PAR16	90	1.8	16	50
7 watt amber PAR30	200	5.5	50	200
13 watt amber PAR38	400	11	100	400

Site	Location/Street	Building/Pole	Number	Fixture	Bulb	Replace Fixture with or Remove		Comments
Townsite Campground	Section A	poles	10	Non CO	Inc 100-150w	**Remove**	-	
Townsite Campground	Section A	building	3	Non CO	HPS LU 70w	**FCO**	**Amber LED**	
Townsite Campground	Section B	building	6	Non CO	HPS LU 70w	**FCO**	**Amber LED**	
Townsite Campground	Section B	building	1	FCO	?	**FCO**	**Amber LED**	
Townsite Campground	Section B	pole	2	Non CO	Inc 100-150w	**FCO**	**35W HPS/Am LED**	***Campground Entrance Marker Lights?***
Townsite Campground	Section E	building	3	Non CO	HPS LU 70w	**FCO**	**Amber LED**	
Townsite Campground	Section G	building	4	Non CO	HPS LU 70w	**FCO**	**Amber LED**	
Townsite Marina	Marina	poles (8 lamps)	8	Non CO	HPS LU 70 or 50w	**FCO**	**35W HPS/Am LED**	
Townsite Marina	Parking	poles	6	Non CO	HPS LU 150w	**FCO**	**50W HPS/Am LED**	
Townsite	Waterton Ave	poles	11	Non CO	HPS LU 150w	**FCO**	**50W HPS/Am LED**	
Townsite	Waterton Ave; by camp kit.		3?	Non CO	HPS LU 150w	**FCO**	**50W HPS/Am LED**	
Townsite	Cameron Falls bridge	poles	2	Non CO	HPS LU 150w	**FCO**	**50W HPS/Am LED**	don't appear to be working
Townsite	Fortis Streetlights	poles	46	Non CO	HPS 100w	**FCO**	**50W HPS/Am LED**	50W HPS may be accpetable if 8 m poles are not too high
Park Compound	Res Con Building	building	2	Non CO	HPS LU 70w?	**FCO**	**Amber LED**	entrance light, main and basement entrance
Park Compound	Res Con Building	building	1	Non CO	HPS LU 70w	**FCO**	**Amber LED**	small secuirity light, back entrance
Park Compound	Res Con Building	building	2	Non CO	HPS LU 150w	**FCO**	**Amber LED**	Inc?, garage
Park Compound	Res Con Building	building	2	Non CO	?	**FCO**	**Amber LED**	front of building flood lamps; don't appear to be working
Park Compound	Operations Building	building	6	Non CO	HPS LU 70w?	**FCO**	**Amber LED**	entrance light, restoration, carpentry, reception, back of ops, loading bay entrance
Park Compound	Operations Building	building	1	Non CO	HPS LU 150w?	**FCO**	**Amber LED**	entrance light, IRV Entrance
Park Compound	Garage	building	1	Non CO	?	**FCO**	**Amber LED**	small wall pack light, garage entrance
Park Compound	Garage	building	1	Non CO	?	**FCO**	**Amber LED**	flood light, side of garage
Park Compound	Garage Storage	building	1	Non CO	?	**FCO**	**Amber LED**	small wall pack light, entrance
Park Compound	bunkhouse	building	2	Non CO	?	**FCO**	**Amber LED**	small wall pack light, walkway by laundry door & courtyard
Park Compound	bunkhouse	building	1	Non CO	Inc	**FCO**	**Amber LED**	laundry door
Park Compound	bunkhouse	building	18	Non CO	Inc	**FCO**	**Amber LED**	bunkhouse doors (18)
Park Compound	bunkhouse	building	2	Non CO	?	**FCO**	**Amber LED**	flood lights, bunkhouse doors (2)
Park Compound	Salt Shed	building	2	Non CO	?	**FCO**	**Amber LED**	security light, Entrance & Loading Bay (2)
Park Compound	Highways Storage Shed	building	2	Non CO	Inc	**FCO**	**Amber LED**	loading area (2)
Upper Compound	Stables	building	1	Non CO	HPS?	**Remove**	**or FCO Amber LED**	HPS? Entrance light small wall pack (1)
Upper Compound	Sewage lagoons	building	5	Non CO	HPS?	**Remove**	-	Entrance light wall pack (5)
Upper Compound	Sewage lagoons	building	1	Non CO	HPS?	**Remove**	**or FCO Amber LED**	Entrance light small wall pack (1)
Townsite	Administration Building	building	1	Non CO	?	**FCO**	**Amber LED**	doorway, inc. (1)
Townsite	Cameron Creek Bridge	pole	2	Non CO	?	**FCO**	**50W HPS/Am LED**	box fixture (2)
Gate	Gate Kiosk	pole	4	Non CO	?	**FCO**	**70W HPS**	**Subject to Hwy Requirements** double box fixtures (4)
Gate	Gate Kiosk	pole	1	Non CO	?	**FCO**	**70W HPS**	**Subject to Hwy Requirements** box fixture (1); across from Randall's house
Gate	Gate Kiosk	building	6	Non CO	?	**FCO**	**Amber LED**	inset fixtures (6); dark sky compliant
Gate	Gate Kiosk	building	2	Non CO	?	**FCO**	**Amber LED**	caged drop down fixture? (1 or 2)
Townsite	Marina	pole	3	Non CO	HPS LU 50 or 70	**FCO**	**50W HPS/Am LED**	double box fixtures (3)
Townsite	Marina	pole	2	Non CO	HPS LU 50 or 70	**FCO**	**35W HPS/Am LED**	box fixture (2)
Townsite	Marina	pole	6	Non CO	HPS LU 150	**FCO**	**35W HPS/Am LED**	box fixture (6)
Townsite	Waterton Ave	pole	11	Non CO	HPS LU 150	**FCO**	**50W HPS/Am LED**	box fixture (11)
						Amber LED	**Set brightness level at installation**	

A *light that helps preserve the night*



When necessary,

Eco-Light

for patios, yards,
parking lots and roadways

Complies with Parks Canada, RASC and IDA Guidelines for Outdoor Lighting

No glare or light trespass
Low impact on night ecology
Spectrum helps preserve night vision

www.csbg.ca

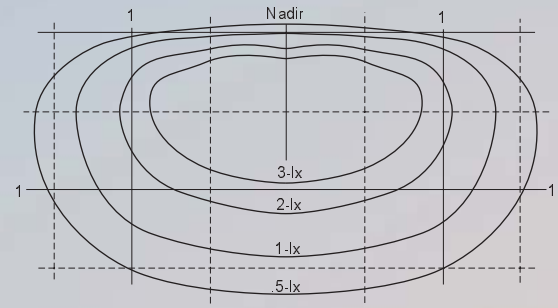
Canadian Scotobiology Group

Eco-Light

Illumination (DSP Compliant)

- Exceeds Full Cut-off shielding
  (Sharp Cut-off) <1% in “glare Zone”)
- BUG Ratings - 0, 0,
- Minimal Backlight

- Baffled LEDs for safe viewing
- Colour - amber (>500 nm)
- 12 field-settable brightness levels
- Uniformity over target area



IES File: www.csbg.ca/images/IES-H875C.ies

FOR
Wall mount, pole mount,
parking lot and roadway,
off-grid security light,
patio and garage lighting.

- Wall Mount (building entrance)
Typical Mounting height: 2.3-meters
Illuminated area: about 7 x 3 meters

- Pole Mount (pathway lighting)
Typical Mounting height: 5-meters
Illuminated area: about 15 x 8 meters

- Pole Mount (parking lot and roadway)
Typical Mounting height: 8-meters
Illuminated area: about 25 x 12 meters

CSbG's “amber” spectrum avoids biologically sensitive range. It optimizes illumination for photopic (cone cell) visibility while helping to preserve night vision.

The “blue peak” of white LEDs exhibit a poor fit to daytime vision, while adversely affecting our night vision and health.

Canadian Scotobiology Group
P.O. Box 79, Rideau Ferry, ON, K0G 1W0

1-800-278-2032 1-613-283-7815
rdick@csbg.ca

Electrical

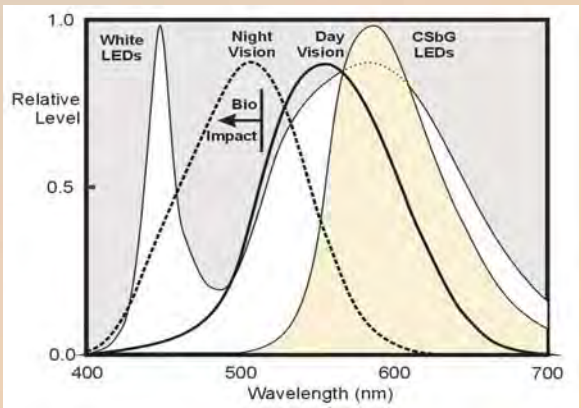
- 110/220/277 vac
- 4-25W (10-watts typical)
- Brightness is field-adjustable

Mechanical

- Cool LEDs for long life
- Powder coat aluminium
- 10x8x3 inches (25x20x8 cm)
- Versatile mounting
- 3.2 lbs (1.5 kg)

ESAFE SPE-1000-13
U.S. Patent Application No. 14/086,129

4W, 1-Lux, 4.3m Mounting Height



Rationale for Specifications:
www.csbg.ca/Specs.pdf
www.csbg.ca/Poster.pdf

Canadian Scotobiology Group Inc.
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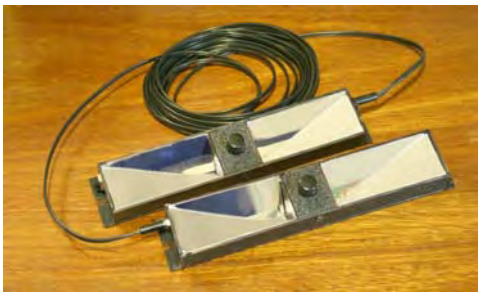
Mounted "Path-Light"
ECO-FRIENDLY



A Light that helps Preserve the Night

Power Requirements
- 6Volts DC, 100 mA max per unit (20mA typical)

WHY NOT OTHER LIGHT FIXTURES?

White Light
- Undermines our natural night vision
- Disrupts the biology of plants and animals
- Exacerbates impacts of glare and light trespass

Poor Shielding
- Causes glare for approaching pedestrians
- Glare for over hundreds of meters
- Poorly defined target area
- Sprays light where it is not needed
- Light trespass impacts plants and animals

"Hot Spot" Illumination
- Ruins night vision
- Limits visibility to only centre of beam
- Prevents visibility into periphery
- Small illuminated area for a given power

OUR MOUNTED PATH-LIGHT

Colour
- Amber colour to help preserve night vision
- No blue-light components that affect our circadian rhythm and undermines health

Shielding
- No glare for pedestrians
- Light only where it is needed
- Illumination limited to path width

Illumination
- Uniform illumination 5 mounting heights with no "Hot Spot"
- Adjustable brightness (30:1) for various uses
- Low illumination for wilderness applications

Flexible mounting for *Pathways, Laneways, stairways*

Fasten under hand-railing or on bollards
"Daisy-chain" for long runs
Mount under building eves
to highlight walkway, garden or lawn

Mounted Path-Light
(Adjustable brightness to suite application)