A Preliminary Report to the Community Preservation Advisory Committee
on the
Report to the Business, Research, and Economic Development Committee of the 124th Session of the Maine Legislature
in response to
LD 11 Resolve, To Encourage the Preservation of Dark Skies

Image 1 North America at Night, courtesy NASA/GSFC/Craig Mayhew and Robert Simon
Note the darkness in the northeast, in the shape of Maine

LD 11, signed by the Governor on May 4, 2009, requires the State Planning Office (SPO) to "…make recommendations on standard language that will limit light pollution…" and "…identify policy options for promoting outdoor lighting standards for commercial development." The first task was completed when SPO issued the Technical Assistance Bulletin: Lighting Manual - Promoting Quality Outdoor Lighting in Your Community, which includes a model lighting ordinance for local municipal adoption. This report attempts to address the second task of LD 11.

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Appendix

NOTE: *In performing research for this report, State Planning Office staff interviewed local Code Enforcement Officers, Planning Board members, lighting engineers, lighting designers, amateur astronomers, and other interested parties.*

NOTE: *A "shielded" light fixture is a general term describing lights with coverings on the top to prevent direct upward lighting. A "full-cutoff" or "cutoff" light fixture is a technical term with a very specific definition. Graphic 3 in this report, on page 9, demonstrates that technical definition.*

Background

Four decades ago, the Environmental Movement reintroduced many Americans to their natural surroundings. While in most states, this appreciation led to vocal debates on the best methods for "cleaning up" the environment, here in Maine the question for many residents was how to preserve and maintain the existing "unspoiled" splendor. Many residents in Maine pushed for state legislation, leading to, among other things, the Shoreland Zoning Act (1971).

For some reason, neither in the national Environmental Movement as a whole, nor in the heightened environmental ethic adopted in Maine, was the night sky ever considered part of the "environment." Few people valued the darkness of the night sky as a resource worth preserving equivalent to the clarity of lake waters.

This "oversight" of the star-filled night sky as an environmental resource was first addressed by a group of astronomers in the southwest United States in 1988. These astronomers formed the International Dark Sky Association, and their educational and outreach efforts, along with thousands of other Americans who have argued for the preservation of a dark night sky, have eventually led to thirteen states adopting some form of outdoor lighting regulations. Maine was the second state to do so, in 1991 (Title 5 M.R.S.A. section 1769).

Now, the federal government is also linking "natural resources" with "dark nights." According to a 2009 internal white paper on outdoor lighting in National Parks, the National Park Service concluded "that unintended consequences of the proliferation of outdoor lights have degraded the quality of these national treasures." The National Park Service is currently working on Servicewide Outdoor Lighting Guidelines that will greatly reduce the light pollution degrading many visitors' experiences.

Acadia National Park officials state that Acadia National Park is the only national park on the east coast from which one can view the Milky Way with the naked eye. To preserve this rare resource, in 2008 Acadia launched the "Night Sky Initiative" in partnership with the Island Astronomy Institute and Friends of Acadia to measure, promote, and protect the quality of the night sky above Acadia National Park and surrounding communities. This partnership has developed two model ordinances, one simple and one basic (with a more advanced model in the works for sophisticated towns). The partnership was also recently awarded a $27,000 grant from the Quimby Family Foundation to 1) acquire sophisticated light pollution measurement technology, 2) host a Night Sky Festival to promote community stewardship of dark nights, 3) continue monitoring of light pollution in and around the Park, and 4) establish night sky quality as an indicator of Maine's unique quality of place.

Problem

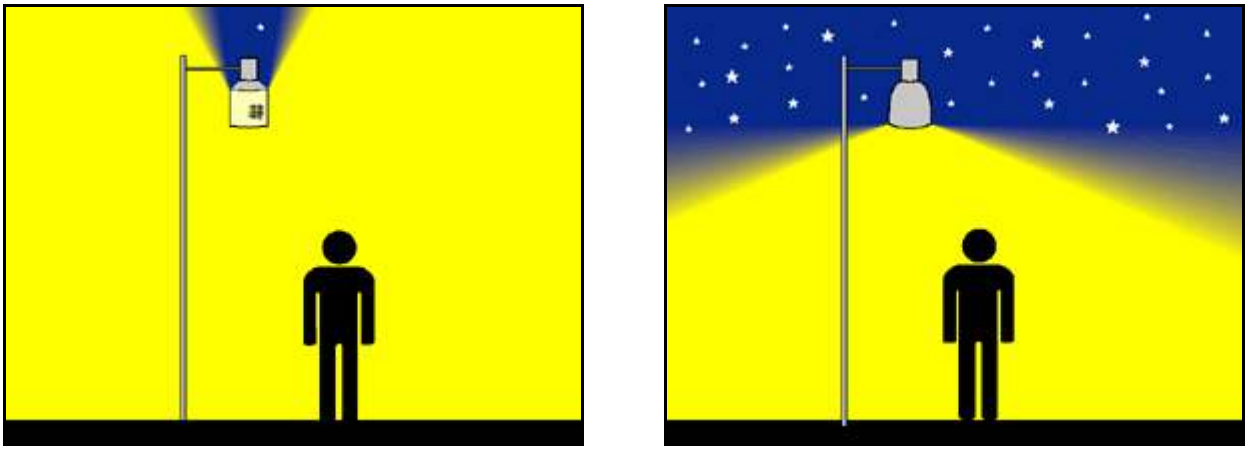
Light pollution, like all kinds of pollution, is an unintended consequence of scientific progress. While humans live on the ground, and therefore artificial lighting need only illuminate the ground, we have nonetheless lit up the night sky. Light pollution is artificial light unnecessarily spread outward and upward.

Biologically, our circadian rhythms, a fundamental aspect of who we are as humans, tell us to sleep when it is dark at night. Similarly, nocturnal animals are called to action when it is dark at night. What happens when it isn't dark…ever?

We are well aware that our insatiable appetite for energy causes both environmental degradation and national security issues. Why then do we waste so much energy lighting up the night sky?

Components of Light Pollution

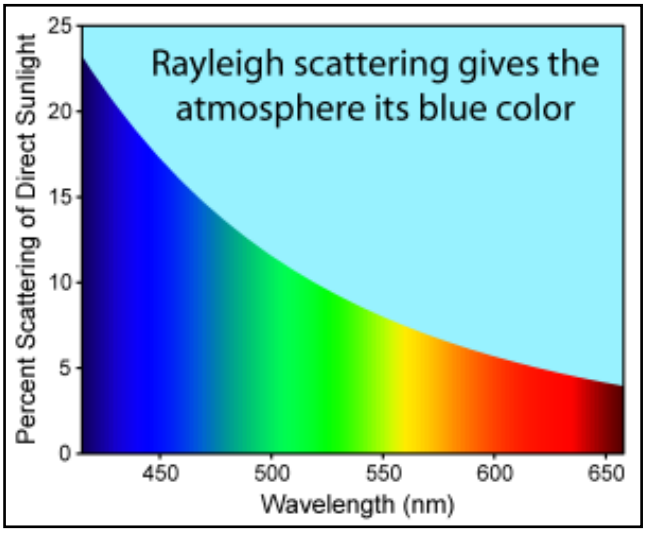
A. Upward Lighting



Graphic 1 Unshielded vs. Shielded Lighting, courtesy McDonald Observatory, U. of Texas

Most light pollution streams outward and upward from unshielded lights. However, a significant portion also reaches skyward through reflection in the air (water molecules and dust), on the ground (especially when there is snow on the ground), and even windows, building façades, and other human constructs.

B. Color



Graphic 2, courtesy Robert A. Rohde

Other than shielding the light fixtures themselves, the most important issue is light color. During daylight, the natural sky is blue. The sky is blue because of the way our atmosphere interacts with light, and at a basic level, blue light is "scattered" through the atmosphere more than other visible light. Earth's atmosphere at night is the same as during the day, there is just no sunlight to interact with that atmosphere. Artificial light containing blue wavelengths will be "scattered" by the atmosphere more than artificial light containing yellow wavelengths, and therefore blue light causes more light pollution.

There are many options in creating artificial light. Traditional incandescent, halogen, fluorescent, metal halide, and high pressure sodium are the most common. Each of these types of artificial light produces different colors, and therefore causes different levels of light pollution. White lights, which happen to be the most popular, contain the entire visible spectrum, and cause more light pollution than a lamp emitting mostly yellow light.

Regulations

I. Other States

Twelve states besides Maine have adopted some level of outdoor lighting regulations. California has the most complex, although their regulations are part of the statewide effort to reduce energy use, rather than a stand-alone light pollution policy. Many states allow exemptions for aesthetic lighting. Within New England, both Connecticut and New Hampshire require public utility companies to install full-cutoff lighting if that lighting is both greater than 1,800 lumens and paid for by local municipalities (which is often the case when the road is locally-maintained).

Appended to this Report is a spreadsheet containing all the states with outdoor lighting regulations, along with a general description of the characteristics of those regulations.

II. Maine State

Like most states with outdoor lighting regulations, Maine's legislation only covers state-funded lighting. Not having a blanket statewide regulation covering all development allows agencies within the state to develop their own regulations, and municipalities to adopt their own ordinances. As the preservation of the night sky movement has grown stronger, more conflicting state agency standards and local ordinances are popping up, each trying to regulate private development in their own way.

The chart below lists those Maine state agencies regulating outdoor lighting. The Department of Environmental Protection (DEP) is currently undergoing rulemaking on updating the Site Law regulations, and part of that update is adoption of standards regulating outdoor lighting; which would then apply to all development undergoing Site Law review. The DEP is proposing standards similar to those used by LURC.

Agency	Type of Development Regulated	Must Be	Year Rule Adopted
Transportation	State-funded outdoor lighting greater than 1,800 lumens	Full-cutoff	1991
LURC	Residential, commercial, and industrial outdoor lighting over 160 watts (incandescent) or 60 watts (other)	Full-cutoff	2004
Housing	All outdoor lighting on projects using MSHA funds	Follow International Engineering Society of North America (IESNA) standards	2005
Education	All outdoor lighting on projects using DOE funds	Follow U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) standards	not formally adopted

The Land Use Regulation Commission, or LURC, is the only state agency currently regulating outdoor lighting on privately-funded commercial development. LURC planners state that there was an initial learning curve for developers, but that seems to have worked itself out. The real

problem is that there is very little enforcement of the regulations. LURC's budget for compliance checking is severely limited, so it is very difficult to know whether the actual brick and mortar structure fits the paper plan.

III. Maine Municipal

Similar to state agencies, the problem at the municipal level is not the sheer number of towns with outdoor lighting standards, rather it is the fact that so few are alike. The towns around Acadia National Park have adopted ordinances based upon the models developed through the Night Sky Initiative. However, other municipalities in Maine have adopted their own standards according to their own local desires.

The chart below identifies "rating used." This is an indication of what rating system the municipality uses to determine whether a light should be shielded. For example, Rockland's standard is that any light producing over 1,800 lumens must be full-cutoff. Brunswick's standard is that any light using over 200 watts must be "a cutoff luminaire." A 100 watt incandescent light bulb produces approximately 1,800 lumens. While a commercial development with 1,900 lumens lights would be regulated in Rockland, that same development in Brunswick would not be regulated.

Municipality	Type of Development Regulated	Engineered Lighting Plan Required	Rating Used
Kittery	Multifamily, Non-residential	Yes	Combination
Kennebunk	All	sometimes	Combination
Arundel	All	Sometimes	Combination
Saco	Multifamily, Non-residential	Yes	Combination
Scarborough	Multifamily, Non-residential	Yes	Combination
Portland	All	Sometimes	Combination
Freeport	Multifamily, Non-residential	Yes	Combination
Brunswick	Non-residential	Yes	Watts
Topsham	Non-residential	Yes	Combination
Augusta	Non-residential	Yes	Combination
Rockland	All	No	Lumens
Tremont	All	No	Lumens
Mount Desert	All	No	Lumens
Bar Harbor	All (over 1,800 lumens)	Sometimes	Lumens
Bangor	Non-residential	No	Design

To further complicate matters, a footcandle is the true measure of light. By definition, a "footcandle" is a measure of light falling on a given surface; one footcandle is equal to one

lumen per square foot. But to measure a footcandle one needs a light meter; whereas, lumens and watts are printed right on the package of the light bulb. A lumen is the amount of light energy generated, and a watt is the amount of electrical power required to produce the light energy. An engineered lighting plan typically identifies approximately how many footcandles will be produced on the ground throughout an entire site plan.

A "combination" rating system usually means a more complex program, for example Kittery requires certain uniformity ratios of illuminance levels across parking lots (with maximum footcandles in specific places), requires cutoff lighting for different lumen amounts based upon what type of development, and also has different criteria for period or historical lighting.

IV. Utilities

The Central Maine Power Company (CMP) recently adopted an organizational policy on outdoor street lights. CMP will only install full-cutoff fixtures whenever a light needs to be replaced, or whenever a stretch of road requires a new light. According to a company spokesperson, this policy is a direct reaction to concerns of light pollution. Most Maine municipalities prefer to use a 100 watt street light. Understanding that conditions are different in each town, use is different in each town, and other variables, the company spokesperson nonetheless stated that, on average, a full-cutoff 100 watt street light now costs municipalities approximately $11 per month, whereas they were paying $10 a month with the non-cutoff light.

CMP is the only utility company in Maine with an internal policy to use shielded outdoor lights.

Cost

Cost is a major concern when discussing regulation of commercial development. The most important cost concern is the time it takes to get through the application process. If there is a Design Review Board in addition to the Planning Board, that adds to the cost. If there is state DEP review in addition to the Planning Board, that adds to the cost. If the Planning Board has additional items to "check off," that adds to the cost.

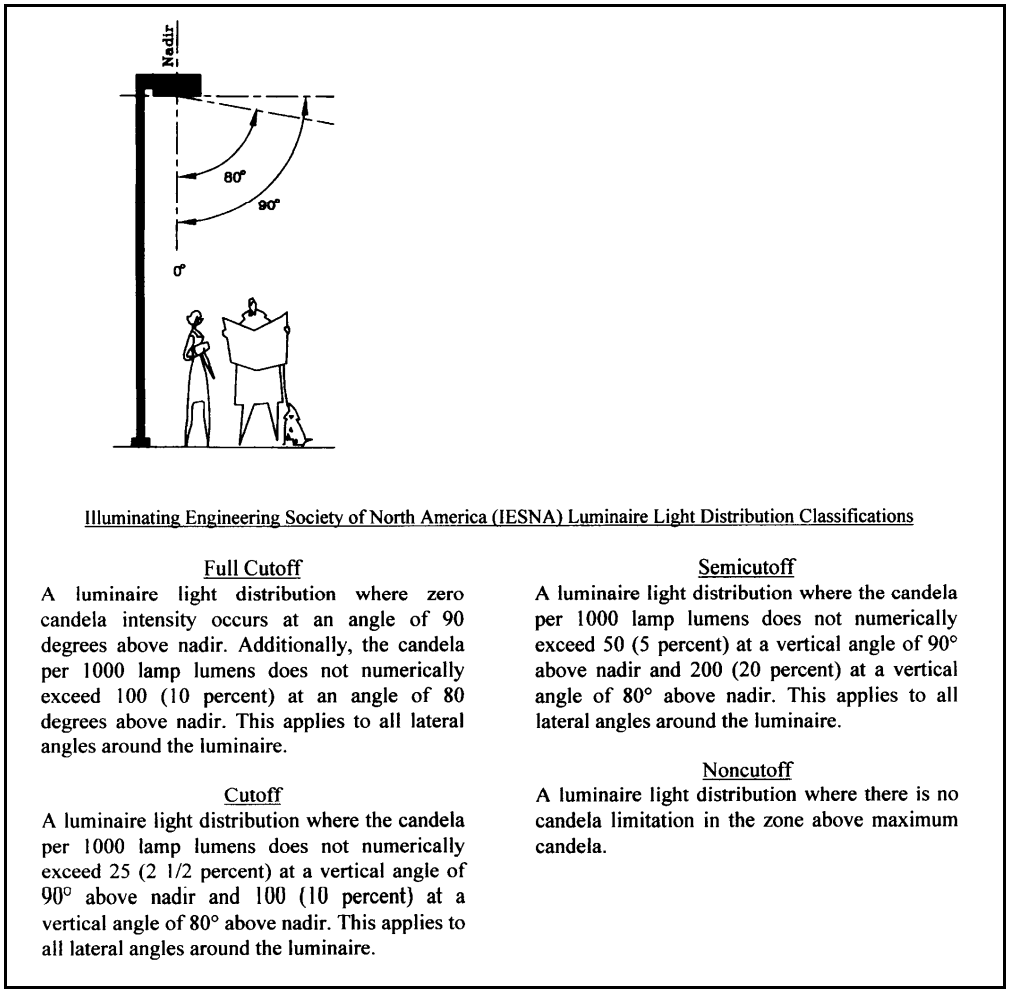
Larger Commercial Developments or Developers

Developers of larger commercial developments typically hand over their proposal to a project manager, who employs engineers and sometimes outdoor lighting designers. Those engineers and outdoor lighting designers are given a simple mandate – put together a design that fits the town code and will get me through the application process on the first try. Generally speaking, engineers and designers are free to use whatever artificial lights are necessary, as long as the

design meets the town code. Costs of individual pieces of the plan, such as whether to use metal halide or high pressure sodium, or whether to use a boxed fixture design or a circular fixture design, are up to the designers, and are secondary to the overall goal of getting the plan approved.

However, one can imagine that the more complex a town ordinance, the greater difficulty for engineers and designers in meeting the requirements of that ordinance. As the complexity of the design increases, the secondary costs mentioned above take on new import for the developer.

The graphic below outlines various lighting fixture classifications. "Full-cutoff" is the most popular for towns to require. Unfortunately, most towns require "full-cutoff" lights without understanding how similar they are to "cutoff" lights. Only a tiny fraction of the lighting in "cutoff" fixtures is allowed upward. Yet the mandate of "only full-cutoff" fixtures severely handcuffs engineers and designers.



Graphic 3 Light Distribution Classifications, courtesy IESNA and Larry Bartlett

Placing full-cutoff lighting in a parking lot does not in itself eliminate light pollution. Full-cutoff lighting has very little outward lighting, so the parking lot would require more light poles to cover the same ground space as with cutoff or noncutoff lighting. More light poles costs more money. One could counter the more light poles dilemma by installing taller lights, but many towns also limit light pole height. Many towns also require that there be a minimal amount of light at the property line. When limiting pole height, and fixture design, it is difficult for the engineer to find a solution that properly illuminates the parking lot, while also eliminating light on neighboring properties.

Finally, if one requires full-cutoff fixtures, but does not regulate how powerful those lights can be, there is a potential for greater overall brightness, lots of reflection, problematic glare, and human eyes that have adjusted to the super-bright parking lot and then have difficulty seeing on the less bright roadway.

Another problem with brightness is that many towns require an average brightness. This allows individual lights to be super-bright, with others very dim, creating a maze for customers. The preferred, and easier method for engineers and designers, is limiting the maximum brightness, combined with a requirement that there be a certain ratio throughout the development of maximum brightness to minimum brightness.

There are two things governments can regulate that would eliminate much light pollution, while also allowing professional engineers and designers the freedom to keep costs down for the developer – *fixture type* and *brightness*. Requiring a ***cutoff***, rather than a full-cutoff fixture, is much more cost-friendly. Requiring a ***maximum brightness***, combined with a brightness ratio, rather than an average, is also much more cost-friendly. Regulating items beyond these two begin to significantly increase costs.

Small Businesses and Local Developers

While professional engineers and lighting designers have access to a wide array of outdoor lighting options, the small local developer is more limited. Many small local developers simply want to open a little shop out of their home, or build a small commercial structure next to their house. These commercial developers may want more lighting than one would typically find around a solely residential development. Yet, for these small local developers, just as they may construct their own building, they may install their own lighting. What are the lighting options for them? Below is a sampling of general hardware stores in Maine, the places that these small local developers will most likely go to purchase lighting for their commercial development projects.

Retail Store and Location	# of Outdoor Lights Available in Store	# of Shielded Outdoor Lights Available in Store	Store employee Knowledge of Shielded versus Unshielded Lights, or Light Pollution
Aubuchon, Lewiston	10	0	none
Home Depot, Topsham	60	2	none
True Value, Farmingdale	16	0	none
Lowe's, Augusta	60	3	none

The shielded lights that were available off the shelves in the stores were approximately the same price as similarly designed unshielded lights. The issue is not so much cost as it is availability.

This sampling was not taken over the phone. SPO staff visited each store, and it was obvious that the main concern for retailers and manufacturers is energy. Most outdoor lighting boxes touted their energy saving capabilities, whether from a different bulb such as fluorescent, or from fixture design such as motion sensor (light only comes on when needed). Advertising at the stores also highlighted energy savings, with many signs comparing costs of lower wattage bulbs to traditional incandescent bulbs. The general public education campaign on energy is clearly working.

At the same time, the general public education campaign on light pollution is clearly not working. No store staff had any knowledge of cutoff or shielded lighting, or even knew about the concept of light pollution. At one store, SPO staff requested a list of all available outdoor lighting, not just those on the shelf, but also what could be ordered from the store. The store clerk produced a list of over 30 outdoor lights not available in the store; none of those were cutoff or shielded.

Any regulation by the state must include a public education component to alert retailers and builders of the issue of light pollution. This could be done inexpensively by providing information to trade and retail associations for distribution to their membership. A web page listing locations where cutoff lighting can be purchased could be developed by the State Planning Office.

Enforcement

A special type of cost is enforcement. A regulation is only as good as the enforcement mechanism. It is relatively easy to write a law, but much more difficult to spend the hours and resources policing that law every day. A particularly unique enforcement challenge with outdoor lighting is the fact that one cannot truly enforce the regulation unless one goes out at night. Most state employees work during the day. Most Code Enforcement Officers work during the day. Any enforcement mechanism must consider the increased cost associated with nighttime work, whether through increased pay, multiple employees, or any other system.

Policy Options

The policy options outlined below are approaches that the Legislature may take, rather than the actual language of the regulation. When considering options, the Legislature must determine whether new regulations apply to only new development, or all development, with some window of time during which all commercial development must conform to the new regulations.

A. Uniform State Regulations Affecting All Commercial Development

Benefits

- Provides consistency for developers
- Current state law could easily be modified to include all development, not just state-funded projects

Costs

- Removes local control
- More difficult to modify law when new technologies are developed that may not fit within structure of regulations
- Who at state would enforce, and how much would this increase application review time and cost?

B. Minimum State Guidelines Affecting All Commercial Development

All towns must adopt, similar to Shoreland Zoning

Benefits

- Provides a degree of consistency for developers
- Maintains a degree of local control

Costs

- More difficult to modify law when new technologies are developed that may not fit within structure of regulations
- Lack of uniformity among towns may add compliance costs for developers
- Cost to towns of adoption and enforcement

C. Uniform State Regulations Affecting All State-funded Commercial Development

Benefits

- State leads by example
- Provides consistency to the current agency review framework
- Maintains local control over non-state-funded development

Costs

- More difficult to modify law when new technologies are developed that may not fit within structure of regulations
- Does not regulate light pollution from the vast majority of development – private development

D. Uniform State Regulations Affecting All Municipally-funded Utility Lighting

Benefits

- Would provide consistency to all roadway lighting, both state and municipal funded
- Maintains local control over development

Costs

- Utility companies may increase cost to municipalities
- Does not regulate light pollution from the vast majority of development – private development

E. Uniform State Regulations Placed within Uniform Building and Energy Code

Benefits

- Having all codes in a single place is less confusing for everyone involved
- The building and energy code already regulates outdoor lighting to some degree, so this would ensure that all regulations are consistent
- Code updates are easier, since code is in rule, not statute
- Towns would not have to adopt a standard

Costs

- Building and energy code has gone through a multi-year development process; inserting something new at the end may delay adoption or frustrate stakeholders

F. Require Retailers to Sell Shielded Lighting Alongside Existing Unshielded Lighting

Benefits

- Allows small local developers the ability to easily obtain shielded lighting

Costs

- Requiring retailers to sell something for which there is no immediate market

G. State Establishes Geographic Lighting Zones, with Different Standards in Each Zone

Benefits

- Allows for some local flexibility
- Preserves darkest skies, such as within State Parks

Costs

- What happens with the inevitable conflict at the zone border?
- Does State enforce? If so, how?

Recommendation

We recommend cutoff lighting for all commercial development, with cutoff lighting defined in rule or statute according to the definition on page 9 of this report. The rationale behind this recommendation is that cutoff lighting is the most cost-friendly, and is a flexible performance standard that allows for a variety of lighting solutions to be implemented.

We also recommend utilizing either option B. or E. above to implement the cutoff lighting requirement.

Below is a chart comparing some characteristics of these two options.

	B. Minimum State Guidelines	**E. Uniform Building and Energy Code**
Establishing a Standard	Requires legislation	Requires an amendment to the building code through rulemaking
Enforcement	Local CEO	Local CEO
Ability to modify	Harder: would be a stand-alone statute	Easier: would only require rulemaking
Uniformity	Near complete: would allow municipalities to adopt more stringent standards	Complete: no local modifications allowed
Coverage	All incorporated municipalities would enforce	Applies statewide, but only municipalities with 2,000 or more residents would enforce

Our recommendation has three components:

1. ***Require cutoff lighting for all commercial development***
2. ***Work with stakeholders and industry groups to initiate a public education campaign raising awareness of light pollution***
3. ***Include a module on outdoor lighting in the existing training program for code enforcement officials***

We believe that public education on this issue, as well as specific training for code enforcement officials, are necessary components of any regulatory mechanism. All three recommendations can be accomplished by the State Planning Office without further state funding.

Conclusion

In late summer 2003, a massive blackout spread through the Midwest United States. It was an electrical power grid malfunction of historic proportions. Most of the discussion during and following the blackout centered on how it was a lapse in our nation's security infrastructure, and the multiple tasks required to prevent such an occurrence in the future.

Yet, as millions of people experienced true night, hidden within local news stories were some interesting quotes:

"I could see the stars very clearly, which was rare, and magical."
"Stars like you've never seen in your life. Fascinating and terrifying at the same time."
"No neon, no street lights, no apartment lights. Peaceful."
"We should have power outages more often."

Magical. Peaceful. These are words many people use to describe Maine. These are words we want people to use when describing Maine.

Vacationland's appeal is the ability to maintain a connection with Nature in the midst of modernity's onslaught; Maine is a refuge for many, a rare, magical and peaceful place where one can realize what it is like to be human. But Nature is not just clean lakes, wild rivers, and moose; Nature is not horizontal. Nature is all aspects of our environment, including the night sky that has guided storytellers, artists, and explorers for millennia.

Two generations ago the state acted to preserve clean lakes, with passage of shoreland zoning. One generation ago the state acted to preserve wild lands, with passage of the Land for Maine's Future program. It is time for the state to act again, in preserving our shared heritage and access to dark skies.