DAVID WOLOCH
DEPUTY COMMISSIONER
NEW YORK CITY DEPARTMENT OF TRANSPORTATION

HEARING BEFORE THE CITY COUNCIL
COMMITTEE ON TRANSPORTATION
NOVEMBER 6, 2008

Good morning, Chairman Liu and Members of the Transportation Committee, I am David Woloch, Deputy Commissioner for External Affairs at the New York City Department of Transportation (DOT) and with me here today is Steven Galgano, DOT's Executive Director of Engineering. Thank you for inviting us here today to testify at this hearing on Intro 757 which would require the use of full-cutoff light fixtures for any new or replacement light fixtures, and Intro 806 which would require DOT to replace all street lamp bulbs with light-emitting diode bulbs (LEDs) or replace any street lamps that are incapable of accommodating LEDs with street lamps that are, within one year of the bill's effective date.

Before I discuss the specifics of the bills, I would like to brief the Council on DOT's lighting standards and explain what the difference is between a full-cutoff fixture or luminaire, as called for in Intro 757, and a semi-cutoff luminaire which is the standard luminaire used Citywide today.

DOT is responsible for maintaining over 300,000 luminaires on the City's streets, highways, parks, overpasses, underpasses, bridges and playgrounds. The carefully considered lighting levels and uniformity ratios (which measures light distribution) provided by these luminaires are based on standards established by the Illuminating Engineering Society of North America (IESNA) and reviewed for specific and varied conditions throughout the five boroughs of New York City. As a densely populated urban center we use standards that are adjusted to provide adequate lighting to motorists on the road, as well as to the many pedestrians as they walk throughout the City. Adequate lighting protects public safety by facilitating the flow of traffic and reducing motor vehicle accidents, providing pedestrians with an open visual environment to make them feel safe and secure, and promoting business and industry that is open during nighttime hours. New York City is a 24-hour city and, therefore, it is imperative that adequate lighting be provided for the public at all

times. The standard luminaire that is used Citywide today to achieve these proper lighting levels are high pressure sodium semi-cutoff cobra head luminaires.

I now ask you to turn to the illustrations at the end of the testimony so that I can explain the differences between semi-cutoff and full-cutoff luminaires. The first illustration depicts a streetscape utilizing full-cutoff luminaires. As you will note, full-cutoff luminaires direct light downward in a spotlight effect and none of the light is directed above 90 degrees, and while direct up-light is avoided, it creates areas of shadow and uneven illumination. Additionally, the concentrated down light can cause higher amounts of reflected light and poor uniformity.

The second illustration depicts a streetscape utilizing semi-cutoff luminaires. Semi-cutoff luminaires direct light distribution downward in a more evenly dispersed pattern and up to 5% of the light may be directed above 90 degrees. Semi-cutoffs allow us to increase the spacing between poles since light is being distributed in a wider diameter; they also provide increased illumination of vertical surfaces including building doorways and people which is important for safety concerns and produce less reflected light than full-cutoff luminaires.

Now that you have a basic understanding of our lighting standards and what a semi-cutoff vs. a full-cutoff luminaire is, let me turn to Intro 757 which would mandate the use of full-cutoff luminaires for any new or replacement lighting. DOT is opposed to this bill primarily because it would conflict with the New York City Climate Protection Act (Local Law 55 of 2007) - a law this Council passed - that established energy-efficient practices in the City government's energy consumption by mandating at least a 30% reduction in Citywide greenhouse gas emissions from FY 2006 levels within 10 years (2017).

DOT is making a substantial contribution to meeting this Local Law and reducing energy consumption Citywide through its Wattage Reduction Program - which would have to be discontinued should this bill pass. Under this Program, in June 2007 DOT began replacing all 250 watt high pressure sodium street light cobra heads with 150 watt heads, and 150 watts with 100 watt heads. This Program consists of three phases and, in total, we will convert 250,000 luminaires which will save over 105 million kilowatt hours annually. Additional benefits include lower maintenance costs, and also a reduction of light above 90 degrees, thus making the 5% difference between semi-cutoffs and full-cutoffs that much smaller. Should Intro 757 pass into law, we would

be forced to discontinue this energy savings program since, to date, no manufacturer makes a 150 watt full-cutoff luminaire that meets our technical specifications despite our repeated requests to the manufacturing community to develop one – it simply does not yet exist. As we explained to Council staff previously – when a 150 watt full-cutoff luminaire that meets our specifications is developed, we will gladly look for opportunities to use it.

In effect, our Wattage Reduction Program is helping to meet the goals of the Climate Protection Act of 2007 and will result in real energy savings, money savings and green house gas credits, while Intro 757 does nothing to reduce energy consumption – it is important to understand that Intro 757 is not an energy conservation bill. In addition, semi-cutoff luminaires only add 5% more upward light than full-cutoffs, and as I noted earlier our Wattage Reduction Program reduces this 5% even further.

Our focus is on safety and energy efficiency and we are also always striving to make use of the most current technology, looking for ways to reduce energy consumption and increase cost savings. Our efforts extend beyond our Wattage Reduction Program:

- All of the City's 32 watt incandescent fire alarm lamps have been replaced with 7 watt LED lamps.
- All 12,000 highways signage 85 watt fluorescent lamps have been replaced with 3,000 100 watt Metal Halide units.
- We are reviewing our existing lighting catalogue with particular emphasis on non-custom contemporary street fixtures that will provide more energy efficient alternatives with attention to lighting levels on the street.
- We are in direct communication with members of IESNA, lighting designers and lighting manufacturers to insure that current guidelines are considered for future installations.
- We are working with the Climate Group and the Clinton Climate Initiative among others to explore along with other cities the best uses for full and semi-cutoff luminaires, as well as more efficient lighting sources.

Since there is no manufacturer that makes a full-cutoff 150 watt luminaire that meets our technical specifications, this legislation would either require us to compromise our energy conservation efforts by requiring us to use higher wattage fixtures or, as I will explain, provide additional poles at a great financial cost to the City, to compensate for the full-cutoff luminaires in order to achieve the necessary lighting uniformity, or require us to compromise our lighting standards, which as stated earlier are accepted standards established by IESNA.

We certainly do not want to compromise our standards - we need to provide adequate lighting to the many pedestrians as they walk throughout the City, as well as to motorists on the road. In fact, in addition to the countless requests for increased lighting from the public over the years, we have also received many requests from City elected officials requesting additional lighting (over 600 requests over the last three years) – and none asking for less lighting. Not surprisingly, States that have passed laws mandating the use of full-cutoffs (including Massachusetts, Rhode Island and New Hampshire) all recognize the unique lighting needs of urban areas and allow the use of semi-cutoffs in their urban areas. The Massachusetts law, for example, specifically states "Any urban area where there is high night-time pedestrian traffic which has been examined by an engineer employed by the Commonwealth and experienced in outdoor lighting and deemed to be an area where the installation of semi-cutoff luminaires are necessary."

As the technology currently exists, in order to maintain our lighting standards and utilize full-cutoff luminaires, closer pole spacing may be required in order to achieve the necessary lighting uniformity. Either street light poles may need to be relocated or additional poles may need to be installed. This may also require Con Edison to excavate streets in order to provide the additional electrical service. The initial purchase, together with installation, increased energy use and maintenance costs would be substantial – and any increase is certainly not something the City can afford at this time.

For example, we currently install 5,000 new street light poles a year and replace approximately 20,000 cobra heads. A complete semi-cutoff cobra head luminaire currently costs us $120. A full-cutoff luminaire, on the other hand, would cost us $240 – twice as much. Therefore, in effect, to convert just these 25,000 luminaires to full-cutoffs would cost us approximately $3 million. And this is just the cost of the luminaire, it does not include the cost of any additional poles if we would need to add them, their installation, increased energy use or maintenance. Again, this not something the City can afford right now.

Lastly, we are also opposed to Intro 757 because under this legislation the majority of historic and decorative lights – which are any lights other than our cobra head standard – would not be permitted as they utilize either semi-cutoff or non-cutoff luminaires. However, there are some existing decorative lights that utilize full-cutoff luminaires, and thus, would not be affected by this legislation. Working with partners such as

the Economic Development Corporation (EDC) and the Downtown Alliance, these were able to be installed in certain locations because our partners are picking up the cost for the luminaires, additional poles and the increased energy usage. So while some historical and decorative lights can simply not accommodate full-cutoffs, we will continue working with our partners to expand the use of historic and decorative full-cutoffs where we can.

In conclusion, while DOT is committed to expanding our use of full-cutoff luminaires where feasible, we are opposed to Intro 757 as it would require us to either discontinue our Wattage Reduction Program putting us in conflict with the New York City Climate Protection Act of 2007; or require us to either compromise our lighting standards or to add additional poles to produce enough lighting to meet our standards; and lastly, require the removal of the majority of our existing historic and decorative lights.

Now let me turn to Intro 806 which would require DOT to replace all street lamp bulbs with light-emitting diode bulbs (LEDs) or replace any street lamps that are incapable of accommodating LEDs with street lamps that are, within one year of the bill's effective date. We are opposed to this legislation due to technology and cost concerns.

In keeping with our efforts to conserve energy and to utilize the latest technology, we have already begun using LEDs Citywide where appropriate. We have replaced all Citywide traffic signals and pedestrian signals with LEDs between 1998 and 2004. In addition to this, we are piloting the use of LEDs on the decorative necklace lighting of the Manhattan and Brooklyn Bridges. We are also actively searching for appropriate locations to test LED pedestrian and street lights. However, LEDs as a light source are still in the developmental phase and to mandate their use Citywide within a year is not prudent. We are concerned about light distribution when LEDs are used, as the quantity of light to reach our standard levels may be difficult to achieve. At the present time LEDs deliver 90 lumens per watt while high pressure sodium delivers 125 lumens per watt – in effect LEDs produce approximately 25% less light for the same amount of energy.

Furthermore, we do not want to tie our hands and limit our use to one specific technology as lighting technology is constantly changing. For example, we are also testing the use of induction lamps on the Manhattan and Brooklyn Bridges. These bulbs may last longer and perform better on our bridges than LEDs

and would cost approximately $175 each for replacements as opposed to an LED which would cost approximately $800 - $1,200 each depending on the location. Mandating a type of technology that may very well change in the near future will not allow us to take advantage of perhaps better and less expensive lighting products.

I think this is a very important point. We are not opposed to utilizing new lighting technology – and our record speaks to this. However, to legislate lighting standards – whether those in Intro 757 or those in Intro 806 – would simply box us in. Technology is constantly changing as we have already seen – and we would prefer to work with the Council as technology improves to make sure we are not missing out on any new opportunities and being cognizant of what other localities are doing.

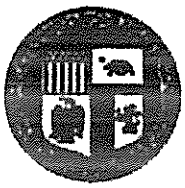
Lastly, while the intent of Intro 806 is admirable, the costs to implement it would far outweigh any benefits. We estimate that to replace all of the City's 305,355 luminaires would cost the City approximately $286 million, in addition to approximately $3 million annually in replacement costs. Similar to Intro 757 – this is not something the City can afford at this time.

Thank you for this opportunity to testify before you today and at this time we would be happy to answer any questions that you may have.

IESNA Cutoff

IESNA Semi Cutoff

CITY OF LOS ANGELES
CALIFORNIA



JAMES K. HAHN
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January 25, 2002

To Whom It May Concern:

FULL CUTOFF LUMINAIRES AND IES RP-8-2000 IN LOS ANGELES

The City of Los Angeles has specified full cutoff luminaires on nearly all street lighting plans for new streetlight installations and conversions of existing installations since 1990. We had previously specified full cutoff luminaires at traffic signal intersections and in hillside areas for several years. We now have about 70,000 full cutoff luminaires in our system. In 2001, Los Angeles adopted IES RP-8-2000 as our street lighting standard, using the illuminance method. We have reviewed the benefits of full cutoff luminaires related to that standard in response to several inquires.

Regarding energy use, our conclusion is that essentially no extra energy is used due to specification of full cutoff luminaires with the 2000 standard, for new installations and conversions on major, collectors, and local streets.

Major streets have experienced no cost increase for installation nor maintenance and no need for additional streetlights to meet the 2000 standard, due to the increased use of 40 foot and 50 foot poles, with longer spacings than for the previously specified 31 foot poles. There is some overall energy increase involved in either the old or the new standards when using taller poles with higher wattages, but the total cost is the same or less due to fewer streetlights.

Local streets with lower average illumination requirements have a minor increase in energy use and cost for new installations with full cutoff luminaires. For the higher average illumination locations the energy use is decreased. Therefore, local streets have no energy increase, overall.

Conversion of less efficient mercury vapor luminaires to full cutoff, high-pressure sodium luminaries has resulted in significant maintenance cost and energy savings on all street types.

Overall we see no energy increase due to the use of full cutoff luminaries and RP-8-2000.

At the same time, the primary purpose of our change to specifying full cutoff luminaires from semi-cutoff luminaires was to reduce light trespass (a residential comfort impact), glare (a detriment to driver and pedestrian visibility) and light pollution or sky glow (an impact on everyone's enjoyment of the sky at night). These benefits are not quantifiable, but are very significant to our life experience. They are certainly part of what the public pays for in street lighting. We believe that our specification of full-cutoff luminaires has been quite beneficial both in controlling costs and energy use, and in the more intangible areas mentioned.

If you have any questions regarding this letter, please call me at (213) 847-6400.

Sincerely,

(Original signed copy on file)
Phil Reed, Director
Bureau of Street Lighting

SMILer (L/SLIAISON/5536)

November 4, 2008

Mr. Alan J. Gerson
New York City Council
51 Chambers Street, Suite 429
New York, NY 10007

Fax 212 788 7727

Re: NYC Proposed Bill for Full Cutoff Streetlights

Dear Council Member Gerson:

This letter is provided as a reference on the experience of the City of Stamford Connecticut in using fully shielded (full cutoff) streetlights.

In 2001 the City of Stamford began using full cutoff streetlights for replacements and new installation, in compliance with a new statute passed by the Connecticut General Assembly.

In the 7 years since, full cutoff streetlights have been constantly deployed, with no instance where the use of full cutoff streetlights has necessitated the use of more streetlights or tighter pole spacing.

Stamford has also adopted a policy of reducing wattage levels with the installation of full cutoff streetlights as part of Stamford's effort to conserve energy.

Stamford has uncovered no problem in using full cutoff streetlights, and would be pleased to share details with the New York City Department of Transportation.

Sincerely,

Nancy Domiziano

Testimony in Support of Intro. 806, LED Street Lights
NYC Council, Thursday, November 6, 2008
Dan Miner, NYC Sierra Club, Chair
www.nyc.sierraclub.org

Switching to high-efficiency LED street lights is a great way for NYC to cut energy costs, and lower our dependence on fuel sources that are behind accelerating climate change, becoming steadily more costly, and are vulnerable to supply disruptions.

We don't need to build any more power plants until we cut our energy waste. A 2007 report from the international consulting firm McKinsey and Co. found that:
- improving efficiency could offset almost all projected demand for electricity in 2030
- largely eliminate the need for new coal-fired power plants
- 1/3 of the U.S. greenhouse gas cuts by 2030 could come from electricity efficiency
- the cost of the efficient equipment would quickly pay for itself in energy savings.

In the last 30 years, US per capita electricity consumption grew 60%, but stayed flat in California, because of high building standards and aggressive efficiency measures. They moved to eliminate wasted outdoor lighting for parking lots and streets. Californians found that about 15% was directed up, illuminating nothing but the sky.
"Why we never need to build another polluting power plant," Joseph Romm, Salon, July 28, 2008, http://www.salon.com/news/feature/2008/07/28/energy_efficiency/?source=newsletter; McKinsey & Co., http://www.mckinsey.com/clientservice/ccsi/greenhousegas.asp

Californians moved to more efficient bulbs. National Energy Technology Laboratory compared outdoor LED lights and standard high pressure sodium lights, and found that LEDs had lower energy use ranging from 25% - 50%.
http://www.netl.doe.gov/ssl/usingLeds/app-series-outdoor-efficiency.htm

San Jose, the capital of Silicon Valley, has just issued an RFP to replace all its street lights with LEDs that can be programmed and remote controlled, and will last at least 50,000 hours. http://www.ledsmagazine.com/news/5/10/21

New York City can increase energy efficiency by upgrading our 300,000 street lamps – now powered by halogen bulbs – to light-emitting diodes, or LED. Intro. 806 would require most City street lights to switch to LEDs within a year.

Light emitting diodes, or LEDs, have many advantages over currently used halogen street lamp bulbs. The colors can be instantly changed. LED bulbs produce no harmful UV rays, and unlike fluorescent bulbs, contain no mercury. Halogen lamps spread light in all directions, but LEDs emit a concentrated beam of light in a specific direction.

LED bulbs last around 10 times longer than traditional halogen bulbs. Because they use less energy, they can be powered by individually powered by solar panels, for a more reliable supply of light that will stay operational during a blackout.

As discussed in my report, "Sustainable Energy Independence for NYC," we have to consider not only strains on the electric grid, but depleting supplies of the fossil fuels that power our electric generating plants. We can expect not only higher fuel and energy prices in the long term – despite the current correction – but shortages and supply disruptions. www.beyondoilnyc.org

Since PlaNYC anticipates increased reliance on natural gas for in-city electricity generation, we should look to natural gas supplies, formerly believed to be abundant. North American natural gas supplies have already peaked. The Geological Survey of Canada says that Canada will not be able to meet US natural gas shortfalls, leaving us dangerously dependent on shipments of gas frozen and shipped from Russia and the Middle East. If the price of gas goes up, so will the price of electricity.

"Natural gas in North America: should we be worried?" David Hughes, ASPO 2006,
http://www.aspo-usa.com/fall2006/presentations/pdf/Hughes_D_NatGas_Boston_2006.pdf

"The US natural gas disaster," Matthew Simmons, ASPO 2004 Conference,
http://www.simmonsco-intl.com/files/ASPO%20B&W%202004.pdf

Coal won't save us. More use of coal will accelerate global warming. Carbon sequestration has not been proven to be commercially possible or effective. FutureGen, a federally subsidized clean coal R&D project, was cancelled. Contrary to the conventional wisdom about the abundance of coal, one study concludes that US coal production has already peaked, with world coal production to peak around 2025. *http://www.beyondoilnyc.org/report-electricity.html*

What should we do? We should aggressively develop of solar, wind, tidal, and geothermal power, while using remaining fossil fuel supplies as efficiently as possible. Switching over to extremely efficient LED lights is an excellent next step.

Contact: *718.786.5300 x 27 or beyondoilnyc@yahoo.com*

In Support of Intro 757

Page 1 – Testimony of Leo Smith

November 6, 2008

Good Morning Chairman Liu and Members of the Committee:

I come respectfully before this Committee in support of passage of Intro 757 which requires the City DOT to use full cutoff streetlights for future replacements and installations. I serve as the Northeast Regional Director for the International Dark-Sky Association. I am also a member of the Illuminating Engineering Society and serve on the Roadway Lighting Committee and in 2006 served as Chair on a task force responsible for determing when roadway lighting might not be necessary. In 2004 I was appointed as on of 8 people on the Model Outdoor Lighting Task Force responsible for developing a Model Outdoor Lighting Ordinance for municipalities. The Model Outdoor Lighting Task Force is a joint effort between the Illuminating Engineering Society and the International Dark-Sky Association.

Full Cutoff streetlights cast more light downward and less light into the sky or onto adjacent properties where the lighting is not needed. An example of a city similar to New York that has deployed full cutoff streetlights is the City of Los Angeles. Starting in 1988, Los Angeles began replacing expired streetlights with full cutoff lights. Today, almost all of the 240,000

streetlights in Los Angeles are full cutoff. Mr. Ed Ebrahimian is the Streetlight Manager for Los Angeles streetlight operations, and can provide direct verification as to the success Los Angeles has experience using full cutoff streetlights, without having to have closer pole spacing or more light fixtures as claimed by the NYCDOT. ed.ebrahimian@lacity.org

In 2001 the Connecticut General Assembly enacted Public Act 01-134 to require full cutoff streetlights for all state and municipal roads. The public utility companies, all municipalities, and the Connecticut Department of Transportation are all required to use full cutoff streetlights under this law. The City of Stamford, one of the largest cities in Connecticut, has been aggressively converting to full cutoff streetlights since 2001, and has been able to downsize wattage when using full cutoff as part of Stamford's energy conservation efforts. Stamford has found no instance where the use of full cutoff streetlights has necessitated the use of more streetlights or tighter pole spacing – an unsubstantiated claim made by NYCDOT. Nancy Domiziano is the Energy/Utility Manager for the City of Stamford responsible for streetlight operations. NDomiziano@ci.stamford.ct.us

Where the Committee finds contradiction and opposition from

NYCDOT to the use of full cutoff streetlights, direct contact with Los Angeles, Stamford and other cities such as Calgary may offer clear and compelling evidence that the opposition by NYCDOT is based on myth and misunderstanding, much of which is fostered by the current vendors who prefer that the status quo not be disturbed.

Human Health – The International Dark Sky Association takes no position on whether streetlights have an adverse effect on human health, since the jury of scientific evidence is still out. Dr. Steven Lockley from the Harvard Medical School has done significant research on the adverse effects on light at night on human health. According to the attached letter from Dr. Lockley, light at night from an unshielded 250 watt streetlight may result in a decrease in the level of melatonin. Lower levels of melatonin correlate with increased rates in breast cancer, according to established scientific studies on the effects of light at night. The use of full cutoff streetlights will lower the amount of light trespassing into apartment windows. These findings have not yet been corroborated by further scientific testing. Dr. Locklev's letter is provided at face value.

Energy Issues – A full cutoff streetlight directs more of the light downward, and as such, often allows for reduced wattage levels to provide sufficient lighting. The City of Stamford has been following a replacement plan where a 100 watt drop lens streetlight is replaced with a 70 watt flat lens (full cutoff) streetlight, resulting in energy savings of 30%. The City of Calgary has also lowered wattage levels when flat lens streetlights were used to replace drop lens streetlights.

Summary – Flat glass or full cutoff streetlights control light pollution and reduce energy waste from stray light. In many cases, by directing more light downward, the full cutoff streetlight wattage can often be reduce without compromising public safety or security.

For these reason, I respectfully urge the Committee to approve Intro 757 requirements to use full cutoff streetlights.

Respectfully submitted,

Leo Smith, Northeast Regional Director and Board of Directors
International Dark Sky Association
1060 Mapleton Avenue
Suffield, CT 06078
860 668 4000

EnviroSmart Streetlight Retrofit

The City of Calgary
Roads

EnviroSmart streetlights

Between 2002 and 2005, The City of Calgary undertook a complete retrofit of its approximately 37,500 residential streetlights, switching to lower-wattage, flat lens EnviroSmart fixtures from the dropped lens "cobra head" fixtures. The City was the first in North America to undertake such a retrofit.

Click the image to see a full-size photo

Before the retrofit, Calgary streetlighting levels were among the highest in North America. The satellite photograph at right shows the light captured by a satellite over western Canada and the United States in 2001. The photograph demonstrates that much of the light generated in Calgary at that time was directed up into the night sky.

"EnviroSmart Streetlights" isn't an actual brand name of streetlight but rather a word mark created to promote the benefits of the retrofit program among Calgarians. The actual fixture is a version of the Cooper OVH series made by Cooper Lighting, while the lamp is a high-pressure sodium (HPS) "Lumalux/Eco" lamps made by Osram Sylvania.

Key benefits of EnviroSmart Streetlights include:

- **Energy and money savings.** The new flat lens fixtures use less energy, which helps to keep operating costs down. Cost savings from reduced energy consumption alone are estimated at $1.7 million per year, while energy savings are estimated at 25,000 MWh. By 2011 or 2012, it is estimated The City will regain the cost of installing the new fixtures from energy savings.

- **Greenhouse gas reductions.** Using less electricity reduces the emissions produced by gas and coal-burning generators.

Related Links

- **Contact Roads**

- **Glare reduction.** Glare from streetlights is significantly reduced with the new flat lens streetlight fixtures, increasing visibility by directing light onto the roadway and preventing it from shining into the eyes of motorists.

- **Light pollution reduction.** New ways of designing and providing streetlighting have been developed in the last several years. The City is committed to reducing our level of light pollution by using the most efficient streetlight fixtures and employing the latest design methods.

- **Maintaining a safe level of lighting.** Streetlighting on residential and collector roads will continue to meet minimum Illuminating Engineering Society (IES) guidelines.

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Last Updated: April 22, 2008

HARVARD MEDICAL SCHOOL
BRIGHAM & WOMEN'S HOSPITAL
DEPARTMENT OF MEDICINE
DIVISION OF SLEEP MEDICINE

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Tel: 617 732 4977
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Leo Smith
Board of Directors
International Dark Sky Association
1060 Mapleton Avenue
Suffield, CT 06078

May 31, 2008

Dear Mr. Smith:

This letter is in response to your inquiry as to whether light levels produced by streetlights might adversely affect sleep, hormone levels and potentially health in people living in a dense urban environment.

By way of introduction, I am a faculty member in the Division of Sleep Medicine, Brigham and Women's Hospital and Harvard Medical School and I have been studying the effects of light on human circadian rhythms, including sleep, hormones, alertness and performance rhythms, for 15 years. Among other roles, I am the Chair of the Commission Internationale de l'Eclairage (CIE) Division 6 Technical Committee TC6-63 'Photobiological strategies for adjusting circadian phase to minimize the impact of shift work and jet lag' and a Member of the Light and Health Committee, Illuminating Engineering Society (IES) of North America. I am also on the Editorial Boards of the journal *Sleep* and the Sleep and Health Education Program, Harvard Medical School.

Our studies aim to understand the 'non-visual' effects of light on human physiology. About 10 years ago, a novel photoreceptor was discovered in the mammalian eye, including humans, which is anatomically and functionally different from the rod and cone photoreceptors that we use for vision. This new photoreceptor cells are located in a different part of the eye to rods and cones, in the ganglion cell layer, and these cells are 'hard-wired' to the parts of the brain that control our daily sleep and hormone rhythms, particularly the suprachiasmatic nuclei in the hypothalamus, the site of the central circadian pacemaker or 'body clock'. Light information from the environment is detected by these cells to synchronize the internal circadian clock with the external time of day and day-night changes to ensure that our physiology and behavior is properly synchronized with the external environment. The importance of this regular, daily light-dark cycle exposure is readily observed if this light-dark information is altered. For example, shift-workers who stay awake at night and try and sleep in the day, or those flying across multiple time zones, experience sleep, alertness, performance and metabolic disorders because their internal clock cannot readjust quickly enough to the change in light-dark cycle and consequently becomes desynchronized from the environment.

In addition to resetting the biological clock, light also acutely suppresses the production of the pineal hormone melatonin. Melatonin is the internal biochemical signal of darkness and night duration and its production changes in response to season and light exposure. Under a natural light environment, light would never be seen when melatonin is produced and would therefore be unaffected. With the invention of artificial light, however, light exposure now often occurs during the night, stopping the production of melatonin and increasing alertness. In animal studies, melatonin can act as an oncostatic – can slow down the growth of cancerous tumors – and suppression of melatonin speeds up some types of tumor growth. While such studies have not been repeated in humans, there is good epidemiological evidence that female shift-workers, who are often exposed to light at night when their melatonin production occurs, have higher rates of breast cancer than non-shift working women. Notably, totally blind women, who have less light exposure, have reduced rates of breast cancer. While we have yet to understand fully the environmental and health impact of being exposed to light at night, these preliminary data suggest a detrimental effect of prolonged exposure to light at night.

While early research into the effects of light on sleep and hormones suggested that bright light exposure was necessary to stimulate a response, over the past 20 years ours' and others' research has shown that the sleep and circadian systems are exquisitively sensitive to light, and that very dim light is capable of eliciting measurable effects on human physiology. There are many papers detailing the effects of light levels equivalent to that experienced indoors in artificial room light, down to light as dim as 1.5 lux. Below I will review briefly the results from several papers from our own laboratory (copies of the papers are enclosed). There are other papers which I would be happy to provide if necessary.

The first studies describe the effects of different intensities of light on the circadian pacemaker, melatonin levels, alertness and brain activity (see Zeitzer et al., *Journal of Physiology* 2000 and Cajochen et al. *Behavioral Brain Research* 2000, enclosed). Subjects were exposed to one intensity of white light ranging from 3 lux to 9100 lux for 6.5 hours during the night. During the light exposure, blood samples were drawn to measure levels of the pineal hormone melatonin, they were asked to rate their alertness levels, and electrodes were placed in their face and head to measure the rate of slow eye movements and brain activity. The circadian rhythms of melatonin were measured the day before and the day after the light exposure to assess the effects on the biological clock.

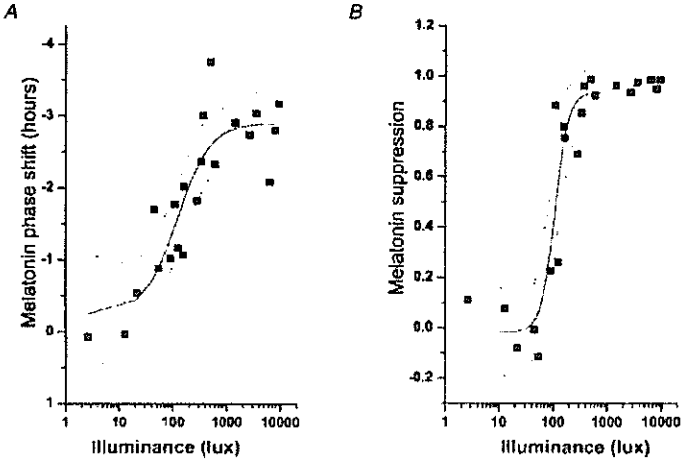


Figure 1

Figures 1 and 2 show the dose-response effect of light on the physiological and behavioral responses. Figure 1 shows the effect of light on circadian rhythm resetting (A, left panel) and suppression of melatonin production (B, right panel). The first thing to note is that the dose-response function is such that about 100 lux of light causes ~50% of the maximum response to very bright 10,000 lux light. Secondly, light from 20-100 lux is still capable of causing a 0.5 -1 h shift in the timing of the circadian pacemaker (A) and suppressing melatonin by up to 20% (B).

Figure 2 shows the results from the same study but for the dose-dependent alerting effects of light. The left panel shows subjective ratings of alertness and the middle panel shows the rate

of slow eye movements, considered a reliable objective marker of fatigue. The right panel shows the power density in the electroencephalogram (EEG) recordings in the theta-alpha range (5-9 Hz); high brain activity at these frequencies is indicative of sleepiness. As Figure 2, shows, all three measures of alertness showed a dose-dependent change with light intensity such that higher intensities caused a more alerting effect. Even a low intensities (100 lux and lower), however, light was still able to induce a measurable change in fatigue.

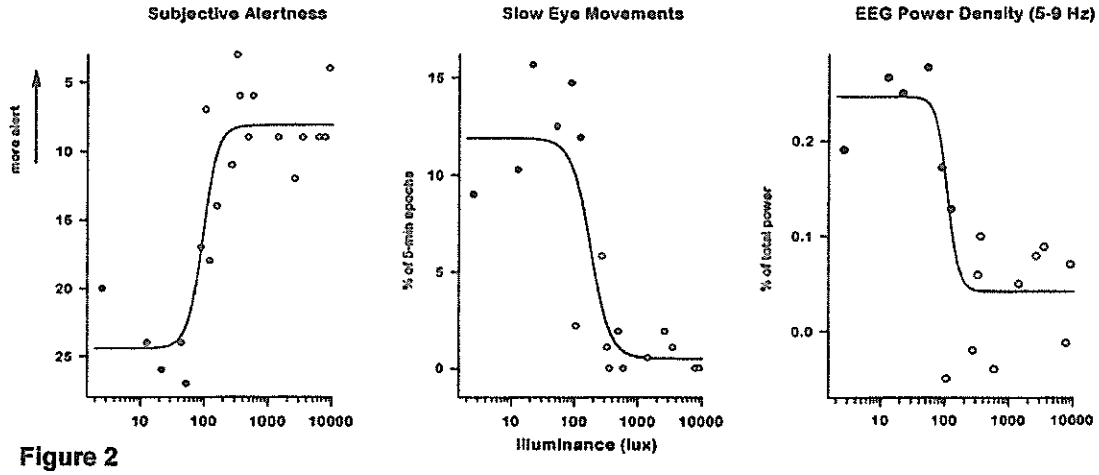


Figure 2

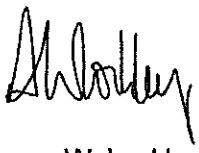
The final laboratory study was conducted to test the power of dim candle-light (~1.5 lux in the vertical angle of gaze) to keep the circadian system synchronized to 24 hours (Wright et al., *Proceedings of the National Academy of Sciences USA*, 2001; attached). Subjects lived in the laboratory for up to 55 days and were scheduled to live on one of three different 'day'-lengths; 23.5 h, 24.0 h and 24.6 h under dim light while awake and darkness when asleep. Although the dim light was unable to reset the circadian pacemaker enough to remain synchronized to the 23.5 h and 24.6 h days, candlelight was sufficient to keep the subjects entrained to 24 hours. Notably, most totally blind people are unable to remain synchronized to 24 hours, again highlighting the importance of even dim light on affecting human physiology and behavior.

These and other studies have shown that dim light is capable of stimulating effects on human sleep and hormonal levels. While brighter light elicits larger effects, we cannot consider dim light an inert stimulus and must keep it in mind when reviewing the appropriateness of light environments. Studies are underway to measure the actual light levels that people are exposed to while indoors and I anticipate that these levels will be significant in urban environments, and even higher when individuals live closer to intrusive street lighting. There is absolutely no need for any horizontal or vertical light to be emitted from street lamps; focusing light solely downward will provide better, more focused lighting for traffic and pedestrians and allow sufficient lighting to be produced with lower energy usage and at a reduced cost. Fixtures which permit horizontal and vertical light are not only inefficient and unnecessary but also emit light inappropriately into living spaces, particularly bedrooms. This light intrusion, even if dim, is likely to have measurable effects on sleep disruption and melatonin suppression, particularly in those whose bedrooms might be in close proximity to streetlights. Even if these effects are relatively small from night-to-night, continuous chronic sleep and hormonal disruption may possibly have longer-term health risks. For example, recent epidemiological studies have shown increased rates of obesity and cancer are associated with decreased nightly reported sleep duration. Intrusive street lighting, as well as wasting money and energy, is likely to have an adverse effect

on human health, effects which are entirely avoidable with better planning of urban lighting fixtures. Short- and long-term measures to reduce light pollution will reduce energy demands, reduce reliance on carbon-based fuels and improve the health of the urban environment.

With these consequences in mind, I applaud your efforts to have intrusive street lighting abolished and I wholeheartedly support your campaign. Please let me know if I can be of further assistance.

Yours sincerely,



Steven W. Lockley, Ph.D.

Assistant Professor of Medicine, Division of Sleep Medicine, Harvard Medical School
Associate Neuroscientist, Division of Sleep Medicine, Brigham and Women's Hospital
Honorary Associate Professor in Sleep Medicine, Warwick Medical School

Encl.

Zeitzer JM, Dijk DJ, Kronauer R, Brown E, Czeisler C. Sensitivity of the human circadian pacemaker to nocturnal light: melatonin phase resetting and suppression. *Journal of Physiology* 2000;526 Pt 3:695-702.

Cajochen C, Zeitzer JM, Czeisler CA, Dijk DJ. Dose-response relationship for light intensity and ocular and electroencephalographic correlates of human alertness. *Behavioral Brain Research* 2000; 115(1):75-83.

Wright KP Jr, Hughes RJ, Kronauer RE, Dijk DJ, Czeisler CA. Intrinsic near-24-h pacemaker period determines limits of circadian entrainment to a weak synchronizer in humans. *Proceedings of the National Academy of Sciences USA*, 2001; 98(24):14027-32.

On Light Pollution

Susan Harder, 440 Kent Avenue, Brooklyn, NY 11211: 631 329-0456.
"Light Pollution Activist"
35 Year resident of New York City, retired small business owner
Section Leader, International Dark Sky Association
Lighting Designer and consultant to municipalities on outdoor lighting regulations

CONTENTS: Testimony to NYC Council's Transportation Committee on streetlight shielding

Transportation Hearing on streetlight shielding. New York City Council, November 4, 2008

Susan Harder, 35 year resident of New York; Retired NY small business owner. For last 10 years, "light pollution" consultant to municipal planning departments and public works officials, and the Long Island Power Authority. New York State Section Leader, International Dark Sky Association. Address: 440 Kent Avenue, Brooklyn, NY 11211 631 329-0456

"Bad" night lighting is the rule rather than the exception in New York and elsewhere because little attention has been paid over the years to the detrimental effects of poorly designed lighting systems. Now that greater attention is being paid to wise energy use and to the environmental and human health issues which are now known about night lighting, it is time to CHANGE our current practices.

"Bad" night lighting ("light pollution" = unshielded, excessive, or unnecessary night lighting) results in energy waste; glare; poor visibility, and detrimental effects to flora, fauna, and human health.

"Good" outdoor night lighting:

Will provide:

a. Better **Visibility** for drivers and pedestrians, and visibility should be the primary design criteria.
b. **A Safer city environment** -- because studies have shown that excessive lighting will not prevent crimes, per US Justice report and a Chicago alley study (in the materials); and glare has been shown to cause accidents.
c. A Sense of security – because glare from unshielded lights makes us feel less safe since we cannot see as well. (squint/dark shadows)
d. Less "sky glow" since light will be directed where it is useful
e. Greater protections for flora and fauna. Birds and trees suffer from poor lighting.

To achieve **good outdoor night lighting**:

a. Shield the "light source" (this is the primary tool to reduce light pollution)
    1. to reduce glare in the line of sight for drivers (which is especially important as our eyes "age"); and
    2. to eliminate "up" lighting above the fixture where it serves no useful purpose.
b. Do not exceed light levels as recommended for the application
c. Use timer controls to shut off lights when not needed and during daylight hours
d. Use energy efficient light bulbs that provide better visibility.

Over the past ten years I have worked to institute good outdoor lighting regulations in a number of communities. Streetlighting changes have been the easiest (with the exception of NYC) to institute. With a modicum of educational materials, municipal public works officials on Long Island and elsewhere in the state have changed out streetlights to shielded fixtures to reduce light trespass, glare, and "up" lighting, often without laws, all based on a common sense approach to the issue.

There is pending legislation in the state legislature that would require that all lighting which is paid for with public funding be "fully shielded", including streetlights. This measure is widely supported, and passed overwhelmingly in the Assembly; sponsored by NYC Assemblywoman Linda Rosental, previously sponsored by Pete Grannis. (in the materials). It will be brought to the Senate in the new year, but, if you ask Senate sponsor, Carl Marcellino, he will let you know that NYC DOT's opposition has been problematic. Their opposition letters have been riddled with misstatements about the tenets of the bill and the expected costs.

HARDER (continued)

With respect to STREETLIGHTING, specifically:

For the most part, all roadway lighting in this country is designed by the lighting manufacturers and/or in concert with utilities who are interested in "dumping" the night load of electricity. Even the light levels for roadway lighting have been written by the manufacturers through their "Roadway Lighting Committee" within The Illuminating Engineering Society.

Unfortunately, very little research has been done about the cost benefit of roadway lighting; and less, on night vision and lighting. These are areas that deserve study and research since roadway lighting, if used only for public benefit would reduce infrastructure costs considerably. There have been studies emerging which show a direct connection between light entering bedroom windows and increased cancer rates. Streetlighting that is unshielded will project light into bedrooms above the fixtures, as it does in my case from streetlights that are two blocks away.

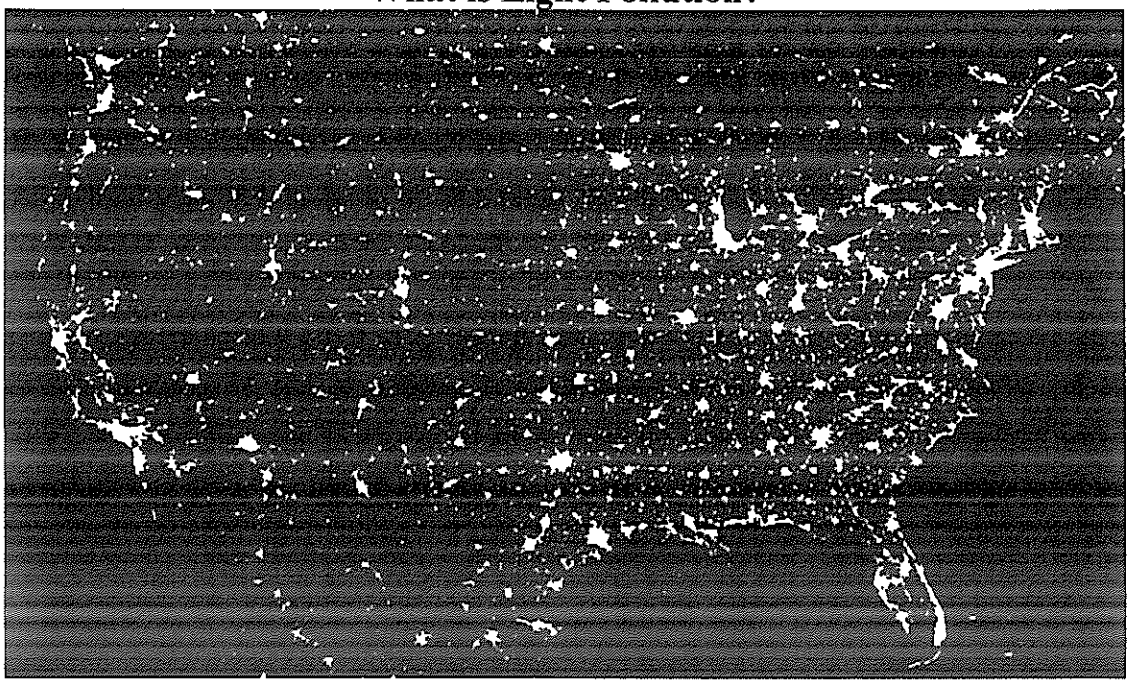
New York City needs to institute an aggressive re-evaluation of streetlighting and establish a set of Warranting Criteria in order to determine when streetlighting is effective, at what light levels, and how visibility can be increased while reducing "light pollution". NYC DOT has never conducted this type of evaluation and they have no warranting criteria for new and replacement streetlights to reduce light pollution.

Great savings in electricity and infrastructure costs can result from warranting criteria. Some limited access freeways in the City may benefit from alternatives to overhead fixtures. As well, in midtown, there are pole mounted fixtures that are so poorly designed with respect to light distribution from the fixture (much of the light is directed upward), that over 500 watts per pole, and dozens of poles per block are used. If the fixtures were fully shielded and properly spaced, less than half the wattage would be needed, and the glare would be reduced and a sense of safety increased.

. New Jersey commissioned a "Light Pollution Study" and on New Jersey roadways there is a stark contrast: visibility on the highways is much better since they use full cutoff fixtures. And, after insisting that full cutoff fixtures could not be used anywhere in NYC, NYC DOT has installed new full cutoff fixtures on the Manhattan Bridge. (see photo).

NYC has few regulations in place regarding night lighting. Guidelines and regulations are in effect around the world which can serve as models, including in the US Green Building Council LEED Program which issues a credit for "light pollution" reduction.

What is Light Pollution?



The United States At Night

It is estimated that over $4.5 billion dollars is wasted every year in the US on Light Pollution

LIGHT POLLUTION occurs when outdoor lighting is misdirected, misplaced, unshielded, excessive or unnecessary. As a result, light spills unnecessarily upward and outward, causing glare, light trespass, and a nighttime urban "sky glow" overhead, indicating wasted energy and obscuring the stars overhead.

THE SOLUTION:

Direct your outdoor lights toward the ground and turn them off when not in use. Install shielded fixtures or light bulbs that direct the light only where you need it, adjusting the wattage necessary for the task.

Stand on your property lines and check for light trespassing onto your neighbors' property. When away, put indoor lamps on timers for security purposes or use an alarm. Outdoor lighting alone will not provide protection from theft, graffiti, or vandalism.

Find out about your local and state outdoor lighting codes.

Ask your neighbors to do the same.

Write, call or email your state and local elected officials, urging them to strengthen and enforce outdoor lighting codes and to require businesses, schools, institutions, municipalities, and individuals to comply.

Ask your neighbors to do the same.

WHY?

Energy conservation through sensible lighting practices means less dollars spent on expensive electricity, and less pollution in generating that energy, primarily by burning fossil fuels.

Bare bulbs cause glare, interfering with night vision, especially for older drivers. Maritime navigators are blinded by off-shore glare which interferes with navigational markers.

The night is full of birds, animals, and fish whose habitats are negatively affected by artificial light. There is evidence that light at night is a health risk for humans, both for sleep deprivation and reduction in tumor suppressing melatonin.

Our stars are a natural resource. For generations before us and after us, with your help, the night sky can remain a source of inspiration, information, and contemplation.

Light Pollution can be eliminated. without sacrifice.

For More Information:

The Dark Sky Society: www.darkskysociety.org

Development of Outdoor Lighting Regulations

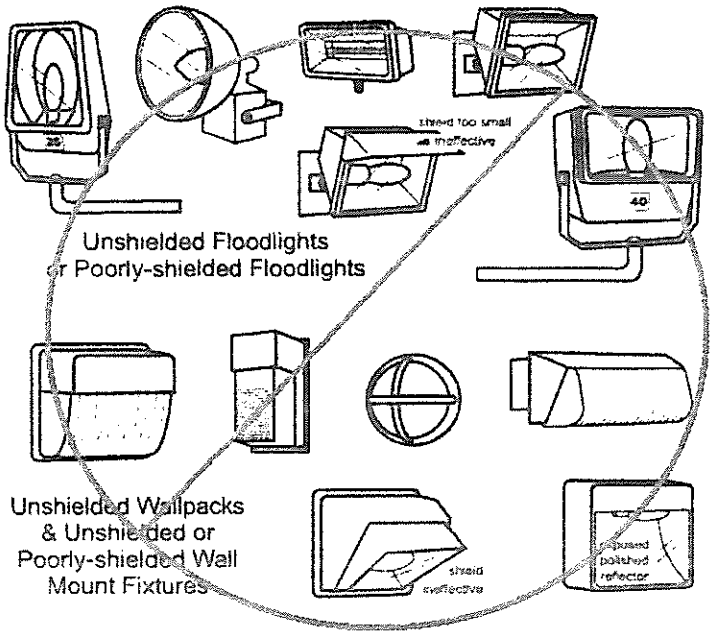
Many Municipal Zoning Codes have references to outdoor lighting and require review by a planning agency to qualify for a building permit for commercial and residential construction. Municipalities may be included in these regulations or may have policies for their own lighting, including street lighting. Most of these references to lighting are not practical to enforce or check for conformance due to incomplete or technically incorrect terminology. With a greater concern for energy conservation and with the increasing awareness of problems due to "light pollution" (misdirected, excessive, unnecessary, or unshielded night lighting), there is a desire by communities to enact comprehensive outdoor lighting regulations. There are many new resources outlining justification for lighting codes and methods to address new and pre-existing installations. Fortunately, addressing pre-existing lighting will provide a cost saving benefit as well as benefiting the community in terms of safety and asethetics.

Since there is no "one size fits all" "model" lighting code, it is recommended that each municipality follow this process to arrive at regulations set by their own community.

1. Form a small citizen based advisory committee (or a sub committee to a standing advisory committee) to begin the process of writing a lighting code, drawing on residents that have expressed an interest in this topic. The committee will be needed, over time, to provide educational materials and presentations, as well as annually reviewing the code for amendments. At least one member from the municipal planning department, a town attorney, the building inspector, and one or two members of the municipal council. A member of a similar committee from outside the community that has successfully completed this process should be appointed as a consultant.
2. Each member of the committee will need to read the Outdoor Lighting Handbook, a layman's review of lighting terminology and lighting facts and figures.
   It is available on line:
   http://www.darksky.org/lighting_regulations/summary-of-lighting-code-handbook.php
3. The Town Attorney will need to review and compile all references to outdoor lighting in the current town code. Ideally, the new code will collect all references into one new section in the code.
4. Often Planning Departments can approve lighting requirements for building permits prior to enactment of zoning laws. If so, these should be implemented right away.
   See Guidelines for Good Lighting Plans:
   http://www.darkskysociety.org/handouts/LightingPlanGuidelines.pdf
5. Ahead of regulations, consider distributing a town-wide mailing and/or producing a community television station program to educate the public about the reasons to use good night lighting to reduce light pollution. Some communities set up astronomy programs to focus attention on the night sky and the effects of "sky glow" from misdirected night lighting. Schools are often involved in this type of education.
6. The municipality itself will need to set an example and to allocate resources and time to review and correct their own lighting to conform in advance of requirements they wish to impose on local businesses, including all municipal streetlighting. A Warranting Policy for all new and pre-existing streetlights will be needed in order to assure appropriate use and type of equipment.
7. Each community will also need to determine a "sunset" period to retire all non-conforming lighting in the town to help with enforcement. This can vary from four to ten years as lighting equipment is generally amortized over a period of no more than fifteen years.

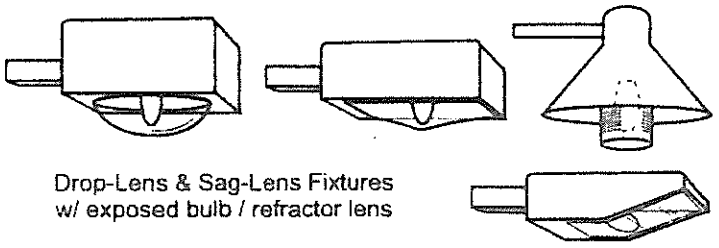
Unacceptable / Discouraged

Fixtures that produce glare and light trespass

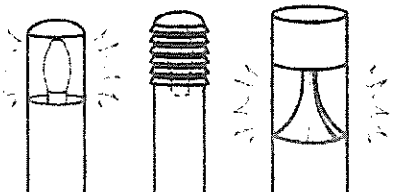


Unshielded Floodlights
or Poorly-shielded Floodlights

Unshielded Wallpacks
& Unshielded or
Poorly-shielded Wall
Mount Fixtures

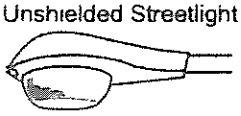


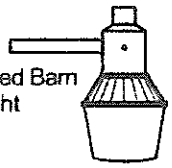
Drop-Lens & Sag-Lens Fixtures
w/ exposed bulb / refractor lens



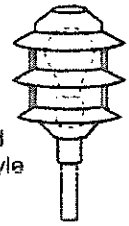
Unshielded Bollards

Unshielded Streetlight



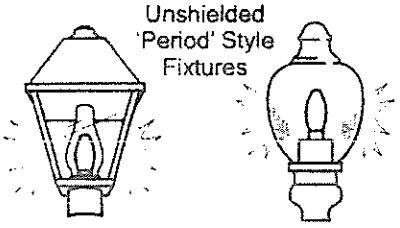


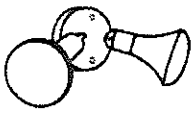
Unshielded Barn
Light



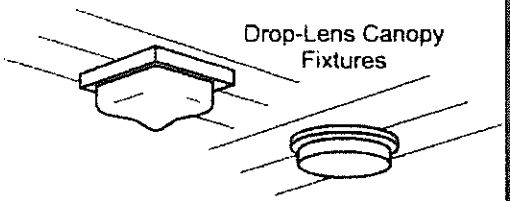
Louvered
Marine' style
Fixtures

Unshielded
'Period' Style
Fixtures





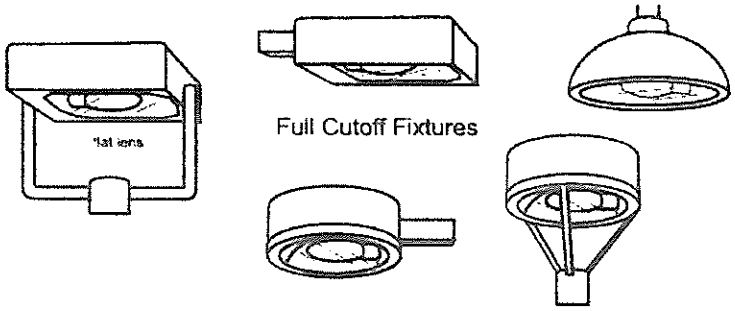
Unshielded PAR
Floodlights



Drop-Lens Canopy
Fixtures

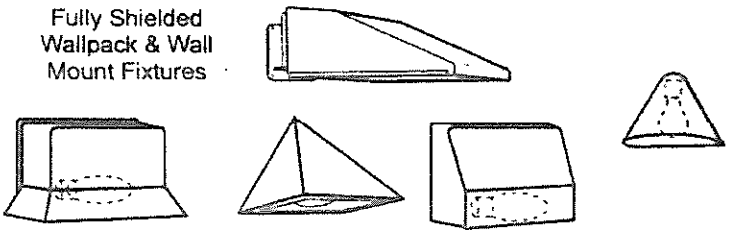
Acceptable

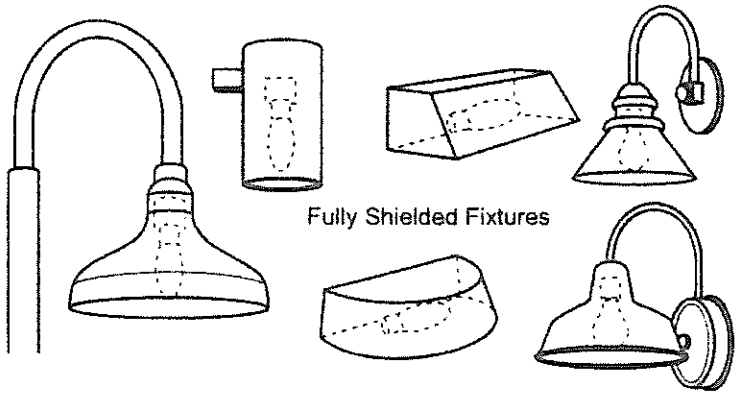
Fixtures that shield the light source to minimize glare and light trespass
and to facilitate better vision at night



Full Cutoff Fixtures

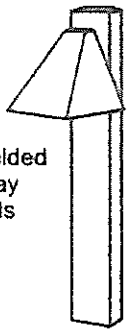
Fully Shielded
Wallpack & Wall
Mount Fixtures



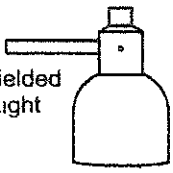


Fully Shielded Fixtures

Full Cutoff Streetlight



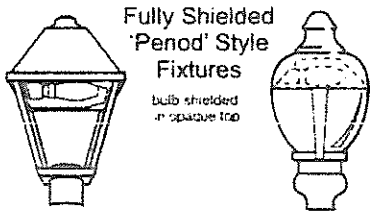
Fully Shielded
Walkway
Bollards



Fully Shielded
Barn Light

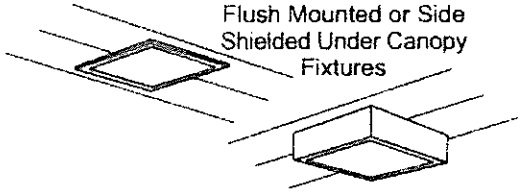
Fully Shielded
Decorative
Fixtures

bulb shielded
in opaque top



Fully Shielded
'Penod' Style
Fixtures

bulb shielded
in opaque top



Flush Mounted or Side
Shielded Under Canopy
Fixtures

US GREEN BUILDING COUNCIL

LEED

Light Pollution Credit:

Light Pollution Reduction

Intent: Eliminate light trespass from the building and site, improve night sky access and reduce development impact on nocturnal environments.

Requirements:

Meet or provide lower light levels and uniformity ratios than those recommended by the Illuminating Engineering Society of North America (IESNA) Recommended Practice Manual:
Lighting for Exterior Environments (RP-33-99). Design exterior lighting such that all exterior luminaires with more than 1000 initial lamp lumens are shielded and all luminaires with more than 3500 initial lamp lumens meet the Full Cutoff IESNA Classification.

The maximum candela value of all interior lighting shall fall within the building (not out through windows) and the maximum candela value of all exterior lighting shall fall within the property. Any luminaire within a distance of 2.5 times its mounting height from the property boundary shall have shielding such that no light from that luminaire crosses the property boundary.

Potential Technologies & Strategies.

Adopt site lighting criteria to maintain safe light levels while avoiding off-site lighting and night sky pollution. Minimize site lighting where possible and model the site lighting using a computer model. Technologies to reduce light pollution include full cutoff luminaries, low-reflectance surfaces and low-angle spotlights.

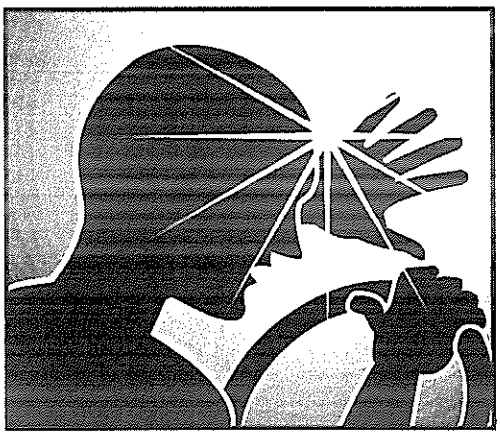
A Municipal Guide to Responsible Outdoor Lighting

An educational, user-friendly guidebook for municipalities interested in establishing safe, responsible outdoor lighting standards designed to reduce light pollution.

Outdoor Lighting Problems and Issues Facing Municipalities

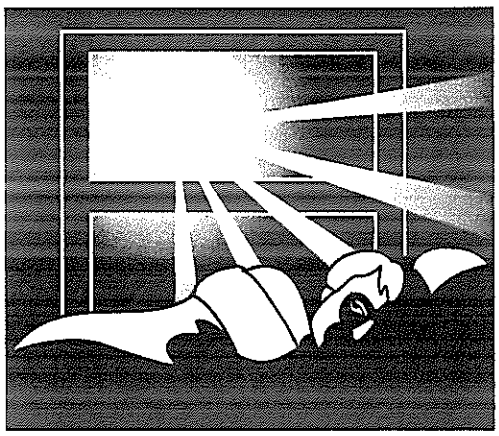
Originally designed for the benefit and security of our society, much of today's outdoor lighting is poorly applied. This can detrimentally impact a community's quality of life, environment and public safety. Most of the solutions are common sense.

Glare



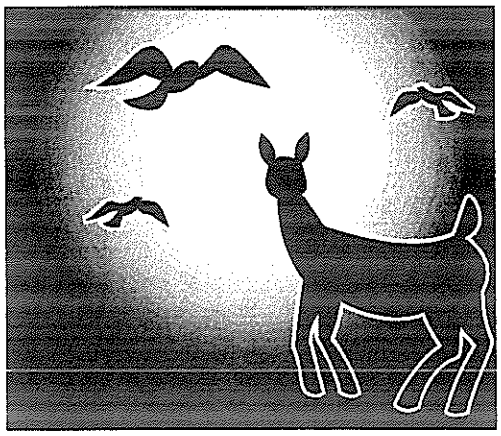
Glare from poor outdoor lighting can actually reduce visibility and safety at night.

Intrusion



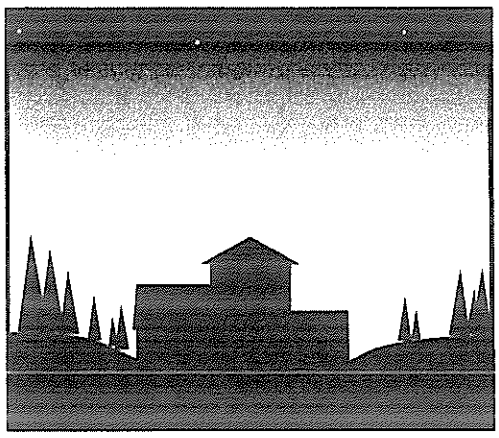
Light Trespass from poor outdoor lighting intrudes into homes and onto properties, where it is not wanted.

Nature



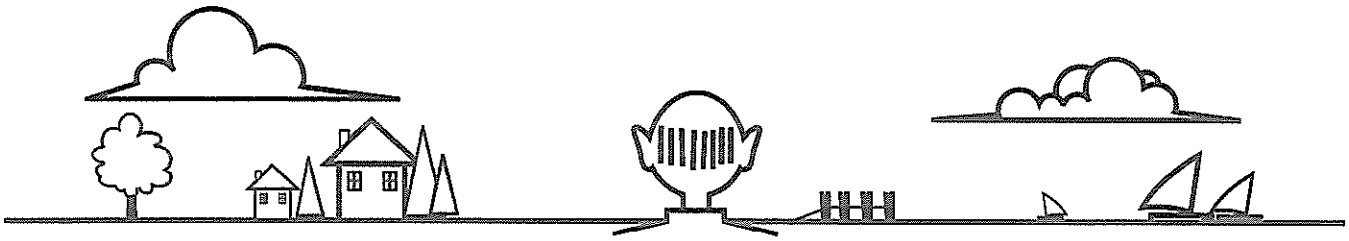
Stray light spills into natural areas, which can disturb the natural cycles of flora and fauna.

Sky Glow

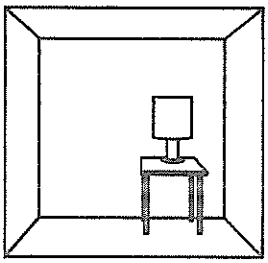


Poorly directed light not only wastes energy, but it also produces 'sky glow', which hides the starry night sky.

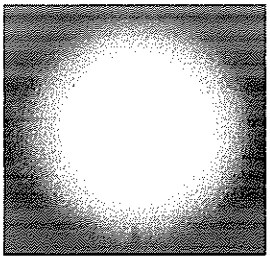
Understanding Outdoor Lighting (Vision)



An important aspect of natural human vision is 'peripheral vision', which allows us to see a wide view of our surroundings. We feel safest when we are able to visualize most of what is around us.



Indoors at night, we usually enjoy good peripheral vision with lighting. It is because there are many surfaces that reflect light and surround us with illumination - like walls and ceilings.

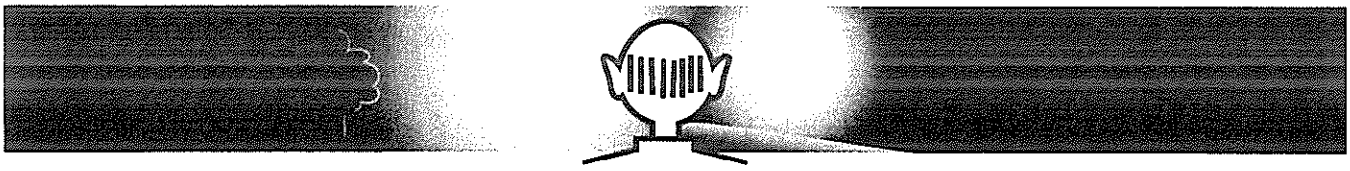


In contrast, outdoor lighting is mostly surrounded by the deep backdrop of night, which creates a very different kind of lighting environment for the eye.

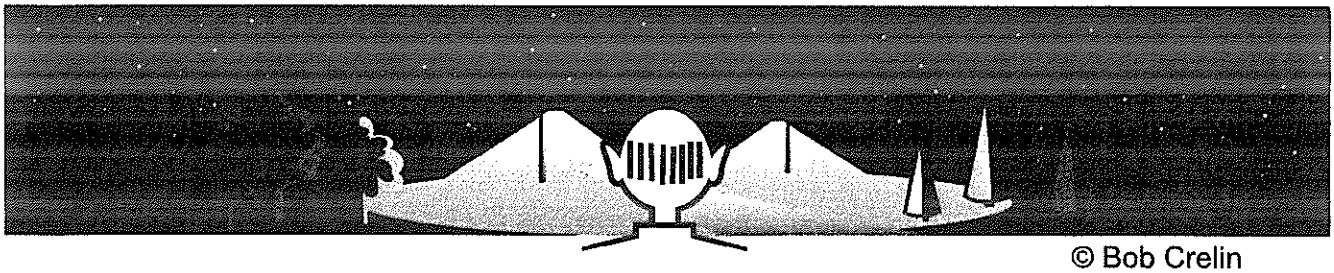
Reducing Contrast for Better Visibility

The eye is *not* designed to adjust to see in both darkness and brightness at the same time. Therefore, *the greater the contrast between dark and light*, the less that our eyes can see overall.

Outdoors at night, overly-bright lighting creates a strong contrast against the surrounding areas. In this unnatural environment, the eye will automatically adjust to the brightest object in the field of view (usually, the exposed, bright light source). Surrounding areas which are less bright, become difficult to discern, and we lose much of our peripheral vision.



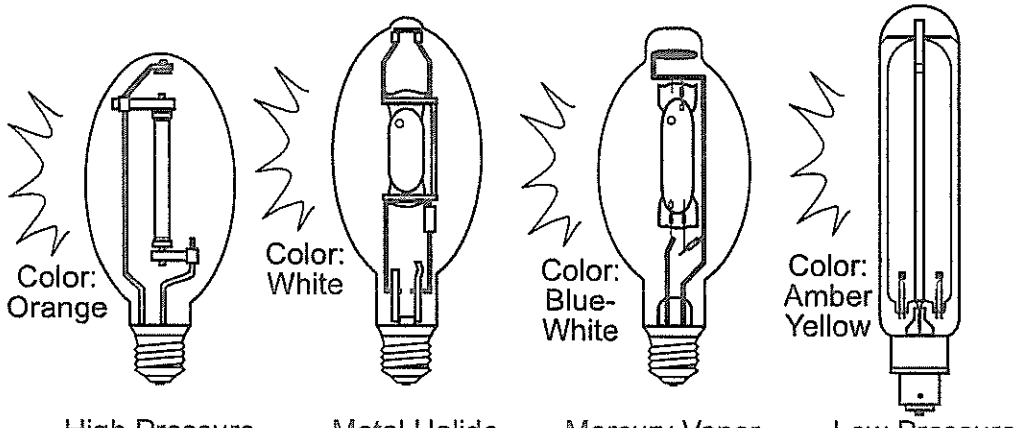
Shielding the brightness of a light source reduces the contrast. Similar to stage lighting in a theater, this presents a 'scene' of the light reflected off of the subjects in view. The lessened contrast allows the eye to naturally adjust to the dim surrounding areas - restoring much of one's peripheral vision.

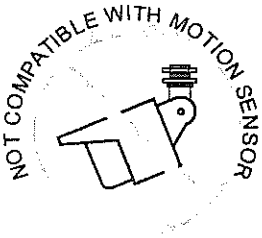


Understanding Outdoor Lighting Light Sources

High Intensity Discharge Lamps & Luminaires (HID)

Used for larger commercial, municipal site lighting, sport and street lighting





Luminaires (lighting fixtures) that use HID lamps and ballasts are designed for lighting large areas, for long hours, while offering minimal maintenance. HID lamps are powered by a ballast, or electronic transformer that is designed for each lamp specifically. Because of this ballasted system, a different lamp, or different wattage lamp cannot be 'swapped' in HID luminaires. Also, because of their slow start-up time, motion sensors cannot be used with HID luminaires

Uses for the different HID types:

High Pressure Sodium (HPS)
Orange-gold light used for most general purpose applications - roadways, parking lots

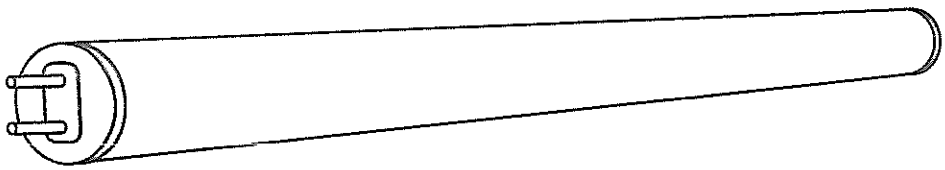
Metal Halide (MH)
White light for full color rendering - outdoor display sales, architectural lighting

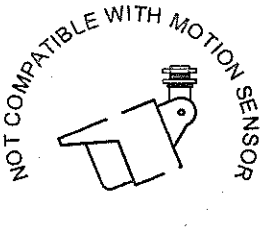
Mercury Vapor (MV)
Blue-White light is an older, less efficient technology - mostly superceded by MH and HPS

Low Pressure Sodium (LPS)
Amber-Yellow light, monochromatic: efficient, but limited color rendering, best for use near astronomical observatories to minimize interference with observation/research

Fluorescent Lamps & Luminaires (FL)

Used for larger and small commercial, sign lighting, municipal site lighting and other applications



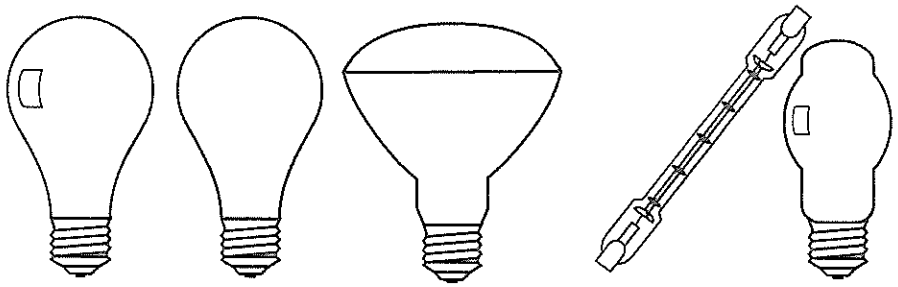


Luminaires (lighting fixtures) that use fluorescent lamps and ballasts are also designed for lighting large areas, for long hours, while offering minimal maintenance. Very energy efficient, fluorescent lamps are powered by a ballast, that is designed for each lamp specifically. Different wattage fluorescent lamps also cannot be 'swapped' in different luminaires and can't be used with motion sensors, because of their slow start-up time.

Light Sources continued

Incandescent & Halogen (INCD and HLGN)

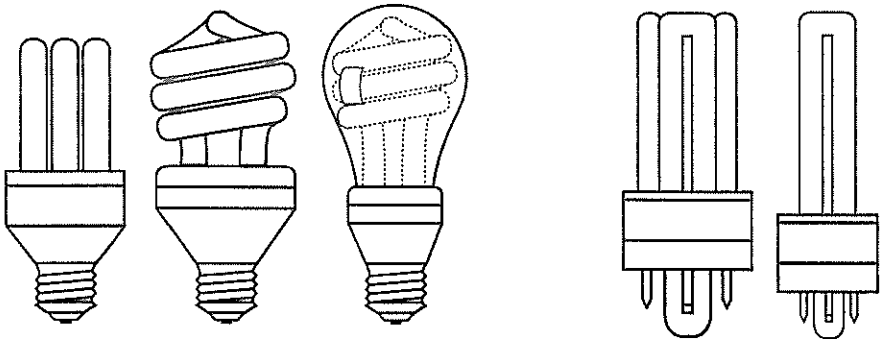
Used for residential lighting, small commercial and some municipal areas

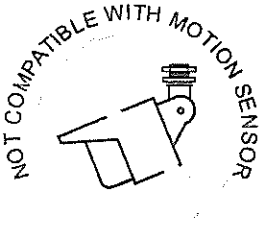


The lamps (or bulbs) most familiar to us are the standard incandescent bulbs, which are used for lighting small/medium areas and doorways. Halogen lamps are a similar technology but offer brighter light output per watt for the same types of uses. These light sources are the least energy efficient, and are not designed for long hours of use. Because there is no ballast, different wattage lamps can be 'swapped' in different INCD or HLGN luminaires and can also be used with motion sensors.

Compact Fluorescent (CFL & PL)

Used for residential lighting, small commercial and some municipal areas





Screw-in compact fluorescent lamps (CFL) are a modern alternative for standard incandescent lamps. CFL lamps have a self-contained ballast and can be used for most of the same type applications as INCD. PL (plug-in) compact fluorescent lamps use a separate dedicated ballast. These light sources are very energy efficient, and are designed for long hours of use. NOTE: some CFL bulbs are not designed for use in extreme cold temperatures (below -10˚F). Some CFL lamps are designed for use with motion sensors - please check specifications.

EDUCATION

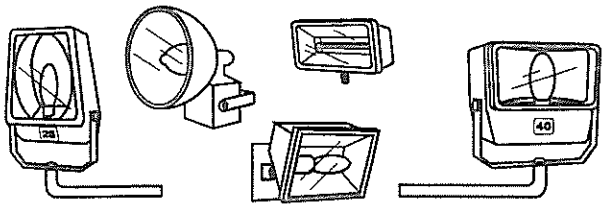
Understanding Outdoor Lighting Luminaires

Luminaire (Fixture) Types

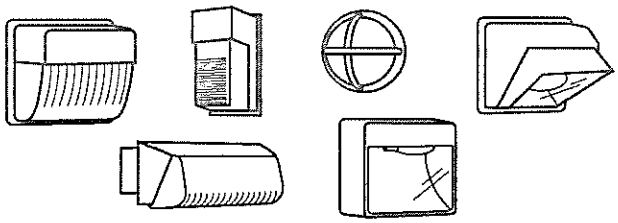
Unshielded, Partially Shielded

Full Cutoff, Fully Shielded

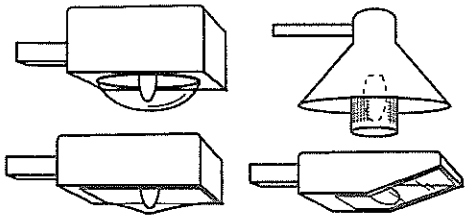
Floodlights (unshielded)



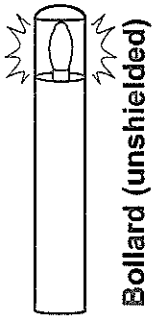
Wallpack-type (unshielded, or partially shielded)



Drop-Lens & Sag-Lens Cutoff Fixtures



Bollard (unshielded)

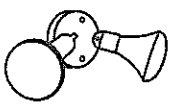


Drop-Lens Streetlight

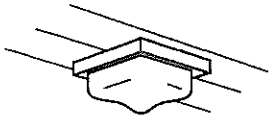
Unshielded "Security" Light

Unshielded Decorative Fixtures

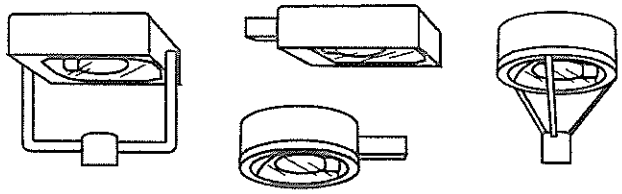
Unshielded PAR Floodlights



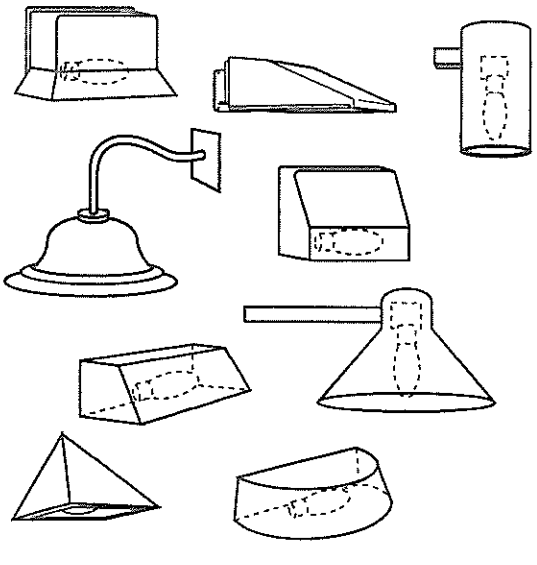
Drop-Lens Canopy Fixtures



Full Cutoff Fixtures



Shielded Wall-Mounted Fixtures



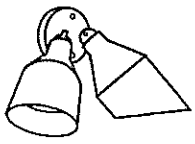
Shielded Bollard

Full Cutoff Streetlight

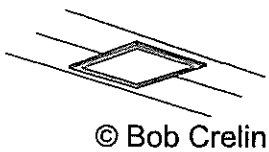
Shielded "Security" Light

Fully-Shielded Decorative Fixtures

Shielded PAR Floodlights



Flush-Lens Canopy Fixtures



Understanding Outdoor Lighting Measuring Light

How Bright is a Light Source? Use **Lumens,** NOT Watts.

When discussing the rated power, or power needs of an electric device, we often use the term "watt(s)". Lamps and light fixtures have a wattage rating. This is often mistakenly thought of as a measure of a lighting product's 'brightness'.

Watt is a unit of electrical power, indicating the rate at which the electricity is being used. However, a light's wattage is not a reliable indicator as to how 'bright' a light source will be.

Instead, a **Lumen** is a unit of light output, indicating the rate of flow of light. The lumen rating of a lamp or light fixture is the best commonly-used indicator of a light source's brightness.

To illustrate the problems of comparing a light's wattage rating in relationship to it's brightness, Figure 1 is a comparison of similar wattage lamps, and their brightnesses.

Figure 1.

Wattage Rating	100 watt Incandescent Lamp	100 watt High Pressure Sodium Lamp*
Brightness	1700 lumens	9000 lumens

* Total fixture wattage would include ballast wattage of aprox. 30 watts - total 130 watts

Notice the large difference when comparing the brightness (lumens) of these two 100 watt lamps. The 100 watt HPS lamp is over **5 times** brighter than the 100 watt incandescent lamp.

Figure 2 shows a comparison of two lamps of similar brightness, yet different wattages.

Figure 2.

Wattage Rating	100 watt Incandescent Lamp	26 watt Compact Fluorescent Lamp*
Brightness	1700 lumens	1650 lumens

* Ballast included

These two lamps are very close in brightness (lumens), however the wattage rating of the compact fluorescent lamp is almost **one quarter** of the wattage rating of the incandescent lamp. Today, packaging and materials provided with consumer and commercial lighting products indicate the lumen rating of the lamp, or light source.

Understanding Outdoor Lighting (Lighting Plans)

Determining Proper Light Levels, **Illuminance**, **Footcandles**, etc.

Light pollution is not only caused by poorly-shielded lighting, but also by the reflected light from installations that are needlessly over-lit. Preventing overlighting can be accomplished by referencing recommended standards for safe and adequate illuminance levels (see below).

Illuminance is a measure of light density at a given point, or points (measured horizontally at ground level, or vertically on a vertical plane). Illuminance is measured in **footcandles** (lumens per square foot), or by **lux** (lumens per square meter). Most commonly in the USA, footcandles are used when displaying illuminance levels in lighting plans.

Site **lighting plans** should include **iso-footcandle** (iso-lux) **diagrams**, which are created by the lighting designer, or lighting manufacturer, and calculated/endered by computer program. These indicate footcandle levels at ground level, on a point-by-point grid (see Figure 3). Iso-footcandle diagrams should also include a **calculation summary** of footcandle (Fc) levels of the lighting plan, shown in **maximum, average** and **minimum**, as well as the **uniformity ratio** (see figure 4). The **luminaire schedule** (Figure 5) lists and describes the equipment.

Figure 3 • Iso-Footcandle Diagram of Site Plan (section of)

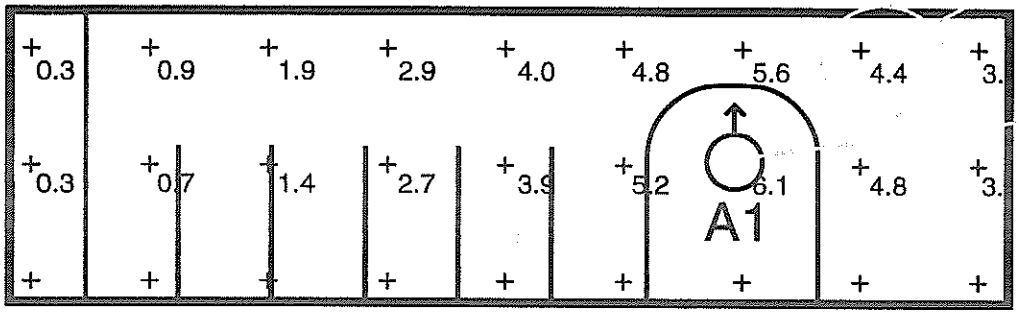


Figure 4 • Calculation Summary (of Footcandle levels)

Calculation Summary					
Area Name	**Units**	**Max**	**Avg**	**Min**	**U.Ratio - Max/Min**
Display	**Fc**	**6.0**	**2.5**	**0.3**	**20.0**
Secondary	**Fc**	**3.2**	**1.2**	**0.1**	**32.0**

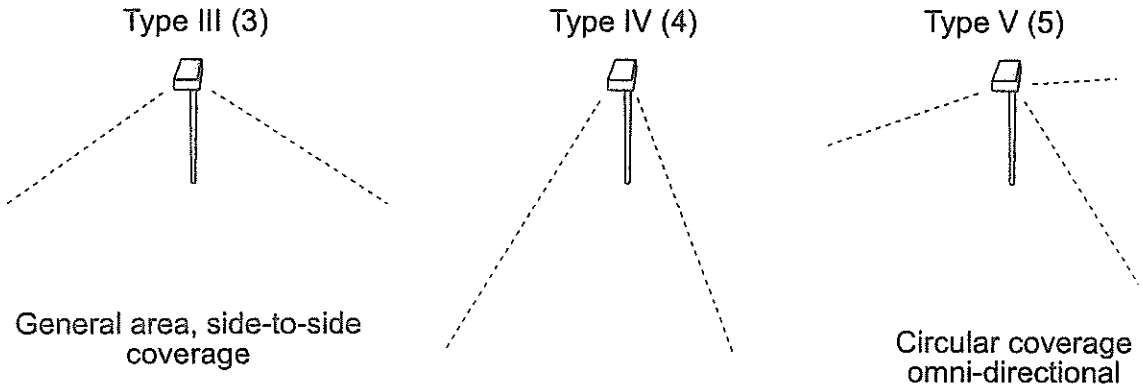
Figure 5 • Schedule Showing Luminaire (fixture) information

Luminaire Schedule					
Symbol	Label	Qty	Description/Model	Lumens	Height
○→	A1	4	General Light X-3, 400 MH-IV	36000	18'
□→	A2	2	General Light X-1, 175 MH-III	16000	18'

Understanding Outdoor Lighting (Lighting Plans)

Determining Proper Light Levels, **Patterns and References.**

Luminaire Distribution Pattern Types
established by the Illuminating Engineering Society of North America (IESNA)
These patterns below illustrate the way that each luminaire type directs it's lighting.



Referencing **Illuminance Recommendations** for Site Lighting Plans

The Illuminating Engineering Society of North America (IESNA, or IES) is an organization that is referred to as a standard-maker for many lighting application recommendations.
The IESNA offers recommended illuminance levels for different types of commercial sites as well as parking lots, roadways, sportsfields, etc. These standards are researched and peer-reviewed. Selected 'Recommended Practice' (RP) booklets are available through the IESNA, and can be used as a legitimate reference when setting light level limits. Below are specific RP booklets which offer illuminance recommedations which will control most light pollution and light trespass problems.

IES

• ***Lighting For Exterior Environments***
#RP-33-99
List Price $45.00*

• ***Lighting For Parking Facilities***
#RP-20-98
List Price $45.00*

• ***Addressing Obtrusive Light***
(Urban Sky Glow and Light Trespass)
in Conjunction with Roadway Lighting
#TM-10-00
List Price $15.00*

*price subject to change

Preventing Glare & Trespass (Shielding)

The Problem - **Glare**

At night, the direct view of a luminaire's light source (lamp and/or reflecting or refracting elements) can diminish vision and intrude into neighboring properties - where it is not wanted. However, direct light from low-brightness lighting may not cause these problems to the degree of concern.

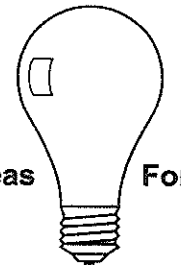
Therefore, the key is to determine a threshold- in other words, **at what brightness, and above** that a light source needs to be **shielded.**

Shielding the glare of the direct light above a given brightness will serve to prevent the problems

☆ The Action ☆

Using the **lumen-rating** (brightness) of the light source, determine **the lumen threshold** that a luminaire should be shielded.

Below are suggested lumen thresholds for shielding which will minimize visual glare and intrusive trespass.



For rural and low ambient light areas

900 lumens

equal to aprox. 60 watt incandescent

For urban and high ambient light areas

1800 lumens

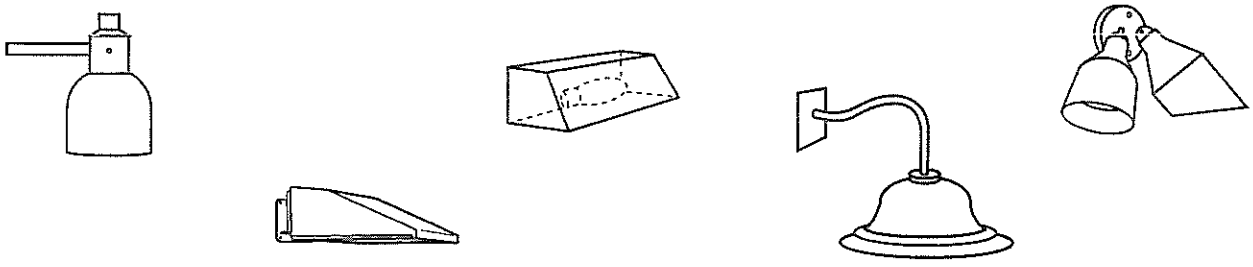
equal to aprox. 100 watt incandescent

Suggested wording:

☆ **Any luminaire with a lamp rated at _____ lumens or above, must be a full cutoff**

(Please note: because of the exposed view of light source, 'cutoff' type luminaires are not included here)

Some examples of full cutoff and fully-shielded luminaires
(for more examples, see the right column of illustrations on page 5).



Controlling Over-Lighting (Site Lighting Plans)

The Problem - **Excessive Outdoor Illumination Levels**

Today, many commercial sites use outdoor lighting illumination levels that are several times brighter than those needed to operate their business safely. This over-lighting can negatively impact a community by direct and reflected light that trespasses into neighboring properties and contributes to sky glow.

To prevent excessive lighting levels, a municipality can choose to refer to appropriate illumination level recommendations, established for the lighting industry by the IESNA. By using these legitimate directives, lighting designers, manufacturers and architects, etc. can design to a industry-recognized standard.

☆ The Action ☆

The regulation will refer to those relevant publications with offer illuminance recommendations for commercial sites.

☆ Suggested wording

All lighting plan submissions must observe illuminance recommendations for site lighting as published in booklets **RP-33-99** and **RP-20-98** by the IESNA (see page 9)

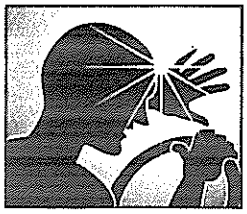
Lighting plans shall, at least, meet these illuminance level recommendations, and shall not exceed recommended maximum levels by 25%. (see page 8)

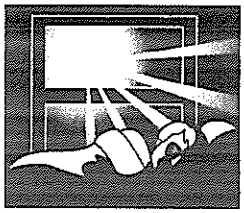
Check List for Reviewing Site Lighting Plans

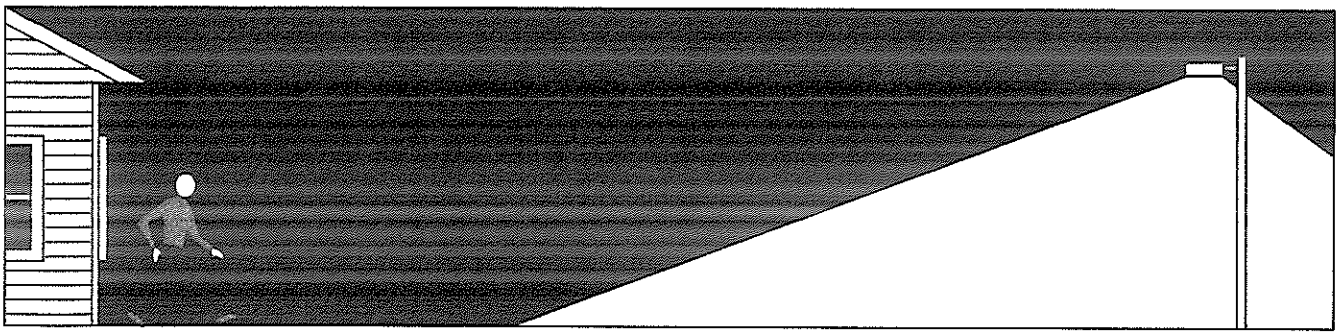
1.) For ALL outdoor lighting plan submissions, the following items are required:
Luminaire (fixture) manufacturer's cut sheet(s). Luminaire cutoff charactertistics, lumen-rating and mounting height must be clearly indicated.

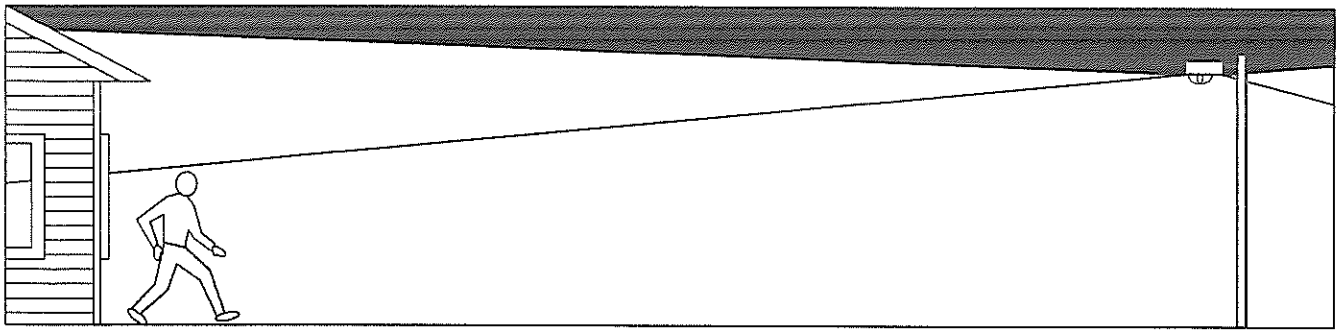
2.) For outdoor lighting plan submissions employing 3 or more luminaires,
the following items are required:
An iso-footcandle diagram depicting:
a. positions of all luminaires
b. point-by-point footcandle readings on grid showing full site coverage including 10' beyond property line
c. footcandle calculation summary, showing max/avg/min & uniformity ratio (max/min)
d. luminaire schedule, indicating total luminaires, descriptions and mounting height

Controlling Glare & Light Trespass (Luminaires)









New York Times

October 7, 2008
EDITORIAL

A Little Less Light

It is almost impossible for most of us to imagine the time, long before the invention of the light bulb, when the stars were bright enough to cast shadows. Nobody wants to go back to dark alleyways, but we also know that man-made light can pollute as well as illuminate.

Scientists are only now studying how perpetual twilight affects the lives of birds and other animals, but there is no doubt that a clear, starry night has become a diminishing human pleasure.

Huge, electrified cities spread their nighttime glow for miles. On a 9-point scale — with 1 being a truly dark night — New York City ranks as a 9 and most suburbs seldom reach below a 5. Light is so pervasive that during a blackout in Los Angeles, some residents became alarmed at a liquidlike substance that had taken over the sky. It was, of course, the Milky Way.

Environmentalists, most notably the Arizona-based International Dark-Sky Association, have begun pushing for ways to preserve as much of the night sky as possible. The organization also helps promote dark parks where visitors can observe a starry night, if not like Galileo's, at least like those still visible a few decades ago.

Some public officials in Connecticut and Arizona have done particularly well promoting these darker skies by using better lighting. Pete Grannis, the New York State environmental commissioner who has long been pushing to limit light pollution, should stay on the case. Now, New York City Councilman Alan Gerson also has begun arguing that streetlights should be aimed downward in a way that spares the sky and cuts the glare in people's eyes. It is a sensible proposal and well worth the energy.

http://www.nytimes.com/2008/10/07/opinion/07tue4.html?_r=1&oref=slogin

http://www.nytimes.com/2008/10/07/opinion/07tue4.html

NATIONAL GEOGRAPHIC November 2008

NATIONAL GEOGRAPHIC

Our Vanishing Night: Most city skies have become virtually empty of stars.

By Verlyn Klinkenborg

If humans were truly at home under the light of the moon and stars, we would go in darkness happily, the midnight world as visible to us as it is to the vast number of nocturnal species on this planet. Instead, we are diurnal creatures, with eyes adapted to living in the sun's light. This is a basic evolutionary fact, even though most of us don't think of ourselves as diurnal beings any more than we think of ourselves as primates or mammals or Earthlings. Yet it's the only way to explain what we've done to the night: We've engineered it to receive us by filling it with light.

This kind of engineering is no different than damming a river. Its benefits come with consequences—called light pollution—whose effects scientists are only now beginning to study. Light pollution is largely the result of bad lighting design, which allows artificial light to shine outward and upward into the sky, where it's not wanted, instead of focusing it downward, where it is. Ill-designed lighting washes out the darkness of night and radically alters the light levels—and light rhythms—to which many forms of life, including ourselves, have adapted. Wherever human light spills into the natural world, some aspect of life—migration, reproduction, feeding—is affected.

For most of human history, the phrase "light pollution" would have made no sense. Imagine walking toward London on a moonlit night around 1800, when it was Earth's most populous city. Nearly a million people lived there, making do, as they always had, with candles and rushlights and torches and lanterns. Only a few houses were lit by gas, and there would be no public gaslights in the streets or squares for another seven years. From a few miles away, you would have been as likely to smell London as to see its dim collective glow.

Now most of humanity lives under intersecting domes of reflected, refracted light, of scattering rays from overlit cities and suburbs, from light-flooded highways and factories. Nearly all of nighttime Europe is a nebula of light, as is most of the United States and all of Japan. In the south Atlantic the glow from a single fishing fleet—squid fishermen luring their prey with metal halide lamps—can be seen from space, burning brighter, in fact, than Buenos Aires or Rio de Janeiro.

In most cities the sky looks as though it has been emptied of stars, leaving behind a vacant haze that mirrors our fear of the dark and resembles the urban glow of dystopian science fiction. 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 throw shadows on Earth—is wholly beyond our experience, beyond memory almost. And yet above the city's pale ceiling lies the rest of the universe, utterly undiminished by the light we waste—a bright shoal of stars and planets and galaxies, shining in seemingly infinite darkness.

We've lit up the night as if it were an unoccupied country, when nothing could be further from the truth. Among mammals alone, the number of nocturnal species is astonishing. Light is a powerful biological force, and on many species it acts as a magnet, a process being studied by researchers such as Travis Longcore and Catherine Rich, co-founders of the Los Angeles-based Urban Wildlands Group. The effect is so powerful that scientists speak of songbirds and seabirds being "captured" by searchlights on land or by the light from gas flares on marine oil platforms, circling and circling in the thousands until they drop. Migrating at night, birds are apt to collide with brightly lit tall buildings; immature birds on their first journey suffer disproportionately.

Insects, of course, cluster around streetlights, and feeding at those insect clusters is now ingrained in the lives of many bat species. In some Swiss valleys the European lesser horseshoe bat began to vanish after streetlights were installed, perhaps because those valleys were suddenly filled with light-feeding pipistrelle bats. Other nocturnal mammals—including desert rodents, fruit bats, opossums, and badgers—forage more cautiously under the permanent full moon of light pollution because they've become easier targets for predators.

Some birds—blackbirds and nightingales, among others—sing at unnatural hours in the presence of artificial light. Scientists have determined that long artificial days—and artificially short nights—induce early breeding in a wide range of birds. And because a longer day allows for longer feeding, it can also affect migration schedules. One population of Bewick's swans wintering in England put on fat more rapidly than usual, priming them to begin their Siberian migration early. The problem, of course, is that migration, like most other aspects of bird behavior, is a precisely timed biological behavior. Leaving early may mean arriving too soon for nesting conditions to be right.

Nesting sea turtles, which show a natural predisposition for dark beaches, find fewer and fewer of them to nest on. Their hatchlings, which gravitate toward the brighter, more reflective sea horizon, find themselves confused by artificial lighting behind the beach. In Florida alone, hatchling losses number in the hundreds of thousands every year. Frogs and toads living near brightly lit highways suffer nocturnal light levels that are as much as a million times brighter than normal, throwing nearly every aspect of their behavior out of joint, including their nighttime breeding choruses.

Of all the pollutions we face, light pollution is perhaps the most easily remedied. Simple changes in lighting design and installation yield immediate changes in the amount of light spilled into the atmosphere and, often, immediate energy savings.

It was once thought that light pollution only affected astronomers, who need to see the night sky in all its glorious clarity. And, in fact, some of the earliest civic efforts to control light pollution—in Flagstaff, Arizona, half a century ago—were made to protect the view from Lowell Observatory, which sits high above that city. Flagstaff has tightened its regulations since then, and in 2001 it was declared the first International Dark Sky City. By now the effort to control light pollution has spread around the globe. More and more cities and even entire countries, such as the Czech Republic, have committed themselves to reducing unwanted glare.

Unlike astronomers, most of us may not need an undiminished view of the night sky for our work, but like most other creatures we do need darkness. Darkness is as essential to our biological welfare, to our internal clockwork, as light itself. The regular oscillation of waking and sleep in our lives—one of our circadian rhythms—is nothing less than a biological expression of the regular oscillation of light on Earth. So fundamental are these rhythms to our being that altering them is like altering gravity.

For the past century or so, we've been performing an open-ended experiment on ourselves, extending the day, shortening the night, and short-circuiting the human body's sensitive response to light. The consequences of our bright new world are more readily perceptible in less adaptable creatures living in the peripheral glow of our prosperity. But for humans, too, light pollution may take a biological toll. At least one new study has suggested a direct correlation between higher rates of breast cancer in women and the nighttime brightness of their neighborhoods.

In the end, humans are no less trapped by light pollution than the frogs in a pond near a brightly lit highway. Living in a glare of our own making, we have cut ourselves off from our evolutionary and cultural patrimony—the light of the stars and the rhythms of day and night. In a very real sense, light pollution causes us to lose sight of our true place in the universe, to forget the scale of our being, which is best measured against the dimensions of a deep night with the Milky Way—the edge of our galaxy—arching overhead.

U.S.News & World Report

Turning Out the Lights

The dangers of a bright night are becoming more apparent

By Ben Harder Posted March 14, 2008

The night is not what it was. Once, the Earth was cast perpetually half in shadow. Man and beast slept beneath inky skies, dotted with glittering stars. Then came fire, the candle, and the light bulb, gradually drawing back the curtain of darkness and giving us unprecedented control over our lives.

But a brighter world, it is becoming increasingly clear, has its drawbacks. A study released last month finding that breast cancer is nearly twice as common in brightly lit communities as in dark ones only added to a growing body of evidence that artificial light threatens not just stargazing but also public health, wildlife, and possibly even safety.

Those findings are all the more troubling considering that an estimated 30 percent of outdoor lighting—plus even some indoor lighting—is wasted. Ill-conceived, ineffective, and inefficient lighting costs the nation about $10.4 billion a year, according to Bob Gent of the International Dark-Sky Association, a nonprofit that aims to curtail light pollution, and it generates 38 million tons of carbon dioxide a year.

Motivated by such trends, more than two dozen cities worldwide will go dim on March 29 in an hourlong demonstration. At 8 p.m. local time, Atlanta's and Chicago's tallest towers, the Phoenix Suns' arena, and San Francisco's Golden Gate Bridge will join many other sites in turning off their lights. According to the World Wildlife Fund, which is organizing the event, an estimated 2.2 million Australians switched off their lights or took other action during "Earth Hour" last year in Sydney, briefly reducing that city's energy use by more than 10 percent.

A number of groups are trying to measure light pollution and assess its detrimental effects on the environment in the hope that people will reduce their own contribution to the problem. Last week, as part of an annual program called GLOBE at Night, thousands of students and amateur scientists stared up at the constellation Orion from locations across the country and reported how many of its stars they could see. No data are yet available, but in dark, rural areas, says Gent, about 2,000 stars are typically visible at night, compared with "maybe five" in a bright city square—and about 5,000 in centuries past. "One of the goals," says Steve Pompea of the National Optical Astronomy Observatory in Tucson, Ariz., "is to identify urban oases—places in our cities that are dark enough to see the sky."

People who are working while others are stargazing may face the greatest risks. Hormonal disturbances triggered by nighttime exposure to white or bluish light can disrupt circadian rhythms and fuel the growth of tumors, experiments show. Two decades of research indicate that women who work night shifts have unusually high rates of breast cancer, and some data suggest a parallel effect on male workers' prostate cancer rates. Last December, a unit of the World Health Organization deemed shift work a probable human carcinogen.

Yet light and cancer may be even more fundamentally linked. In last month's study, a team that included Richard Stevens, the University of Connecticut Health Center epidemiologist who first proposed the connection, compared satellite images of Israel at night with maps showing where cancers are most common. Its analysis suggests that 73 percent more breast cancers occur in the country's brightest communities than in its darkest.

Beaming up. Light beamed into the sky is squandered, since it's not illuminating any target. Yet many fixtures—like old-fashioned spherical streetlamps—send plenty of photons upward and outward. "If you fly into a city at night and you can see the streetlights from the airplane," says Chad Moore, leader of the National Park Service's Night Sky Program, "that light is counterproductive." As the light bounces off particles in the air, it casts a far-reaching "sky glow," he says. "We have documented light from distant cities traveling roughly 200 miles into national parks."

And while lighting is often installed in the name of safety, says Gent, it may ironically benefit criminals. A pedestrian temporarily blinded by the glow of an ATM, for instance, may be an easier target for a mugger hiding in the shadows. In fact, most light that goes directly from its source to a person's eye is worse than worthless. Such glare—from a car's high beams, a poorly aimed porch light, or even an unshielded window—inhibits night vision, paradoxically making it harder to see. That can endanger drivers, not to mention hapless deer.

Even far from the city, light can threaten wildlife. To avoid predators, says conservation biologist Paul Beier of Northern Arizona University, "a lot of herbivores just eat much less under moonlit conditions." Artificial glow may make every night seem lit by a full moon, perhaps resulting in chronic underfeeding. Moreover, he says, "lighting can be very disorienting for animals that are trying to move at night." So wildlife corridors might be compromised by even a single lit roadway, says Travis Longcore, coeditor of the book *Ecological Consequences of Artificial Night Lighting* and codirector of the Los Angeles-based Urban Wildlands Group. "If the corridors aren't dark, the animals they're protected for aren't going to use them."

Glare also endangers sea turtles, bats, and other species, Longcore says. Glowing beacons on communication towers attract and disorient migratory birds, sometimes causing thousands to perish in collisions in a single night. An unpublished study by Joelle Gehring, a scientist with Michigan State University, shows that switching the towers' solid red beacons to flashing ones would slash avian mortality. Gehring is now working with agencies and industry groups to determine if the change is feasible and safe for low-flying aircraft.

Local communities, meanwhile, are taking light-limiting steps of their own. In Illinois, the lieutenant governor has commended the example of Homer Glen near Chicago, which in December became the latest of numerous municipalities nationwide to pass an ordinance requiring new businesses to install fixtures that minimize glare by directing light downward; limit their per-acre light output; and turn off nonsecurity lights soon after closing for the night. Residents like Debra Norvil, who helped craft the rules, also are complying with certain restrictions. Norvil has removed some of her landscape lighting and turns off the rest at 10 p.m. "The night sky is a national treasure," she says.

And while light pollution "isn't our nation's biggest problem," says Moore, "it's one of the easier environmental problems to fix. You can change a light bulb, and it's done."

http://www.usnews.com/articles/science/2008/03/14/turning-out-the-lights.html

NEW YORK TIMES New York Section Page One
http://www.nytimes.com/2008/11/02/nyregion/02lights.html?_r=1&ref=todayspaper&oref=slogin
November 2, 2008

Efficiency's Mark: City Glitters a Little Less

By KEN BELSON

The bright lights of the big city are getting a little bit duller — with just a hint of green. Motion sensors ensure that unoccupied offices, storerooms and canteens go dark after workers and cleaning crews leave at night. Dimmers soften overhead lights that once could burn only bright or not at all. Timers guarantee that buildings fade to black while the city sleeps.

Gone are the days when cheap electricity, primitive lighting technology and landlords' desire to showcase their skyscrapers kept floor after floor of the city's highest towers glowing into the night. Now, rising energy costs, conservationism, stricter building codes and sophisticated lighting systems have conspired to slowly, often imperceptibly, transform Manhattan's venerable nightscape into one with a gentler glow.

Instead of tower after tower shining at all hours — the World Trade Center stayed aglow long after its occupants went home — the skyline is becoming a patchwork of sparsely sparkling buildings decorated with ornamentally lighted tops.

"The tall tower with the illuminated floors on all night long is probably a thing of the past," said Randy Sabedra, the owner of RS Lighting Design, who is helping to create a new map of the city's most prominently lighted buildings. "You're not relying on the glowing floors to have the building presence. It is relying on the crown of light."

Since electricity set it ablaze more than a century ago, the skyline has dimmed a number of times. During World War II and the energy crisis of the 1970s, New Yorkers considered it patriotic to turn out lights. But such frugality disappeared once times were flush again (though the current troubles could leave more office space vacant, and thus dark).

The building boom of the last decade, the ever-expanding electronic billboards of Times Square and unshielded traffic lights have solidified New York's status as one of the country's most light-polluted cities, according to the International Dark-Sky Association, which has pushed for city and state legislation to turn the lights down.

New York scores a 9 on the 9-point Bortle Dark-Sky Scale, the association's favored measure, along with other major cities like Houston and Las Vegas; a typical suburban sky ranks a 5, while Tucson, which has stringent outdoor lighting codes, is also a 5.

Illumination Overkill

"The light bulb has not really gone on in their head yet," Susan Harder, who runs the association's New York section, said of city officials. "We'll always have an iconic skyline, but we don't need this big glow over the city."

To that end, the State Assembly passed legislation in June requiring that new outdoor lighting have shields that reduce glare and waste; the bill's sponsor, Assemblywoman Linda B. Rosenthal, a Manhattan Democrat, said it would most likely be taken up by the State Senate if the Democrats manage to win a majority on Tuesday (Republicans currently hold a one-seat advantage).

City Councilman Alan J. Gerson has introduced a variety of similar measures — to require full streetlight shields and motion detectors in all commercial and government buildings, and to mandate more efficiently lighted billboards. The first of the proposals could be taken up as early as this month. "The sky won't be totally dark," Ms. Rosenthal said. "But it's 2008, so we have to take into account energy concerns."

In many ways, the business community is ahead of the politicians. Several of the city's newest skyscrapers incorporate cutting-edge technologies that appeal to environmentalists — and those eager to keep energy costs down. Landlords have found that meeting stiffer energy efficiency standards in their new and refurbished buildings is a selling point with tenants, especially those that pay their own electricity bills.

"This time, the difference is that we're more conscious of what we're doing and the lighting industry is more advanced," said Meg Smith, a manager in New York for Lightolier, a manufacturer that specializes in lighting fixtures and controls.

Incentives to Change

As demand for electricity in New York rises and global competition drives energy prices higher, the cost of the technology that makes better use of daylight and reduces electricity use at night — motion sensors, software-driven timers and the like — is falling. In some cases, it takes just two years to recoup the investment in this equipment, down from five years not long ago, according to Mark Roush, director of New York marketing for Acuity Brands Lighting, the nation's largest maker of lighting fixtures.

That includes the growing number of rebates from state agencies and utilities, which are trying to reduce consumption to relieve stress on the electric grid and put off building expensive power plants and substations.

Con Edison, for instance, has asked the state for permission to offer businesses a variety of rebates for installing efficient lighting as part of its efforts to cut demand in New York City and Westchester County by 500 megawatts by 2015.

At the new 91,000-square-foot downtown offices of Incisive Media, which owns about 30 publications, including The American Lawyer magazine, the two floors are divided into four zones for overhead lighting so not all of the space has to be lighted or dark at a given time. Individual offices are equipped with motion sensors; on a recent evening, lights automatically shut off as workers left for the day. The cleaning crew was gone by 8 p.m., but because a handful of editors worked later, a timer tucked in a small closet turned off the remaining lights at 11 — and would turn them back on at 6 a.m.

"We have to balance the administrative time versus the energy savings," said Allison Hoffman, an Incisive Media executive who oversaw the construction of the space, at 120 Broadway. "We'll be constantly adjusting."

To qualify for tax credits and rebates from the State Energy Research and Development Authority, Incisive's architects, TPG, designed a system that emits less than 0.78 of a watt a square foot (1.1 watts a square foot are allowed under the building code for refurbished offices). They used fluorescent bulbs that are five-eighths of an inch in diameter, about 40 percent smaller than the previous generation of bulbs, and use 28 watts of electricity, compared with 42 to 48 watts for the old lights. Less-frequented areas like hallways have small halogen lights spaced far apart.

At the National Audubon Society's offices on Houston and Varick Streets, lights-out is set for 7 p.m. Ten minutes before, a warning flash alerts employees who need to work late that they should go to a light switch to reset the timers.

Clay Nessler, vice president of global energy and sustainability at Johnson Controls, helped develop a more complex system for the Citigroup tower in Long Island City, Queens, that helps keep cleaning crews on schedule. "It's going to increase productivity and lead to more efficiency," he said.

At the Renzo Piano-designed new headquarters of The New York Times, on Eighth Avenue, the rows of single 28-watt fluorescent bulbs that line the ceilings are connected to a computer network that lets maintenance workers quickly scan which ones need replacing or repair, rather than trolling the floors.

Like Incisive Media, The Associated Press divided its Manhattan headquarters, which covers two acres of floor space, into zones, allowing groups of workers to tailor the lights to their liking and preventing large banks from burning when just a handful of people are around. Such zones require a bigger initial investment because more circuits, outlets and other equipment need to be installed, but the system, Lightolier's iGEN, helped cut energy use by 28 percent in the first year, Ms. Smith said.

Footing the Bill

Because of the expense, advanced lighting systems are being installed primarily in new buildings or offices being retrofitted for new tenants. So changes to the city's nightscape will come gradually over many years.

But more and more, building owners are writing leases that require tenants to pay for their own electricity, leading many tenants to install more efficient lights. A lot of the new energy-efficient fixtures were designed to fit into the ceiling spaces that now hold older fixtures, making the upgrades easier and cheaper.

"Lights will diminish," said Guy Geier, senior partner at FXFowle, an architecture and interior design firm in Manhattan, "because over 10 or 20 years, those leases are going to roll over and the incentive is going to be there to start installing newer lights."

This is not the first time innovations in technology and construction have been visible in the nightscape. In the early 20th century, many buildings lacked air-conditioners, so most workers sat near the windows; that meant the yellowish light from the incandescent bulbs hanging above their desks flooded through open windows into the street.

Evolving Consciousness

As central air-conditioning and fluorescent lights spread after World War II, architects could build skyscrapers enclosed in glass, which gave off a cooler light; at the same time, more interior space was now viable, though lights there were less visible from the outside.
But as tall towers multiplied, the volume of light in Manhattan increased: Many buildings had only a few light switches on each floor, so if even one person was in the office, large swaths were aglow.

James Sanders, who used to work for the Port Authority of New York and New Jersey, recalled arriving at work one Sunday in 1985, finding only two switches on the entire 84th floor of one of the World Trade Center towers, and discovering that a janitor had to be called to flip one.

"They had to switch a half-acre of lights on just for me," he said. To his bosses, who were the landlords, leaving lights on all evening "was in part a symbol of power," he said.
These days, such landlords can light perimeter offices while keeping the center of a building dark. Others are installing more efficient LED lights outside buildings in place of older floodlights. Still others are focusing on the tops of their towers, joining the Empire State Building, whose color-coded homages are a New York icon.

Con Edison itself has adopted several of these techniques at its 26-story headquarters near Union Square, installing 344 LED fixtures on the clock tower in September. The fixtures, which are meant to last 15 years, use 63 percent less energy than conventional lights, and can be programmed to produce millions of colors without the need for filters (like those used at the Empire State) or other equipment.

Such ornamental statements will most likely become more prominent as the interiors of buildings continue to dim over time.

"New York City's skyline will always be a magical thing," said Mr. Sabedra, the lighting designer at work on the nightscape map. "It's something wonderful and beautiful about the city when it transforms at night, its building glow, its glowing canyons. It's a wonderful sight."

Boston Globe
http://www.boston.com/bostonglobe/editorial_opinion/editorials/articles/2007/11/12/hope_for_a_dimmer_future/

GLOBE EDITORIAL

Hope for a dimmer future

November 12, 2007

FACED WITH inaction at the state level, a number of Massachusetts towns have in recent years taken steps to reduce light pollution. An issue that grows more prominent as development expands, light pollution is the accumulated effect of the excessive artificial glow from buildings, street lamps, and billboards. Unregulated light pollution needlessly wastes energy, creates a dangerous level of glare for drivers, and seeps into nearby homes and apartments at night. While legislation at the local level is welcome, the state should take steps to deal with the nuisance of too much artificial light.

Of all the compelling reasons for the state to enact light pollution regulations, one packs an emotional punch: it is becoming more difficult to see the stars at night - not only in cities like Boston where the sky is becoming blanker, but in the suburbs as well. Astronomers are first to lament the trend. "It's harder and harder to find good places to do any viewing," says Paul Grueter, president of the South Shore Astronomical Society. But outdoor lights also hamper those simply looking for the Big Dipper with the naked eye.

Some changes often proposed by so-called dark sky advocates include shielding outdoor fixtures, so they shine on the ground below but not upward into the sky, and motion-sensor lights that turn on only when needed. A number of cities and towns in the state have some light pollution regulations, including Plymouth, which passed an ordinance in 1997. But many are ineffective, due to a lack of awareness and enforcement, advocates say.

Several states have passed light pollution laws. Arizona mandates shielding for most public light fixtures and requires different lighting levels for urban and rural areas. California's highways are dark-sky friendly. Massachusetts has no such law, despite the efforts of Representative James Marzilli of Arlington and dark sky advocates, who have been introducing legislation on the issue to no avail since the early 1990s.

Marzilli says he is puzzled at the lack of action, considering that Arlington has saved $100,000 a year on more dark-sky-friendly light fixtures, which use less energy. Recently Marzilli sponsored a light pollution bill that is a variant of what he has been introducing for years, and a provision within a broader energy bill that would require the Massachusetts Turnpike Authority to analyze inefficiencies in street lighting. Neither has left committee.

With a new governor professing his green credentials, and growing awareness of the effects of light pollution, these proposals may finally get some attention. The practical environmental, economic, and public safety benefits of regulation are many, but there is also a more profound goal: to make sure future residents of the state have a chance to feel awed as they peer into the night sky. ■

The New York Times
Saturday, November 1, 2008

Opinion

Heavens Above, Parking Lot Below

By CHARLES LOCKWOOD
Published: August 30, 2003
http://query.nytimes.com/gst/fullpage.html?res=9404E5DF1638F933A0575BC0A9659C8B63

This week Mars was closer to Earth than it had been for 60,000 years. But if you ventured out at night to look for ice caps and canals, chances are you saw only a slightly brighter and more pinkish smudge than usual. That's because 99 percent of Americans (and Europeans) live in places tainted by light pollution, according to NASA. Two-thirds of American homes no longer have a view of silky strands of the Milky Way -- we've "lost" 2,000 stars.

Light pollution comes in three basic types: skyglow light trespass and glare. Skyglow is the one that drowns out the stars. It is caused by poorly designed, unshielded and improperly aimed fixtures, like street lamps and billboards with bottom-mounted lights that "uplight" the advertisement. As the light floods upward, it reflects off airborne dust and moisture particles, obscuring the heavens. Thanks to skyglow, the 100-inch telescope at Mount Wilson outside Los Angeles -- where the astronomer Edwin Hubble discovered that the universe is expanding -- has been rendered virtually useless for deep-sky observations.

Light trespass hits closer to home: it is light that crosses property lines, like a neighbor's security floodlight that illuminates your backyard. Glare is caused by too much illumination applied to one area, like overly bright retail signs or high-wattage floodlights along highways. The American Automobile Association has cited glare as a contributing factor in traffic accidents.

Why has America gone night-light crazy? In part, because fear of the dark is as old as humanity. Now, thanks to Mr. Edison and the brothers Klieg, the fear of evening crime is leading us to replace the night with an orange-ish twilight zone. But do these bright lights make us safer? Only in our imaginations. The "more light is better" myth has been shot down in studies done at the Rensselaer Polytechnic Institute and the University of Huddersfield in England, among others. Overlighting does not reduce crime; it merely alleviates fear of crime, possibly creating a false sense of security. Excessive lighting can actually increase danger because it creates deep shadows where criminals can lurk.

Light pollution is also linked to sleep disorders, and it can disrupt plant and animal life, including the nesting and hatching patterns of endangered loggerhead turtles on Florida's beaches. And it is a terrible waste of energy and money. The International Dark-Sky Association, a Tucson-based group, estimates that American consumers, corporations and government agencies waste $2 billion a year on unneeded lighting. A prime culprit is the 175-watt mercury vapor lighting that has long been the choice for parking lots and street lights; the bulbs are cheap, but they draw a great deal of electricity and shed far more light than is usually needed.

Do people really think they need all this light? A study by the California Energy Commission found that most respondents wanted outdoor lighting to be only as bright as the full moonlight, which is about one one-hundredth of a foot candle (the unit used to measure light intensity). Yet most parking lots have lighting of 5 to 10 foot candles.

Some state and local governments have taken notice. Arizona enacted a light-control law in 1991, and has repeatedly strengthened it. Ten other states, and a host of towns ranging from Riverhead, N.Y., to Calabasas, Calif., have followed suit. Such laws vary, but typically they prohibit installation of mercury vapor lights, require newly installed outdoor fixtures to be shielded, and mandate that older, brighter lights be shut off automatically between, say, midnight and sunrise.

What else can be done? Schools, office buildings and industrial parks can replace their glaring dusk-to-dawn outdoor lighting with infrared motion sensors that sense unauthorized visitors and activate floodlights or strobes. Most important, people can pressure their communities to enact laws that regulate existing fixtures -- calling for lower-wattage bulbs and shades around fixtures -- not just new ones.

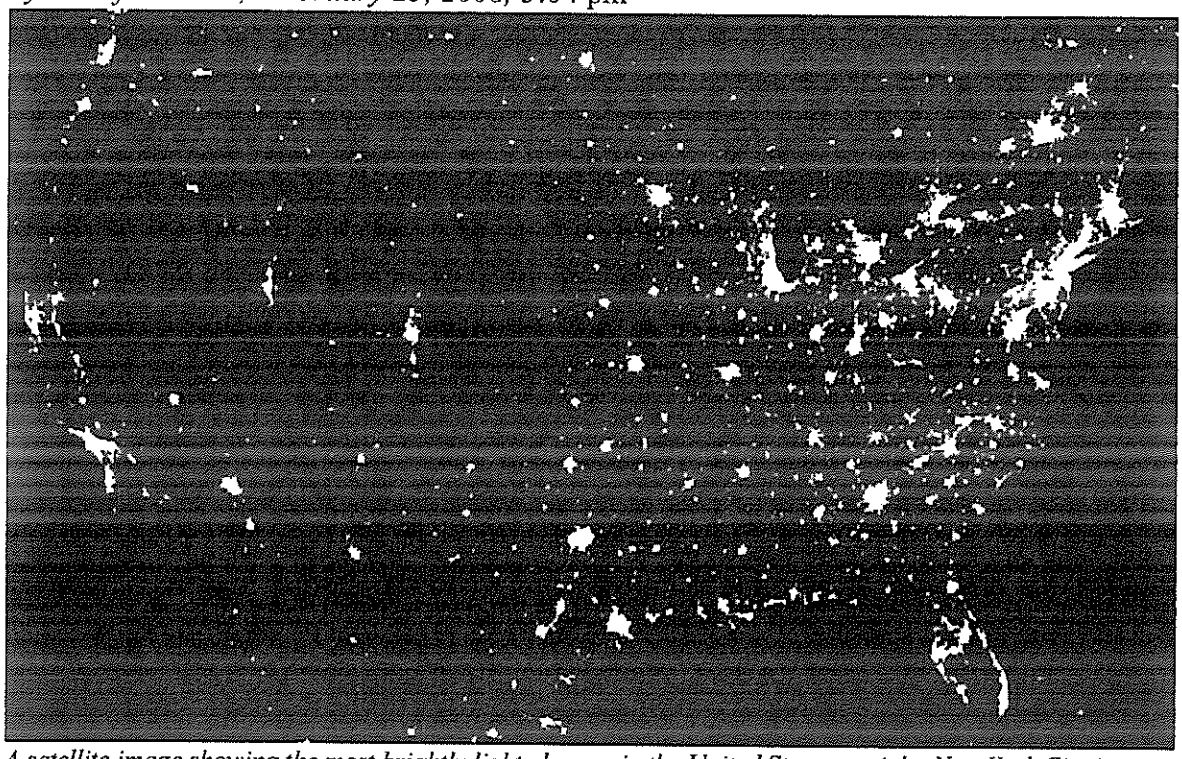
A generation ago, few Americans thought about excess noise or fertilizer runoff; most communities today have rules to fight those types of pollution. Now it's time to recognize light pollution as a danger to our quality of life and our pocketbooks. I'd like to see the Milky Way again, wouldn't you?

Charles Lockwood is author of "Bricks and Brownstone: The New York Row House, 1783 to 1929."

New York Times February 25, 2008 N.Y. REGION CITY ROOM

Bright Lights at Night, Perhaps Not Such a Delight

By Jennifer 8. Lee, February 25, 2008, 3:04 pm



A satellite image showing the most brightly lighted areas in the United States at night. New York City is second only to Las Vegas in measured nighttime brightness.

A new study that shows women who live in areas with brighter nighttime illumination have an increased chance of developing breast cancer drew attention from the folks at City Room.

Isn't New York City one of the more illuminated places in the country, if not the world? Who hasn't seen the satellite images of the tangled white sprawl along the Northeast corridor? When was the last time anyone saw more than a handful of stars from within the five boroughs? On top of that, City Room is right near Times Square, one of the more brightly lighted neighborhoods in one of the more brightly lighted cities in the entire world.

The study [pdf], published in the recent online issue of the journal Chronobiology International, overlaid satellite images and cancer registries in Israel and controlled for other demographic factors.

"It doesn't prove that lighting causes breast cancer," said Richard Stevens, a cancer epidemiologist at the University of Connecticut Health Center, who was involved in the study. "But it is a very important piece of evidence."

The new study is one of a growing number of studies that have suggested that nighttime light is disruptive to the body, though researchers are still trying to understand the underlying mechanisms.

Late last year, an arm of the World Health Organization announced its decision to classify graveyard shift work as a "probable carcinogen," in part because of controlled epidemiological studies of nurses, flight attendants and others who work at night have found breast cancer rates 60 percent above normal. A 2005 study in laboratory mice showed that nighttime exposure to artificial light stimulated the growth of human breast tumors by suppressing the levels of a hormone called melatonin, which curbs tumor growth and is produced by the body at night.

As a comparison, the Israeli study also looked at patterns of lung cancer and did not see increased rates among women who lived in brightly illuminated areas, which was expected since lung cancer is more closely linked to smoking.

With this knowledge in hand, City Room contacted the scientists at the National Geophysical Data Center in Boulder, Colo., to ask, just how bright is New York City?
The area of Manhattan south of Central Park is one of the brightest areas in the world. But it is not as bright as Las Vegas, where the Egyptian-themed and pyramid-shaped Luxor Hotel on Las Vegas Boulevard (well-known as the Strip) shines a light directly into the sky.

Las Vegas may be brighter, but the brightness is confined to a much smaller area. "There are probably more people who live in" the downtown areas of New York City than in similar areas of Las Vegas, said Benjamin Tuttle, a scientist for the Cooperative Institute for Research in the Environmental Sciences at the University of Colorado at Boulder.

New York is not only bright, but it is also part of a continuous sprawling mass of light that stretches from Boston to Washington, in one of the most illuminated areas in the world. Globally, the scientists said, New York is brighter than Tokyo, London or Paris. In the United States, after Las Vegas and New York, other bright cities include Chicago and Atlanta. Boston, Washington, Atlantic City, Wilmington, Del., and Baltimore are about on par with one another. San Francisco, Los Angeles and Seattle are also noticeable from space, but are not as bright as many of the cities on the East Coast.

New York City has been a battleground in the darker sky movement, in part because of environmental concerns (like migrating birds), in part because of nuisance (ballparks' flood lights), and in part because some people just like to see the night sky.
"When you look at satellite images of the night sky, it's clear there is too much light reflected back into space; all of this excess light disturbs the circadian rhythms of animals, migration patterns of birds and is starting to show human health effects," said State Senator Carl L. Marcellino, a Long Island Republican who has sponsored darker sky-legislation.

Light pollution has long been a complaint among New York City residents. "You could read a book in the apartments on the East Side of Manhattan from light that was inappropriately targeted from the ball fields of Roosevelt Island," said Pete Grannis, the commissioner of the state's Department of Environmental Conservation. Mr. Grannis sponsored legislation in Albany to curb bright lights when he was a state assemblyman.

The desire for dimmer lights, however, was not universally shared. "We have gotten nothing but resistance from the city," Mr. Grannis said. (The city's Transportation Department, which oversees the installation of street lights, has explained it had to balance the demands of safety with the demands of the dimmer lights.)

Now Mr. Grannis is looking at policy initiatives through the environmental conservation agency. "We're exploring other ways to deal with light pollution issues in the year ahead," he said. "We have very broad authority in the department."

Such initiatives are already having an impacts, even in urban areas. Dr. Tuttle said, "We have seen over time places that get less bright, which we assume are due to initiatives to contain light in the U.S."

So what can New Yorkers do in light of the emerging importance of darkness and our bodies?

"If you are in an urban area with lots of brightly lit streets and outdoor lighting, which New York has beaucoup of, I believe it would be a good idea to get blackout shades, so you don't get that in your bedroom," Dr. Stevens said. "Try to get your bedroom as dark as a possible." He emphasized, "I am persuaded that it is good for health to get a dark night's sleep."
http://cityroom.blogs.nytimes.com/2008/02/25/bright-lights-at-night-perhaps-not-such-a-delight/?scp=30&sq=%22light%20pollution%22&st=cse

FARMERS ALMANAC 2008

Light Pollution: Are you a culprit?

Before you go to bed, do you switch on your outdoor lights? If the answer is "yes", you may want to rethink your lighting strategy. Excess light is causing light pollution, a serious problem compromising our view of the universe, interfering with astronomical observations, as well as wasting billions of dollars a year, among other adverse effects.

What causes light pollution?

Light pollution is caused by many types of lights, including street lighting, security lamps, advertising and display lighting, floodlights for sporting events and building illumination, and more.Essentially, all these lights cause 1) sky glow over urban/suburban areas, blotting out our visibility of the sky as well as 2) glare that shines dangerously into peoples' eyes as they drive (or walk by). Other big problems, including threatening some forms of nocturnal wildlife, are caused as well. By some estimates, billions of dollars are wasted with these efforts to needlessly light up the sky.

Are you culprit? Take this quiz and find out.

1. Do you light only what needs lighting? Or do you have outside lights all over your yard that go on automatically every night?

Tonight, take a look outside and ask yourself "do I really need all of those lights on out there?" You may find out that you are a culprit.

2. Do your outside lights stay on all night?

If you've decided that the lights are necessary, is it necessary to have them on from dusk to dawn?

3. Do you think the "more light the better?"

Think again. Average 60 watt lighting is probably all that you need to find your way to your front door. You are not performing brain surgery or anything that requires bright intense lighting. The idea that "more is better" doesn't apply to lighting.

4. Do you own or know what cutoff light fixtures are?

Full cutoff fixtures shine the light down rather than up. This avoids excess light shinning into the sky, where it's not usually needed. Cutoff lights also help keep the lights on your property, rather than shinning into your neighbor's yard.

5. Do you own any motion sensor lights?

Nighttime lighting can help you feel more secure. Studies have shown, however, that the light is still out on whether or not nighttime lighting really helps keep criminals out (some suggest it makes it easier for people to steal or vandalize). However, if you feel better having a light by your garage or back door, why not install motion sensor lights. This way the lights will automatically go on whenever there is activity only. They also shut off automatically too.

6. True or False: Light Pollution doesn't affect you.

False. It does. Look at your electric bill. Look at your night sky. Can you make out the big or little dipper? Is there a glow from the next town over? Light pollution affects all of us and there are easy ways to reduce this type of pollution and conserve energy and money.

Make a difference this year. Shut off some of your lights or learn how to install more night-sky-friendly ones. To learn more about Light Pollution go to:

http: www.dark-sky.org mc page do http: www farmersalmanac.com astronomy a light-pollution-are-you-culprit

DNR blames Tucker bird deaths on fog
For the Cumberland Times-News
October 10, 2008 10:37 pm

— HAMBLETON, W.Va. — An investigation of more than 500 dead birds found last month at Tucker County High School found that the birds died from crashing into the building, according to the West Virginia Division of Natural Resources.

As part of standard procedure, officials from the West Virginia Department of Health and U.S. Department of Agriculture tested sample specimens for both West Nile virus and avian influenza. All samples tested negative for both diseases.

An additional sample was sent to the Southeastern Cooperative Wildlife Disease Laboratory in Athens, Ga.

Officials collected the majority of the birds near the outside walls of the school and from the roof. Some were collected from the adjacent parking areas and athletic field. All evidence was consistent with a large-scale collision event.

DNR and the U.S. Fish and Wildlife Service are working with the Tucker County Board of Education and Allegheny Power to remedy the situation at the school. They will modify lighting to make the site less attractive to migratory birds. The site will be monitored for additional mortality for the remaining 2008 migratory period and into future years.

The peak of neotropical songbird migration occurs in late September and early October and is concentrated along mountain ridges. Large bird strikes are not uncommon throughout North America during this time frame.

Events like these occur when several environmental conditions occur simultaneously in proximity to a lighted man-made structure.

These conditions typically include dense fog, southerly winds and a dome of artificial light surrounding a structure. The event can be further amplified by a period of rain prior to the event that concentrates birds by delaying migration.

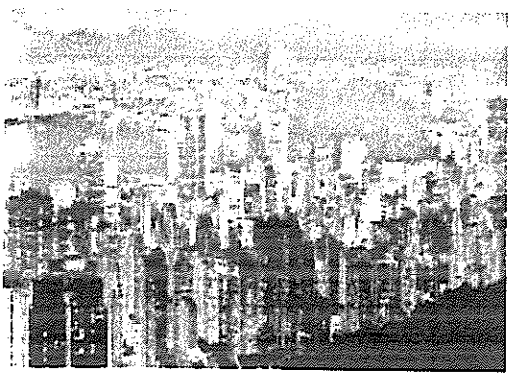
Three days of rain prior to Sept. 29 were followed by a passing cold front that generated southerly winds and ideal migration conditions. These birds headed south, encountered dense fog along Backbone Mountain, were attracted by the dome of light surrounding the school, became disoriented and began to circle the structure, crashing into windows and the outside walls. Some birds may have died from exhaustion from constant circling.

Similar events have been documented in West Virginia in the past.

Officials recovered 501 birds representing 31 species at the site. Seven birds recovered and were released alive.

http://www.times-news.com/local/local_story_284223806.html

Hong Kong



Hong Kong Should Control Light Pollution

Hong Kong, one of the world's most densely built-up and populated metropolises, is under pressure from green groups to curb its energy use from neon signs and lighted advertising. With the popularity of green consciousness and global warming fears, environmentalists are increasingly critical of this ostentatious display, calling it unnecessary and wasteful.

Hahn Chu, the environmental affairs manager for Friends of the Earth, said the trend is getting worse and worse: "Hong Kong always thinks the brighter things are, the more prosperous we seem, but people often forget that we're wasting energy."

A recent public opinion poll on energy conservation by the Council for Sustainable Development found 71 percent of over 80,000 people backed turning off neon lights in the small hours.

The city's environmental protection department received some 50 complaints about light pollution in 2008, up from the 40 cases received in 2007, with neon signs posing a growing nuisance for the public.

One of the worst offenders in an online poll was a massive neon sign advertising luxury brand Prada that blasted an intense white light onto a near-deserted Central street until till 5 a.m. every day.

One respondent called it a flamboyant wastage that creates light pollution.
A Prada spokesperson in Hong Kong said the company was "actively seeking a solution and we will reduce the lighting", but offered no specifics.

Friends of the Earth called on retailers and building owners to set a lights-off time after business hours to conserve energy and reduce emissions.

Hong Kong's electricity consumption grew 18 percent between 1997-2006, outpacing local population growth of 5.9 percent in the same period, the group said.
Light pollution is not a new concept for Hong Kong.

Photographs of global "artificial night sky brightness" from NASA display a conspicuous "luminous fog" around much of Western Europe and North America as well much of Japan, Taiwan, while Hong Kong shows up as a bright spot in the southern China region.

Light pollution has become so pronounced that two thirds of the U.S. population and about half the EU are no longer able to see the Milky Way with the naked eye, according to global experts.

Hong Kong leader Donald Tsang, in his annual policy address last week, said the government would "assess the problem of energy wastage of external lighting and study the feasibility of tackling the problem through legislation." Source: redOrbit Staff & Wire Reports

PREVENTING CRIME:

WHAT WORKS, WHAT DOESN'T, WHAT'S PROMISING:

A REPORT TO THE UNITED STATES CONGRESS 1998

Prepared for the National Institute of Justice

http://www.ncjrs.gov/works/

http://www.renewal.net/Documents/RNET_Research_Effectsimproved-street.pdf

"We may speculate that lighting is effective in some places, ineffective in others, and counter productive in still other circumstances. The problematic relationship between lighting and crime increases when one considers that offenders need lighting to detect potential targets and low-risk situations."

(Fleming and Burrows 1986)

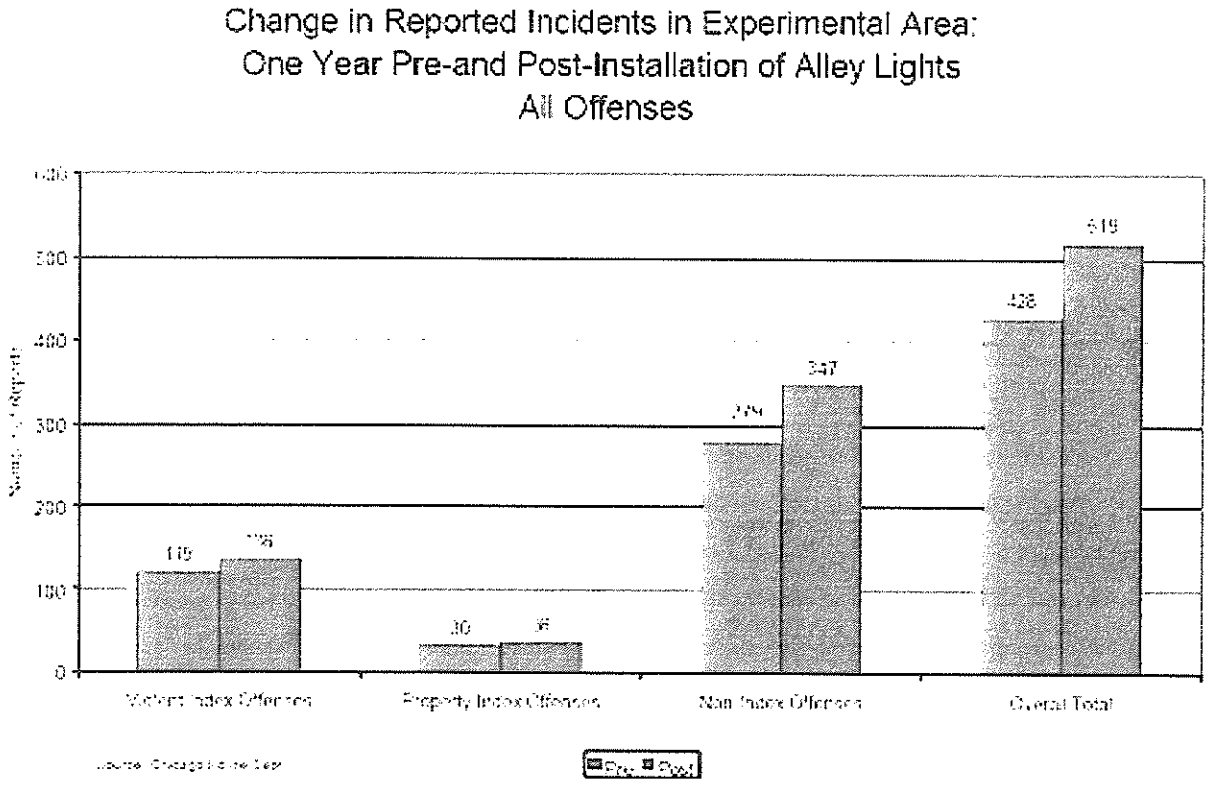
The study found little support to support the misconception that "brighter is safer", and even suggested that poorly designed lighting might actually increase personal vulnerability.

CHICAGO CRIME STUDY

The city of Chicago released this report citing the effect of increased night time illumination and crime.

After massively increasing outdoor lighting...

"...there was a 21 percent increase in reported evening incidents that occurred in alleys (428 to 519).



"These findings indicate that, during the study period, there did not appear to be a suppression effect on crime as a result of increased alley lighting. **In fact, it appears that with the increased lighting came an increase in the number of crimes** reported to the Chicago Police Department."

TULSA WORLD

Security lighting can have dark side

by: PHIL MULKINS World Staff Writer 9/3/2008 12:00 AM
http://www.tulsaworld.com/news/article.aspx?subjectID=15&articleID=20080903_53_E4_hCriti410271

Critics say bright lights actually can obscure criminal activity. Opinions are mixed when it comes to leaving on driveway lights at night to discourage car thieves and burglars. "Lighting up your valuables creates opportunity by attracting the wrong kind of attention" is one point of view. Because most driveway lights are simple floodlights or "farm lights," they create a glaring light that neighbors dislike and block by closing their blinds and drapes. This eliminates neighbor-watchfulness as a deterrent. An alternative is installing motion-detector lights on porches and driveways, but these are obvious to any experienced thief and not really a deterrent.

Patric Johnstone, a longtime blinding-streetlight critic and author of a 61-page report for then-Mayor Bill LaFortune in 2002 on municipal street-lighting, challenges "the flawed premise that street-lighting prevents crime — a theory debunked by the Department of Justice in studies finding no real correlation between street-lighting and crime."

Johnstone posted articles about streetlights on TulsaNow's Web site, at tulsaworld.com/blindlight, stating that their glare can blind witnesses to potential criminal activity. A telling story is that of Minneapolis in a Dec. 24, 2006, Minneapolis Star Tribune story on its "blinded by the streetlights" experience.

Minneapolis has installed thousands of ornamental acorn- and lantern-style streetlamps since 1991, "to improve neighborhoods and reduce crime, but the new lights are overly bright and poorly designed, making it difficult for police officers to see through their glare," the story says. The lighting was so bad that suspects were often not seen by officers. Laboratory tests of the lights showed that they were "thousands of times brighter than their surroundings, meaning they cast a disabling glare." City planners were told of this in 1999 but continued installing them — about 8,500 over 10 percent of the city.

These types of streetlights cast light in every direction — up, down and mostly out into everyone's eyes. It's the same as facing the headlights of oncoming traffic, except streetlights shine relentlessly. Detail disappears as eyes struggle to adjust to their brightness. Contributing to the problem is the low height of the lights and their faux-antique fixtures being ill-suited for modern bulbs. Dimmer bulbs didn't deliver enough light.

Reports from lighting consultants said the glare was a problem for police, motorists and pedestrians, and especially older people. A focus group said the glare made the streets less safe and comfortable, even though the Minneapolis Department of Public Works considered the streetlights' purpose to be "increasing the city's safety and comfort." Minneapolis property owners paid for the lights through tax assessments. Each light cost the city about $6,000.

In Tulsa, Johnstone protested Vision 2025 funding for "acorn" streetlights, saying their design places only 30 percent of their light output on the ground at angles useful to human vision and the other 70 percent into the eyes of observers as glare.

"Acorns are decorative but terribly inefficient, antique-style lights that produce more glare than useful light, and have to be installed at a ratio of three acorns to every one cobra-head light they replace," Johnstone wrote.

Dunmow, United Kingdom
Crime reduction when streetlights turned off

Correction: crime is falling 12:30 - 10 July 2008

THE Broadcast wishes to retract a statement made in last week's article on street lights in Dunmow.

In the story we stated "a massive rise in crime has been recorded". In fact, figures indicate that has actually been a substantial fall in crime, particularly in the hours the street lights have been switched off.

Official figures from Essex Police state that crimes in the town have nearly halved since the scheme began, 58 in April to May 2007, compared to 39 from April to May 2008.

A spokesman from Essex County Council said: "There has been much uninformed speculation that crime has risen since a part night street lighting trial has been operating and Essex County Council would like to point out that in fact the opposite appears to have been true.

"In fact, based on preliminary figures from Essex Police, from September last year (when the trial began) Uttlesford District has seen a substantial fall in crime during the hours the street lights have been switched off (midnight to 5am), opposed to a slight increase during other times.

"In Great Dunmow, one of the areas mentioned in recent press coverage, during the hours part street lighting has been operating overall crime has fallen with another substantial fall between the hours of 12am and 5am and overall crime at all times in the town has also fallen.

"This street lighting trial is being carried out following positive feedback from residents and in order to reduce our impact on the environment and similar examples have been successfully tried in other parts of the country.

"These latest crime statistics will be fully reviewed when the part night trial comes to an end."

A spokesman for Essex Police said: "The county is a very safe one and recorded crime figures for Dunmow and Saffron Walden between the hours of 11.30pm and 5.30am have borne this out.

"A year on year comparison for April 2006 to May 2007 and April 2007 to May 2008 has shown that night-time crime has almost halved in Saffron Walden and reduced by over a third in Dunmow.

"One of the factors raised by Essex Police following consultation with Essex County Council about the street lighting initiative was the fear of crime which must not be underestimated.

"This has recently been highlighted by residents in Dunmow who have sent a petition to the council signed by 39 residents who all feel that their safety is under threat.

"Essex Police is broadly supportive of the street lighting initiative. Where there are specific areas of concern in respect of public safety Essex Police will engage in discussions with the council."

NO LIGHT AT NIGHT: NIGHT TIME BLACK OUTS AND VANDALISM

Battle Ground School District in Clark County has reduced vandalism to almost zero with a policy to darken campus after 10:30 p.m. Spokane School District and Riverside School District have been experiencing similar results for over six years.

Is it possible to save energy and cut crime at the same time? According to school district experience, vandalism has been cut by simply turning off the lights. Sound preposterous? Experience shows that contrary to conventional law enforcement theory, which stresses well-lit areas, many districts had less vandalism once they've instituted a dark campus policy to save energy dollars. This is significant when you consider how much vandalism costs schools.

In 1980, California public schools lost approximately 13 million dollars from vandalism related acts during non-school hours, according to statistics collected by the State Department of Education.

One of the first school districts to reason that vandals get no thrill out of working in the dark was the San Antonio School District in Texas. In 1973 they started a night time black out program at 19 schools. Sam Wolf, Director of Security for the district says, "I remember as a kid, we never hung around in the dark. We hung around a street light or some other kind of illumination. We wanted to see who was with us. With vandalism, the thrill is seeing the windows broken, in seeing the words written on the wall. It is no thrill to hang around in the dark".

Vandalism damage in the district was reduced from $160,000 in the late 1960's to $41,000 per year. Also, "We saved so much on utilities that our business managers and everybody else were quite impressed," says Wolf.

CALIFORNIA RESULTS

Bill Bakers, retired Associate Superintendent for the East Side Union High School District in San Jose, who pioneered an energy savings program that has saved over a million dollars per year, reports:
"We are not aware of any school districts where blacking-out campus coincided with an increase in vandalism, burglary, or arson. There has not been an increase of such incidents in our district during the hours of total blackness. It seems logical that a blackout discourages youth from entering campuses -- they have as much fear of the unknown as anyone else. In case of burglars, any light shown on a campus is cause for suspicion on the part of neighbors and police."

Don Rodriguez, former Energy Manager for Cupertino Union School District reported that vandalism decreased an additional 29% or $8,160 during 1981-82, when they instituted a dark campus policy, along with their anti-vandalism program, Project Pride. Project Pride rebates a percentage of the savings resulting from a decrease in projected losses due to vandalism. It also involves a variety of activities including weekly, monthly, and semiannual reports and graphs and charts on vandalism rates.

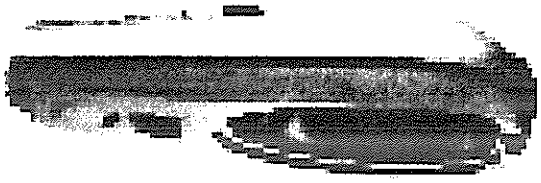
While the cause and effect between night time blackouts and a reduction in vandalism is not clear cut, no one has reported an increase in vandalism due to night time blackouts.

The Livermore Joint Unified School District has had a dark campus policy since 1974. Director of Facilities Maintenance, Rudy D'Ambra says:

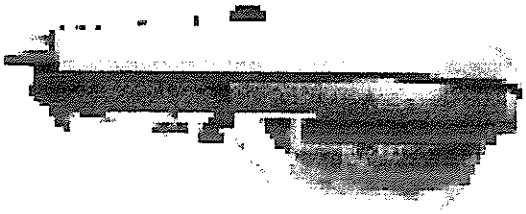
"A dark campus policy positively will not increase vandalism. This is what many people are concerned about, including the police, but it did not happen. We've noticed a slight decrease in vandalism over the years, but we have done other things too, like vandal watches and Sonitrol."

Energy Savings in his district were about ten percent per year after the first full year of the dark campus policy.

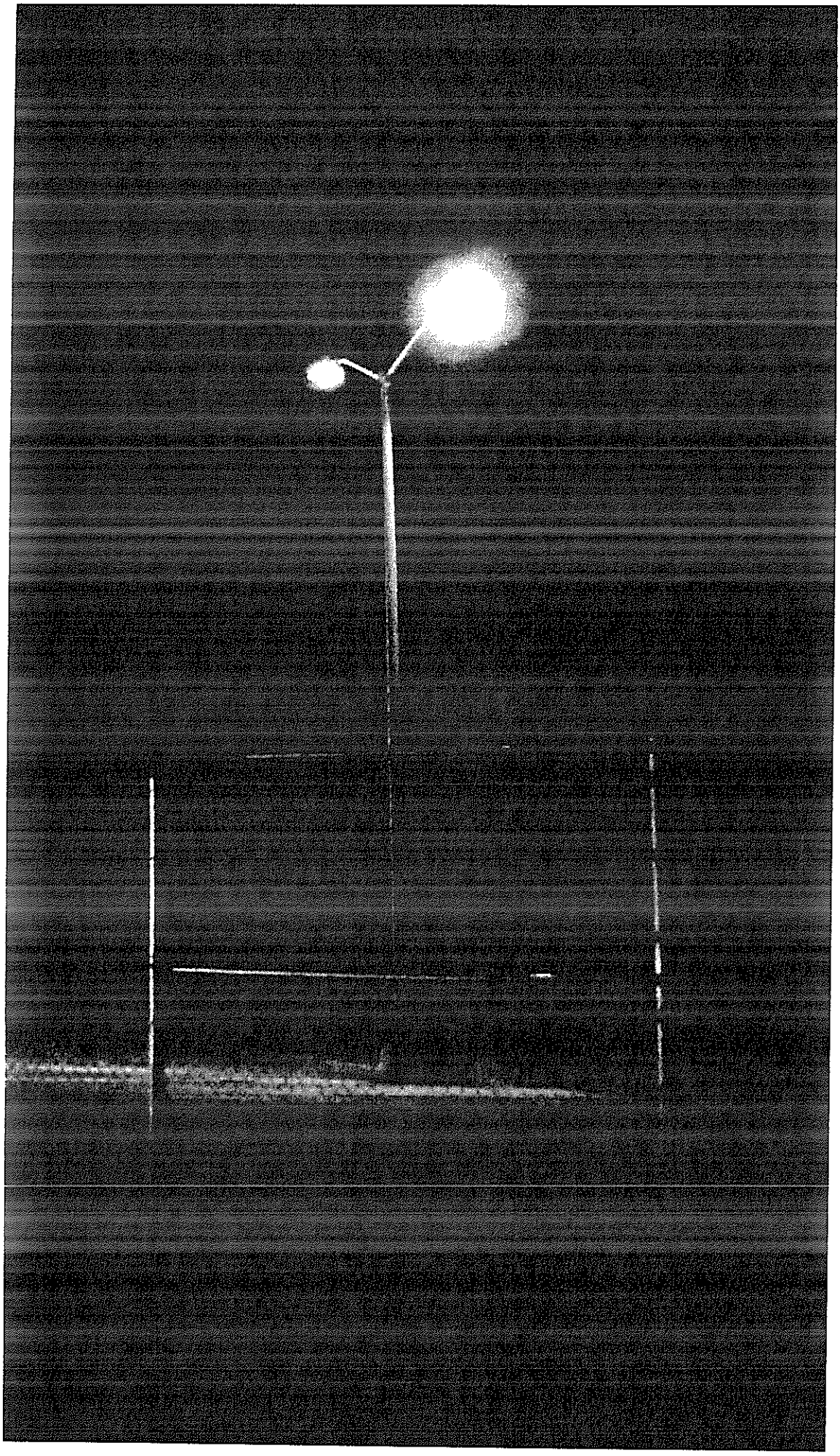
California Energy Extension Service



GOOD Flat-lens cobra head fixtures provide excellent roadway lighting with greatly reduced glare and no uplight.



BAD The ubiquitous drop-lens cobra head luminaire produces a level of glare and uplight that is both unacceptable and unnecessary.



Los Angeles cobrahead

Los Angeles, which has 240,000 streetlights, has had an FCO standard for at least a decade. in fact, its Bureau of Streetlighting (http://www.lacity.org/BSL/index.htm) is so proud of this fact that around 2001 the Bureau created a 24-minute video titled "Looking to the Stars". I have a copy of it somewhere.

more important, I just spoke to Orlando Nova, who heads the Bureau's Technical Services Division. he says they've probably got 80,000 FCOs in place now and they are proactively retrofitting old installations, especially those running on high voltage (i.e. not just when luminaires burn out).

Orlando Nova (orlando.nova@lacity.org; 213-847-1826; but he's leaving today for vacation) Jim Quigley (213-847-1459; Division Manager for Community Services)

"The use of dropped lens fixtures will not produce better lighting. By using properly designed flat glass luminaires the luminance (overall brightness) of the roadway will not be affected significantly. What will be affected is the uniformity with flat glass luminaires being more sensitive to the maximum spacing (not as much beam pattern overlap). However, for this project the new Small Target Visibility method for the roadway lighting should be used. With this design method high uniformity is not as important, in fact, non-uniform lighting has proven to be better for visibility by increasing the contrast. In short, with flat glass luminaires, the result is lower uniformity, which provides better visibility"

"CALGARY ROADS REPORT TO THE S.P.C. ON FINANCE AND BUDGET, 2001 JULY 03"
http://members.rogers.com/michaeljcook/lightpollution/calgary1.pdf

Then there is their counterparts in Canada who are saving better than $2 million annually by not paying to light clouds.

http://calgary.rasc.ca/lp/commun_retro.html
http://content.calgary.ca/CCA/City+Hall/Business+Units/Roads/Street+Lights/Envirosmart+Street+Light+Retrofit+Program.htm

From: Domiziano, Nancy [mailto:NDomiziano@ci.stamford.ct.us]
Sent: Friday, November 09, 2007 1:17 PM
Subject: Full Cutoff Street Lighting in Stamford

In 2005, we installed 529 full cutoff street lights in two different sections of Stamford – one area was purely residential and one was a residential/industrial mixed use area. We looked at the amount of fixtures and determined that to achieve .4fc in the residential areas, almost all of the 70 watt fixtures could be replaced with 50 watt full cutoff fixtures.

We also lowered some 150 watt fixtures to 100 watts and several 400 watt fixtures to 310 watts. The entire project was done over a two month period and no one noticed. I notice when I drive through the area, the glare has been substantially reduced!

We are one of few towns in Connecticut that has purchased the street light system from the utility company and manage our own maintenance. Whenever we replace a head, we use a new full cutoff fixture.

We plan on replacing an average of 500 fixtures annually with full cutoff ones, until our whole system is full cutoff – we have 9,600 light fixtures. If we could do it faster we would, but with budget and manpower constraints, we are replacing them as fast as is possible.

Nancy Domiziano
Energy/Utility Manager
City of Stamford Engineering Bureau
888 Washington Blvd.
Stamford, CT 06901
(203) 977-4203

THE CITY OF CALGARY

Wouldn't it have been more economical to simply replace the old lights as they burned out instead of changing them all at once?

No. If we had done this project by attrition it would have taken about eight or ten years, and it would have been very hard to manage. The City replaced the lamps in the old luminaires on a 5-year cycle. With the retrofit project, the whole luminaire, including the lamp is replaced. As such, the group relamping is not being done during the retrofit, which is resulting in increased savings. In addition to reducing light pollution and glare, The City also wanted to reduce the wattage of residential streetlights in order to reduce electricity consumption. The new streetlights will save The City approximately $1.7 million a year in energy costs once the project is complete. These savings ensure that the project pays for itself. Reduced energy consumption also results in reduced emissions from gas and coal-burning generators. When the EnviroSmart Streetlights project is complete, CO2 emissions will be reduced by as much as 19,000 tons a year.

What can cities do with their old streetlight fixtures?

The City of Calgary embarked on a massive street lighting retrofit. In an effort to be more environmentally sensitive, the fixtures were disassembled and the components – glass, steel, aluminum, etc. – were then recycled. There are a number of pictures on the Web site that show streetlight components being readied for recycling. Some parts were even used for crafts. The old glass refractors can be used as pots and the ceramic arc tubes can be used for sharpening knifes. Representatives of Environmental Assessment and Liabilities at The City of Calgary presented a paper on our environmental monitoring program at the International Association of Impact Assessment Conference in Vancouver in 2004.

The City of Chicago Department of Transportation has published the "Chicago Green Alley Handbook"

It's great to see the strong support for dark sky initiatives coming from a major city DOT. The Handbook will be useful in showing other DOTs, and urging further conversion to FCO streetlights.

http://www.resourcesaver.org/file/toolmanager/CustomO16C45F95080.pdf

On Pages 6-7, one of CDOT's 4 primary purposes for the Green Alley program is stated as:

> **"Energy Conservation and Glare Reduction**
> Imagine if the thousands of light fixtures that provide a safe environment in the alleys were energy efficient and reduced glare and light pollution to the point where you could see the stars at night."

Further in the document, a full page (Page 15), under Technique 5 for designing Green Alleys, shows an illustration of the old SCOs and the new FCOs and states:

> **"Energy efficient, dark sky compliant light fixtures are specially designed to direct light downward, focusing light where it's needed. These fixtures can also incorporate the latest technologies in energy efficiency while maintaining adequate light levels.**
>
> **Potential Benefits**
> - **Reduces light pollution from site**
> - **Reduces glare and provides better light uniformity**

Finally, there's a section titled **Sustainable Solutions for Adjacent Property Owners**

Technique 9 on Page 34 is titled "**Energy Efficient / Dark Sky Lighting**" and is recommended for Residential, Commercial and Industrial applications.

> **"Energy efficient/dark sky light fixtures are designed to direct lamp light downward and outward where it is useful rather than upward where it wastes energy and contributes to glare and light pollution.**
>
> **Potential Benefits**
> - **Reduces energy costs**
> - **Reduces light pollution from site**
> - **Reduces glare and provides better light uniformity"**

Roadway conversion

Message: 5
Date: Tue, 05 Dec 2006 15:16:20 +0000 (America/Los_Angeles)
From: mmotta@massmed.org
Subject: Re: [Nelpag] Examples of Financial savings to company using FCOs?
To: Leo@smith.net
Cc: OutdoorLighting-Forum@yahoogroups.com, nelpag@harvee.org

The Town of Townsend Mass.Converted the entire town to Full cutoff's, and the town manager watched every expenditure to the penny. Savings of about 28% in electric costs and the conversion costs paid for themselves in about 16 months. He has said in past that he would answer inquires about the conversion and savings.

Mario Motta, M.D.

10/08

NEW YORK STATE A07438 Memo:

BILL NUMBER:A7438A

TITLE OF BILL: An act to amend the environmental conservation law and the public service law, in relation to enacting the healthy, safe and energy efficient outdoor lighting act.

The healthy, safe and energy efficient outdoor lighting act reduces harmful outdoor lighting; sets standards for outdoor lighting; provides for the designation of dark-sky preserves; defines light pollution; provides for distribution to customers by electric corporations or municipalities providing electric service of an informational pamphlet relating to outdoor lighting.

PURPOSE OR GENERAL IDEA OF BILL: This bill provides for the management of outdoor night lighting to protect the nighttime environment, enhance safety and security, and conserve energy.

SUMMARY OF SPECIFIC PROVISIONS: Section 1 adds a new Article 20 to the environmental conservation law, the Healthy, Safe and Energy Efficient Outdoor Lighting Act. Article 20 includes sections 20-0101 setting out legislative findings, section 20-0103 stating a short title, section 20-0105 defining terms, section 20-0107 on permanent outdoor lighting, section 20-0109 on dark-sky preserves, section 20-0113 requiring the Department of Environmental Conservation (DEC) , in consultation with the New York Energy Research and Development Authority (NYSERDA) to develop and distribute a model comprehensive outdoor lighting ordinance, and section 200115 requiring DEC, in consultation with NYSERDA to develop and distribute a pamphlet promoting the bill`s goals of energy conservation and more effective night lighting and describing how the provisions of this bill will achieve them and section 20-0117 on applicability. Section 2 directs the Public Service Commission to require that every electric corporation or municipality providing electric service include the educational pamphlets in its bills to customers.

JUSTIFICATION: This bill is intended to limit excessive outdoor illumination. Excessive illumination wastes energy, intrudes on the privacy of others, creates glare which reduces the effect of lighting, deteriorates the natural nighttime environment, and reduces the ability for astronomical observation.

Outdoor lighting is used to illuminate roadways, parking lots, yards, sidewalks, public meeting areas, signs, work sites and buildings. When well designed, it improves visibility, adds an element of safety and creates a sense of security, while at the same time minimizing energy use and operating costs. If, however, it is not well designed it can be costly, inefficient, counterproductive, and harmful to the nighttime environment.

Much of the outdoor lighting in use today wastes energy because it is poorly designed. This waste results in both higher costs for providing such lighting and increased pollution from the power plants that produce the wasted electricity. It is conservatively estimated that $3 to $4.5 billion a year is wasted in the United States in the unintended lighting of the sky rather than the streets, walkways, and outdoor public spaces which the light was intended to illuminate.

In addition to wasting energy, poorly designed lighting often causes blinding glare. Glare occurs when you see light directly from a fixture or bulb. The glare from poorly designed or positioned lighting hampers the vision of drivers and pedestrians, reducing its effectiveness and creating a hazard rather than increasing safety. It shines onto neighboring properties and into nearby residences, reducing privacy, hindering sleep, and diminishing the

beauty of the natural surroundings in areas far removed from the source of such lighting. A large portion of such lighting shines directly upward, creating the sky glow above population centers, adversely affecting the view of the night sky. In addition to lowering the cost of outdoor lighting, limiting sky glow will allow future generations to enjoy the beauty of the stars, and to study and learn from or simply marvel at the wonders of the night sky.

This legislation addresses these problems in the following ways:

* It restricts the installation of new lighting by state agencies or public corporations operating in the state to fully-shielded luminaires. A fully shielded luminaire is constructed and installed in such a manner that all light emitted by it is projected below a horizontal plane through the lowest light emitting part of a light fixture.
* It exempts replacement of luminaires that are part of a continuous roadway lighting design from the requirement that only fully shielded luminaires be installed by state agencies and public corporations.
* It allows the chief executive officer of any state agency or public corporation to exempt the state agency or public corporation from the requirement that it install only fully shielded luminaires, based upon a written determination by the chief executive officer that a compelling safety interest requires that other types of lighting be installed.
* It exempts tunnel, airport, underbridge, traffic control, navigational and natural and cultural monument lighting from the requirement to install fully shielded luminaires.
* It exempts historic-style decorative lighting if the installation of fully shielded luminaires detracts from the aesthetic character of the existing lighting.
* It allows historic-style decorative lighting to emit up to two percent of its lumens above the horizontal plane.
* It requires the commissioner, in consultation with NYSERDA, to develop luminaire efficiency and lamp luminous efficacy standards by the effective date of the legislation and requires that these standards take effect 180 days after the effective date of this legislation.
* It requires that the department in consultation with NYSERDA report to the legislature on technological advances that affect the provisions of this article and recommend amendments to this article which would increase its effectiveness in achieving the bill`s stated purposes.
* It empowers the DEC commissioner to identify and nominate areas for "dark sky preserves" of the state.
* It exempts state agencies, public corporations and electric corporations providing roadway lighting under contract to a public corporation from light trespass restrictions.
* It exempts lighting done for security purposes pursuant to regulations of the Public Service Commission, ATM lighting done to comply with the minimum standards of section 75-c of the banking law and historic theater lighting.
* It exempts lighting that is furthering an activity found to be a sound agricultural practice under the Right to Farm Law.
* It requires the commissioner of DEC in consultation with NYSERDA, the Department of Agriculture and Markets and the Public Service Commission, to promulgate rules and regulations on light trespass.
* It requires the commissioner to prepare and distribute a model outdoor lighting ordinance to cities, towns, and villages throughout the state.
* It requires the commissioner, in consultation with NYSERDA, to develop and widely disseminate a pamphlet describing the purposes and provisions of this act.

PRIOR LEGISLATIVE HISTORY: 2007: A.7438 Passed Assembly 2005-06: A.7404 Passed Assembly 2004: A.6950-D Passed Assembly 2003: A.6950-C Passed Assembly 2002: A.9757-B Rules 2001: A.5352-B Passed Assembly and Senate Vetoed by the Governor 2000: A.6357-A Passed Assembly 1999: A.6357-A En Con

FISCAL IMPLICATIONS: None

The following organizations have endorsed the light pollution legislation introduced in the NYS legislature (2007 endorsements are bold):

- AARP Chapter 2359. (6 KB PDF)
- **Accabonac Protection Committee**. (7 KB PDF)
- Adirondack Council. (49 KB PDF)
- **Amateur Astronomers Association of New York**. (102 KB PDF)
- **Amateur Observers' Society of New York**. (53 KB PDF)
- American Association of University Women. (5 KB PDF)
- **American Lung Association of New York**. (24 KB PDF)
- **Astronomical League**. (73 KB PDF)
- Astronomy Section of the Rochester Academy of Science. (88 KB PDF)
- Astronomical Society of Long Island. (HTML file)
- **Audubon, New York State**. (10 KB PDF)
- **Audubon, New York City**. (604 KB PDF)
- Citizens Advisory Panel (of Long Island). (12 KB PDF)
- **Citizens Campaign for the Environment**. (365 KB PDF)
- **The Concerned Citizens of Montauk**. (80 KB PDF)
- **Custer Institute**. (70 KB PDF)
- **Dark Sky Society**(7 KB PDF)
- (Town of) East Hampton(6 KB PDF)
- **Environmental Advocates** (28 KB PDF)
- **Friends of Edgewood** (142 KB PDF)
- **Group for South Fork**. (8 KB PDF)
- **Hudson Highlands Land Trust** (138 KB PDF)
- **International Dark-Sky Association**. (74 KB PDF)
- **Long Island Pine Barrens Society**. (186 KB PDF)
- **Mohawk Valley Astronomical Society**. (67 KB PDF)
- **Nature Conservancy**. (9 KB PDF)
- **New York League of Conservation Voters**. (192 KB PDF)
- **NYS Council of Landscape Architects**. (121 KB PDF)
- North Fork Environmental Council. (7 KB PDF)
- **New York Public Interest Research Group**. (142 KB PDF)
- Northwest Alliance. (HTML)
- **Riverhead (Town of)** (941 KB PDF)
- Rockland Astronomy Club. (20 KB PDF)
- Safe Alternatives for Energy - Long Island. (36 KB PDF)
- **SELENE**. (13 KB PDF)
- Sierra Club - Atlantic Chapter. (31 KB PDF)
- **(Town of) Southampton** (530 KB PDF)
- **Suffolk County**. (5 KB PDF)
- Sustainable Energy Alliance of Long Island. (21 KB PDF)
- **Syracuse Astronomical Society**. (16 KB PDF)

Introduction No. 757: Fully Shielded Light Fixtures
Comments from: Jennifer Brons, MS, Research Scientist
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November 6, 2008

The motive for Introduction No. 757 is not stated its text. Under the assumption that the goal of this effort is to address the phenomenon of light pollution from street lighting, the Lighting Research Center (LRC) at Rensselaer Polytechnic Institute in Troy, NY offers the following comments.

There are several aspects of light at night that may be offensive: sky glow, light trespass, and glare. Stories in the popular press might lead one to believe that fully-shielded street lights would reduce light pollution in New York City; however, closer examination shows that this strategy will be ineffective at mitigating these three components of light pollution.

Limiting light above the horizontal will not be effective for reducing sky glow for several reasons. In an urban environment such as many parts of New York City, the structures of the city itself create canyons that shield light from traveling directly from the street light toward the sky. Additionally, the use of shielding will not stop the light from reflecting from all those surfaces and eventually contributing to sky glow.

The technique of limiting angles of light leaving a street light may have *some* merit to reduce sky glow in more open areas, but direct upward light from street lights is often not the primary contributor to light going into the sky; rather it is the light reflected from the ground and other surfaces that is most likely to contribute to sky glow. For this reason, the LRC has recently proposed a system of measurement called "Outdoor Site-Lighting Performance" or OSP[i]. This calculation technique employs commercially-available lighting software to account for both contributors to sky glow: direct and reflected light together. Preliminary tests of this system have demonstrated that the most effective technique for reducing the amount of light leaving the boundaries of a property is to limit the amount of light actually contributed to the space. In other words: the more light that is put into an environment, the more light will leave that environment, which will contribute to sky glow.

Light trespass is caused when light enters private property (typically residential) from outside the boundaries of the property. The proposed strategy of prohibiting light above the horizontal may be effective in limiting some complaints of light trespass, but only for individuals residing at a height greater than that of the luminaire. For those residing at or below the level of the luminaire, complaints of light trespass will not be reduced with the use of fully-shielded street lights. To prevent light from entering residential windows, lighting manufacturers have developed "house side shields" that restrict light behind the luminaire to lower than the horizontal. Often these can be mounted as a retrofit to existing street lights to address complaints of light trespass. For new pole locations, trespass can also be addressed by moving poles away from residential windows.

Glare is the third aspect of light pollution. Researchers have been struggling for decades to develop methods to predict complaints of discomfort glare. The LRC has recently published an updated technique as part of the aforementioned calculation system[ii]. The underlying research showed that glare is related to the amount of light reaching the eye, primarily contributed by the offensive street light, but also counterbalanced with light from the surrounding area. Thus, it is not clear whether changing the angles at which light can be emitted will increase or decrease complaints of glare. Although Introduction No. 757 might cause a marginal improvement in glare complaints, the effect for individuals standing *below* the street lights would not necessarily be different with fully shielded street lights, and even for locations *above* the street lights, the impact would be highly contextual, and not equally applicable across all five boroughs.

A purpose of outdoor lighting is to create safe, comfortable environments to encourage nighttime use of the city. In the future, the LRC expects that new lighting techniques and technologies will justify a major investment to change New York City's street lighting. New technologies are expected to increase energy efficiency and reduce maintenance requirements. It is not clear what the incremental cost implications are to No. 757 compared to conventional street light replacements. Even if there would be no incremental cost, this effort will not achieve the (presumed) goal of reducing the three aspects of light pollution in a significant manner, much less address what may be the more pressing issues of maintenance, energy efficiency, and safety.

If the City of New York wishes, the LRC would be happy to propose a research project to investigate issues of light pollution or develop a practical and effective outdoor lighting ordinance.

About the speaker:
Jennifer Brons, M.S., is a research scientist and adjunct assistant professor of architecture at Rensselaer Polytechnic Institute's Lighting Research Center (LRC). She earned her bachelor's degree in architecture from U.C. Berkeley (cum laude) and her M.S. in lighting from Rensselaer. Since 1997, her work at LRC has focused on lighting design applications and human factor studies for new lighting technologies. She teaches lighting design and develops educational material for specifiers about how to use lighting more effectively. She heads the "DELTA" Program, a series of lighting case studies that are available to the public online. Ms. Brons coordinates the light pollution program entitled "Outdoor Site Lighting Performance" on behalf of lighting companies in North America and Europe.

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[i] Brons, J., Bullough, J., and Rea, M. 2008. "Outdoor Site-Lighting Performance: A Comprehensive and Quantitative Framework for Assessing Light Pollution" In *Lighting Research and Technology,* Chartered Institution of Building Services Engineers, London, UK. Volume 40, number 3, pp. 201-224.
[ii] Bullough, J., Brons, J., Qi, R., and Rea, M. 2008. "Predicting Discomfort Glare from Outdoor Lighting Installations" In *Lighting Research and Technology,* Chartered Institution of Building Services Engineers, London, UK. Volume 40, number 3, pp. 225-242.

Introduction Number 806: Light Emitting Diodes in Street Lamps

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November 6, 2008

Light emitting diodes (LEDs) have a very promising future for illuminating our cities. LEDs have already transformed the market for signal lights, exit signs or other examples of indicator lighting. LEDs can have long operating lives and reduced maintenance. Energy efficiency of LEDs is improving rapidly. However, this is an evolving and not yet fully tested technology. Product performance of LEDs is not equal among different manufacturers. There are several compelling reasons why New York City should *not* require the use of LEDs as a retrofit for existing street lighting at this time, nor to require widespread replacement of existing luminaires (fixtures) with dedicated LED luminaires at this time.

The text of Introduction 806 does not state the reasons for a proposed conversion to LED street lights. Presumably, the intention was to decrease operating costs through technologies with longer operating life or to reduce energy use. Assuming these two reasons would be the primary factors driving a switch to LEDs, they are discussed in turn.

Longer life or increased reliability

One of the main promises of LED lighting is a very long useful life, often claimed to be on the order of 100,000 hours. Our research has shown, for the most part, LEDs have not yet reached this number in terms of useful life. With the continuous progress LED manufacturers make every year, some of the LEDs in the market are now approaching useful lives of 20,000 to 40,000 hours, but these numbers must be kept in the context of specific operation conditions. When LEDs are integrated into systems that include other components such as optics, electronic controllers, heat sinks, etc., the operating conditions change and the useful life of the system is often shorter than that of the LED in isolation. While there are many claims about long life and reduced maintenance costs with LEDs, we at LRC have found that few LED systems are capable of delivering on their specifications. Certainly, none of these systems have been in use long enough to determine whether in fact they do last as long as claimed.

Designing and manufacturing good quality and reliable LED systems is not easy. Optimized systems rely on matching suitable components to maximize the benefits that such system is designed for. LEDs are very different from any of the traditional light sources in many regards, from principles of operation, to photometric performance, to failure mechanisms. Because of these differences, retrofit applications seldom take advantage of any of the benefits and often result in decreased overall system performance.

For example, LEDs are much more sensitive to temperature than any other light source. Short and long term performance (life and light output) are greatly affected by the operating temperature of the LED. LED manufacturers design dedicated luminaires taking great care to provide suitable thermal management solutions for each application. Not doing so inevitably results in lower light output and shorter life. Thus, when used as a retrofit in existing outdoor lighting, it is much more likely that LED products will fail more quickly than claimed because of the lack of proper heat management.

Conventional outdoor luminaires (i.e., those for high pressure sodium [HPS], metal halide [MH] or mercury vapor [MV] lamps) create tightly-gasketed housings to prevent water, dirt, and insect ingress. These conventional luminaires are not designed to maximize heat extraction; nor do they need to be. Conventional light sources perform well at high temperatures and do not fail due to overheating.

In the context of heat management, LEDs are more similar to computer chips than conventional light bulbs; to maintain life and light output LEDs require heat to be conducted away from the inner part of an LED light bulb; thus most LED systems require properly designed heat sinks to extract heat from the diodes and out to the environment. Even if a retrofit LED product has an integrated heat sink, when this product is subsequently enclosed in a conventional, gasketed outdoor luminaire, the system can very well overheat, resulting in reduced light output, unacceptable or even ugly color shifts, and ultimately, premature failure.

Thus a primary cause of disappointing LED performance is insufficient heat management. A rule of thumb for LEDs and most electronic devices is that life is reduced by half for every 10°C increase in temperature above the intended design temperature. The Lighting Research Center (LRC) has identified many products that claimed operating lifetimes of 50,000 or 100,000 hours, but in fact only operated for a few thousand hours (less than 8000 hours) before they became so dim as to be effectively useless, even when they were operated in open air.

The LRC is one of many institutions that are performing thermal testing of LEDs. Our research has demonstrated the disastrous effects of improper heat management. There is no uncertainty in the lighting industry about the critical importance of heat management with LEDs.

Additionally, it is important to consider that even when LEDs in well designed, there are many more components in a system that will also need to last as long so that the system can offer a better value in terms of reliability and reduced maintenance costs. Optical and electrical components in any luminaire are also prone to depreciation and failure; thus the ratings of any system need to be clearly specified as a function of the weakest component.

Better lighting conditions:
In addition to fundamental questions about heat management, using LEDs as a retrofit strategy for outdoor lighting also threatens to undermine existing light quantity and quality, as well as increase energy use.

Conventional luminaires employ reflectors to direct light from a bulb out to the illuminated environment. Typically lighting engineers have selected and located luminaire distributions to meet specific goals for lighting uniformity, light levels, color rendering, and wattage. An LED system however often uses reflectors and lenses built into the device itself to control distribution. The physical size and light distribution of the LED system will not match that of the conventional technology (assuming it even fits in an existing street light). Therefore, the pattern of light in the environment would be entirely different than from the luminaire with the original bulb. There might be a bright patch of light immediately under a street light, but subsequent dark stretches between street lights.

Thus, it is not likely that the amount of light actually reaching the ground from an LED retrofit bulb would be comparable to the existing bulb. Furthermore it is not likely (at this time) that matching light levels could be achieved for equal or fewer watts. The lighting industry is still several years away from creating a commercial product that can match the performance of conventional technology to deliver light to the intended surface without increasing power demand. Therefore, to match existing light levels, the City would have to use more watts and/or add new luminaires. This applies to both LED retrofit and replacement strategies.

We at the LRC have not yet seen one example of a retrofit LED product that could match the light output of conventional street lights on the ground for equal or lesser watts.

New, dedicated luminaires are being designed and brought to market that meet the thermal requirements for LEDs. At this time, these are highly-engineered products that cost many times more than conventional luminaires. The cost implications of adopting an LED street-lighting policy are quite substantial.

Summary
We at LRC are enthusiastic for the future use of this lighting technology in dedicated LED luminaires. A few cities in US are making the investment to demonstrate use of LEDs in their street lighting. It would be prudent to watch and learn from these early installations of dedicated LED luminaires while the industry rapidly improves.

For all light sources, light output gradually reduces over time. If the thermal management needs are properly addressed, LEDs may indeed continue to operate for a long time. However, they may eventually glow at such a low output as to be unusable. For this reason, LRC has proposed that the useable life of LEDs not be defined by when the light "burns out", but rather when it reaches a reduced percentage of initial light output[i]. This strategy may require a procedural change for municipalities accustomed to

changing light bulbs when they burn out, rather than removing LEDs that are still operating.

Extensive research is being done at the LRC and other institutions around the world to investigate ways to reduce the barriers to the widespread use of this promising new technology. Research topics include techniques to increase light output, reduce power demand, new phosphor strategies, and increasing the reliability of the electronic drivers that operate LEDs. There are many opportunities for use of new controls technologies to create dynamic and innovative outdoor lighting solutions not possible with conventional lighting technologies. We at the LRC would be pleased to collaborate with New York City on small-scale demonstrations as these techniques and technologies gradually become available. However in the meantime, while the lighting industry endeavors to harness the potential of LEDs, New York City can continue to be well-served by conventional outdoor lighting equipment.

In summary, there are many reasons why it would be unwise at this time for New York City to retrofit LEDs into existing outdoor lighting equipment. Although we expect there to be a strong place for dedicated outdoor LED luminaires in the future, a more tentative posture would be prudent for the near term, such as with a few small-scale demonstrations.

About the speaker:
Jennifer Brons, M.S., is a research scientist and adjunct assistant professor of architecture at Rensselaer Polytechnic Institute's Lighting Research Center (LRC). She earned her bachelor's degree in architecture from U.C. Berkeley (cum laude) and her M.S. in lighting from Rensselaer. Since 1997, her work at LRC has focused on lighting design applications and human factor studies for new lighting technologies. She teaches lighting design and develops educational material for specifiers about how to use lighting more effectively. She heads the "DELTA" Program, a series of lighting case studies that are available to the public online. Ms. Brons coordinates the light pollution program entitled "Outdoor Site Lighting Performance" on behalf of lighting companies in North America and Europe.

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[i] Alliance for Solid State Illumination Systems and Technologies. 2007. "ASSIST Recommends: LED Life for General Lighting" Published online at LRC website. Originally published February 2005, revised August 2007.

numerically exceed 50 (5 percent) at or above an angle of 90° above nadir, and 200 (20 percent) at or above a vertical angle 80° above nadir. This applies to all lateral angles around the luminaire.

Noncutoff: A luminaire light distribution where there is no candela limitation in the zone above maximum candela.

3.0 DESIGN CRITERIA

This Standard Practice includes three different criteria for use in continuous roadway lighting design. These are illuminance, luminance, and STV. The designer should be familiar with all of these criteria in order to decide which one best addresses the needs of the particular project. Calculation procedures and additional information about these methods are included in the **Annexes**. Consideration should also be given to glare and sky-glow issues stated in **Section 4.6**. For issues about light trespass see IESNA TM-10, *IESNA Technical Memorandum Addressing Obtrusive Light (Urban Sky Glow and Light Trespass) in Conjuction with Roadway Lighting.*

The recommended design values, as well as the uniformity ratios as shown in **Tables 2**, **3**, and **4**, represent the lowest maintained values for the kinds of roadways and walkways in various areas. Numerous installations have been made at higher values. Furthermore, the design values can be made using different combinations of luminaire light distribution, lamp sizes, mounting heights, spacings, and transverse locations. These figures do not represent *initial* readings, but the lowest *in-service* values of systems designed with the proper light loss factor. When design values for continuous roadway lighting vary due to changes in the road or area classification no special transitions are necessary.

This document follows the guidelines of IESNA LM-67-94, *Calculation Procedures and Specification of Criteria for Lighting Calculations.*

3.1 Illuminance Criteria

The illuminance method of roadway lighting design determines the amount of light incident on the roadway surface from the roadway lighting system. Because the amount of light seen by the driver is the portion that reflects from the pavement towards the driver, and because different pavements exhibit varied reflectance characteristics, different illuminance levels are needed for each type. The illuminance criteria gives recommendations for average maintained lux for various road and area classifications depending on the pavement type used. The recommended illuminance values and the uniformity ratio are in **Table 2.** Veiling Luminance Ratios, derived from the luminance calculation method, must also be determined to avoid a lighting system that produces disability glare. (See **Table 2.**)

3.2 Luminance Criteria

The luminance method of roadway lighting design determines how "bright" the road is by determining the amount of light reflected from the pavement in the direction of the driver. The luminance criteria is stated in terms of pavement luminance, luminance uniformity, and disability veiling glare produced by the lighting system. **Table 3** provides the recommended luminance design requirements, uniformity and the relationship between average luminance (L_{avg}) and the veiling luminance (L_v).

3.3 Small Target Visibility (STV) Criteria

The STV method of design determines the visibility level of an array of targets on the roadway considering the following factors:

(a) The luminance of the targets
(b) The luminance of the immediate background
(c) The adaptation level of the adjacent surroundings
(d) The disability glare

The weighted average of the visibility level of these targets results in the STV. The values of STV are included in **Table 4** as well as uniformity ratios and luminance requirements for mitigating the effect on approaching headlights. The veiling luminance ratio component is included in the STV calculation methodology.

3.4 High Mast Lighting

Ordinarily, conventional lighting along streets and highways involve mounting heights of 15 meters (49.2 ft.) or less. Poles of 20 meters (65.6 ft.) or greater height have been utilized in several situations:

- Large parking lots - such as regional shopping centers, and stadiums

- Interchanges and complex intersections in both urban and rural areas and tangent sections with more than six lanes

Opinions differ on whether light levels can be lower when high mast lighting is used, compared with the use of conventional poles of 15 meters (49.2 ft.) or less. Typically, the surround conditions are more uniform with the high mast design and, seeing is easier. Prior editions of ANSI/IESNA RP-8 have allowed lower

lighting levels. Consensus opinion is currently to delete such a differential on the basis that adequate research to justify the lower levels has not been conducted.

High mast lighting typically consists of clusters of three to six or more luminaires mounted on rings, which can be mechanically lowered to near ground levels for servicing.

Designs for high mast lighting can utilize the illuminance method. Unique high mast luminaires and both symmetrical and asymmetrical distributions have been used. Cutoff luminaires are desirable to avoid excessive glare. Large lamps consuming up to 1000 watts are sometimes employed.

Because high mast lighting is a tool for illuminating areas rather than specific sections of roadway, the poles are customarily placed well back from adjacent roadways. Installation cost comparisons between high mast and conventional lighting systems vary widely, depending on the application. High mast lighting for interchanges is frequently less expensive to install than conventional lighting, due to the reduced complexity of conduit and conductor and the smaller number of luminaires and poles required. Other than at interchange locations, conventional lighting usually requires a smaller initial cost.

Maintenance costs for the two types of systems differ greatly. Conventional lighting requires the use of a bucket truck and frequently requires extensive traffic control, such as signs, cones, and lane closures. When poles are mounted on concrete traffic barriers (CTB's), the adjacent traffic lane usually has to be closed, resulting in significant traffic disruptions. One or two persons, without special lift equipment, can usually perform maintenance on a high mast lighting system equipped with a lowering device. High mast lighting may also eliminate the risks involved with having personnel working near high speed traffic.

3.5 Pedestrian and Bikeway Design Criteria

The lighting of streets with pedestrian sidewalks and/or bikeways included as part of the right of way, particularly in urban and suburban areas, differs from that of limited access high speed roadways. The driver's tasks include seeing objects in the roadway as well as pedestrians, parked cars, and other elements. The purpose

Table 2: Illuminance Method - Recommended Values

Road and Pedestrian Conflict Area		Pavement Classification (Minimum Maintained Average Values)			Uniformity Ratio	Veiling Luminance Ratio
Road	Pedestrian Conflict Area	R1 lux/fc	R2 & R3 lux/fc	R4 lux/fc	E_{avg}/E_{min}	L_{vmax}/L_{avg}
Freeway Class A		6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Freeway Class B		4.0/0.4	6.0/0.6	5.0/0.5	3.0	0.3
Expressway	High	10.0/1.0	14.0/1.4	13.0/1.3	3.0	0.3
	Medium	8.0/0.8	12.0/1.2	10.0/1.0	3.0	0.3
	Low	6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Major	High	12.0/1.2	17.0/1.7	15.0/1.5	3.0	0.3
	Medium	9.0/0.9	13.0/1.3	11.0/1.1	3.0	0.3
	Low	6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Collector	High	8.0/0.8	12.0/1.2	10.0/1.0	4.0	0.4
	Medium	6.0/0.6	9.0/0.9	8.0/0.8	4.0	0.4
	Low	4.0/0.4	6.0/0.6	5.0/0.5	4.0	0.4
Local	High	6.0/0.6	9.0/0.9	8.0/0.8	6.0	0.4
	Medium	5.0/0.5	7.0/0.7	6.0/0.6	6.0	0.4
	Low	3.0/0.3	4.0/0.4	4.0/0.4	6.0	0.4

*(Refer to **Section 3.6** for Intersection Lighting)*

and benefits of the lighting system also include pedestrian lighting, security lighting, building facade lighting, and overall aesthetic impact on the community.

Design efforts must include the integration of the lighting system into the surrounding area as well as consideration for its impact on buildings and pedestrians. Other specialized equipment is often required to interface with the street furniture.

This section addresses the lighting needs of adjacent pedestrian and bikeway areas only when the roadway is continuously illuminated. **Figure 2** shows an example of a roadway system with various elements often included within the right of way. Both the recommendations included in this section as well as those for the roadway included in prior sections should be evaluated.

3.5.1 Pedestrian Areas and Bikeways Design Recommendations. Pedestrian areas are divided into three categories.

3.5.1.1 High Pedestrian Conflict Areas— Commercial areas in urban environments may have high night pedestrian activities. It is important to provide visibility for a driver to create a reasonably safe environment for the pedestrian and cyclist. Since the reflection characteristics of surfaces vary and are generally unknown during design, use of illuminance values is recommended. Vertical surfaces such as buildings and pedestrians should also be illuminated in order to create a bright environment. **Tables 5, 6,** and **7** include recommended minimum maintained average vertical illuminances for pedestrian areas at a height of 1.5 m (4.9 ft.) in both directions measured parallel to the main pedestrian flow. Glare from the luminaires must be restricted by paying careful attention to luminaire mounting heights, lamp light output, and photometric distribution.

3.5.1.2 Medium Pedestrian Conflict Areas— Intermediate areas have moderate night pedestrian activities. These areas may typically be those near community facilities such as libraries and recreation centers. Safety for the pedestrian as well as providing guidance to primary travel ways are key elements in the design of a lighting system in

Table 3: Luminance Method - Recommended Values

Road and Pedestrian Conflict Area		Average Luminance	Uniformity Ratio	Uniformity Ratio	Veiling Luminance Ratio
Road	Pedestrian Conflict Area	L_{avg} (cd/m^2)	L_{avg}/L_{min} (Maximum Allowed)	L_{max}/L_{min} (Maximum Allowed)	L_{Vmax}/L_{avg} (Maximum Allowed)
Freeway Class A		0.6	3.5	6.0	0.3
Freeway Class B		0.4	3.5	6.0	0.3
Expressway	High	1.0	3.0	5.0	0.3
	Medium	0.8	3.0	5.0	0.3
	Low	0.6	3.5	6.0	0.3
Major	High	1.2	3.0	5.0	0.3
	Medium	0.9	3.0	5.0	0.3
	Low	0.6	3.5	6.0	0.3
Collector	High	0.8	3.0	5.0	0.4
	Medium	0.6	3.5	6.0	0.4
	Low	0.4	4.0	8.0	0.4
Local	High	0.6	6.0	10.0	0.4
	Medium	0.5	6.0	10.0	0.4
	Low	0.3	6.0	10.0	0.4

(*Refer to* ***Section 3.6*** *for Intersection Lighting*)

SIDEWALK	MEDIAN STRIP	TRAVEL LANES
Street Light Poles	Left Turn Lane	Normal Vehicular Traffic
Utilitly Junction Boxes/Panels	Plantings	Bus Lanes
Fire Hydrants	Traffic Signs and Signals	Street Car or Light Rail Lanes
Garbage Containers	Street Light Poles	Bicycle Lanes
Landscaped Areas	Banner Poles	Curb Extensions
Trees	Pedestrian Refuge Areas	On Street Parking
Traffic Signs and Signals	Trees	Traffic Calming Devices
Outdoor Cafe Tables	Curbing	
Loading Areas / Elevators	Lighting Rail and Bus Platforms	
Private Overhead Signs		
Private Awnings / Marquees		
Bus Shelters		

Figure 2. Typical components within the right-of-way.

these areas. These values do not consider areas with increased crime and vandalism.

3.5.1.3 Low Pedestrian Conflict Areas—The lighting system in residential areas may allow both driver and pedestrian to visually orient in the environment, detect obstacles, observe other pedestrians, read street signs, and recognize landmarks. **Table 7** includes recommended illuminance values. These values do not consider areas with increased crime and vandalism.

3.5.1.4 Pedestrian Bridges over Roadways, Underpasses and Mid-block Crosswalks—Other features such as pedestrian bridges, underpasses, and mid-block crosswalks may require different treatments than for the areas in which they are located.

For underpasses facial recognition and security considerations should be of primary concern because of the limited options for retreat from a hostile individual. Also luminaire mounting restrictions can create problems by causing obstructions/hazards to pedestrians as well making glare control from the luminaires more difficult. Underpasses or pedestrian tunnels may also have daytime lighting needs. The recommendations for the pedestrian areas of the underpass are given in **Table 8**.

Mid-block crosswalks form a special type of "intersection" because pedestrian traffic is in conflict with vehicular traffic on only one street. Special lighting is needed for mid-block crosswalks because these are potentially more hazardous than intersection locations, due to their unexpected nature. For night conditions, the appropriate luminaire locations are

similar to those at street intersections; i.e., to the far right for each direction of approaching travel. Luminaires are typically placed just beyond the crosswalk, on each side of the street. In most cases, this will produce a relatively high illuminance level. The average illuminance level in the crosswalk area should at least be equal to that provided at the intersection of two major streets; i.e., about 34 lux (3.4 fc). (See **Table 9.**)

3.5.2 Calculations Required. Several calculations must be performed in order to properly design a lighting system. These include the requirements for the roadway system as well as those for the pedestrian areas (if different). Calculations should be performed for the roadway area to check conformance with the recommended levels given in **Tables 2, 3,** or **4** and **5, 6, 7,** and **8** (if applicable) for pedestrian areas. Veiling luminance calculations must also be performed if using the illuminance or luminance methods. Then illuminance calculations should be performed for the adjacent pedestrian areas to determine the adequacy of the design. The illuminance calculations include the horizontal levels at the walkway as well as the vertical values at each point at a height of 1.5 m (4.9 ft.) in all directions of pedestrian travel. A properly designed system will meet the roadway luminance and veiling luminance requirements (refer to **Annex A** for the appropriate procedures) as well as the pedestrian horizontal and vertical illuminance requirements.

Table 4: Small Target Visibility - Recommended Values

Road and Pedestrian Conflict Area		STV Criteria	Luminance Criteria		
Road	**Pedestrian Conflict Area**	**Weighting Average VL**	**L_{avg} cd/m² Median <7.3 m**	**L_{avg} * cd/m² Median ≥7.3 m**	**Uniformity Ratio L_{max}/L_{min} (Maximum Allowed)**
Freeway "A"		3.2	0.5	0.4	6.0
Freeway "B"		2.6	0.4	0.3	6.0
Expressway		3.8	0.5	0.4	6.0
Major	High	4.9	1.0	0.8	6.0
	Medium	4.0	0.8	0.7	6.0
	Low	3.2	0.6	0.6	6.0
Collector	High	3.8	0.6	0.5	6.0
	Medium	3.2	0.5	0.4	6.0
	Low	2.7	0.4	0.4	6.0
Local	High	2.7	0.5	0.4	10.0
	Medium	2.2	0.4	0.3	10.0
	Low	1.6	0.3	0.3	10.0

Table based on a 60 year old driver with normal vision, an 18 cm x 18 cm (7.1 in. x 7.1 in.) 50 percent reflective target, and a 0.2 second fixation time.

*(Refer to **Section 3.6** for Intersection Lighting)*

* *This column also applies to freeways and expressways where the alignment at the two roadways is independent of each other, or where there is a median barrier sufficient to block the direct view of oncoming headlights or a one way street.*

Testimony of Lauren Schuster

New York Public Interest Research Group

Before the Committee on Transportation

of the New York City Council

In Support of Proposed Legislation on Energy Efficient Street Lighting

November 6, 2008

Good morning, Chairman Liu and members of the Committee on Transportation. My name is Lauren Schuster. I am an environmental campaign coordinator with the New York Public Interest Research Group (NYPIRG).

NYPIRG is New York's largest nonprofit environmental and consumer advocacy organization, with more than 20 offices across the state, including chapters in each of the five boroughs. NYPIRG has a long history of advocating for energy conservation measures at the City and State level.

Thank you for this opportunity to testify in support of Intro. No. 757, introduced by Council member Gerson and eleven other council members, which would require any new or replacement street lighting in New York City to use fully shielded light fixtures.

There are many reasons to support this legislation, including transportation safety (due to reduced glare), aesthetics, and benefits to human health and wildlife. NYPIRG supports this legislation because it will reduce New York City's energy use. According to the National Oceanic and Atmospheric Association (NOAA), 30% of the United States' outdoor lighting is reflected skyward. The lack of adequate standards for outdoor lighting fixtures results in wasted illumination and wasted energy. Most of our energy comes from burning fossil fuels, which has enormous consequences on our health and the environment, and is the major cause of global warming and climate change.

NYPIRG supports using the most energy efficient street lighting possible. Fully shielded light fixtures would enable the City to reduce the overall wattage used while still producing the same amount of light. Fully shielded light fixtures radiate a focused light, because no light can be emitted above the 90 degree horizontal. Less light is wasted because light cannot escape upwards and outwards towards unintended targets. The ability to light intended targets only would allow New York City to use lower wattage bulbs while illuminating the same area at the same intensity. Replacing existing street lights with fully shielded light fixtures would thus lead to a greater

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OFFICES IN: ALBANY, BINGHAMTON, BUFFALO, CORTLAND, LONG ISLAND, NEW PALTZ, NEW YORK CITY, OSWEGO, PURCHASE & SYRACUSE

increase in energy efficiency and overall savings in energy costs. This has been experienced by other cities that have retrofitted their street lights, such as Calgary, Canada and Stamford, Connecticut.

We commend the many steps the City Council has taken to improve energy efficiency and environmental protection in New York City. New York City is emerging as a national leader in sustainability. This legislation is one of several measures that are currently pending in the Council that focus on energy efficient lighting. Energy efficient lighting standards are a commonsense measure that will help contribute to reducing energy use and combating climate change.

Passage of this legislation could also help spur the State Legislature to move forward on similar legislation that has been introduced there.

NYPIRG urges the City Council to adopt this measure as soon as possible. Thank you again for this opportunity to testify today.

November 6, 2008

RE: Introduction 757

My name is Glenn Phillips, I am the Executive Director of New York City Audubon. New York City Audubon is a grassroots conservation organization dedicated to the protection of wild birds and their habitats for the benefit of all New Yorkers. Our 10,000 members, volunteers and other supporters live in all five boroughs and care passionately about the plight of birds in North America, since the 1960's populations of even our most common birds have declined dramatically, despite legislation to protect them, birds like the common grackle, among the most abundant species in New York City have declined across their range by over 60% -- that's a loss of over 80 million common grackles in forty years.

Habitat loss remains the most important cause of the dramatic declines of birds, but lighting has been a contributor to declines in bird populations, and the solutions to this problem provide benefits for all New Yorkers. Birds have migrated from the tropics to the temperate zones of North America for tens of thousands of years. They evolved sophisticated internal navigation systems that depend on light cues as well as magnetic ones. Today, those mechanisms are disrupted by pervasive artificial light. Scientific studies by Sidney Gathreaux, Bill Evans and others have documented the impact of light pollution on birds and in Ecological Consequence of Artificial Night Lighting, published in 2006, call for fully shielded fixtures as a method for reducing the problem. Our Bird-safe Building Guidelines, which I've provided copies of as a reference, provide more information on the impacts of night lighting on birds.

Introduction 757 is a common sense solution to the problem of light pollution, and will provide multiple benefits to New Yorkers, improving public safety by reducing glare, reducing the city's carbon footprint and energy costs by using more efficient fixtures and benefitting migrating birds. On behalf of New York City Audubon's 10,000 members, I would like to thank Council Member Gerson for introducing this legislation, and I strongly encourage the Transportation Committee to support this important legislation. This legislation is an important first step in bringing New York City to the forefront of efforts to make our city more sustainable.

Transportation Committee
of the New York City Council
November 6, 2008, Hearing

Explanation of Streetlighting Calculations

The attached two tables contain information that was presented to DOT three years ago, and again earlier this year, to demonstrate that fully shielded streetlights can match the performance of the semi-cutoff fixtures now in use.

The performance of a streetlight is evaluated on two measures. One is the amount of light striking the pavement, measured in "footcandles." The other is the evenness, or uniformity, of that light, measured as the ratio of average footcandles to the lowest footcandle reading in the section of pavement being examined.

East 86th Street

The first table examines the existing lighting arrangements on East 86th Street in Manhattan. Although data are shown for each of the blocks from Fifth Avenue to East End Avenue, the information to focus on is the right-hand columns containing average data for these eight blocks. The first row is the existing GE semi-cutoff fixture (SCO), and the second row is a fully shielded or full-cutoff GE fixture (FCO). As you can see in the right-hand columns, there is no significant difference in results for these two fixtures.

The data in the rows below the heavy line are for other fully shielded fixtures. These calculations were included just to assure DOT that a number of manufacturers offer fully shielded fixtures having generally similar performance. The fully shielded Cooper fixture just below the heavy line actually performs better than the existing semi-cutoff fixture preferred by DOT.

"Competition street"

The second table relates to a 2004 streetlight design competition that was conducted jointly by DOT and the Department of Design and Construction. The materials provided to competitors included a description of a hypothetical New York City streetlighting installation. We ran calculations on this presumably representative street to be sure the 86th Street results were not atypical.

In this table the first two rows contain data for the GE and Cooper semi-cutoff fixtures (SCO) that are widely used by DOT. The rows below the heavy line show results for a number of fully shielded or full-cutoff fixtures (FCO). Several of these fixtures exceed the performance of the semi-cutoff fixture preferred by DOT.

DOT files - 86th Street from Fifth Avenue to East End
Various 250W full-cutoff cobras luminaires added

Average footcandles and av/min uniformity

	Fifth-Madison		Madison-Park		Park-Lex		Lex-Third		Third-Second		Second-First		First-York		York-East End		8-block average	
	Av	Av/Min	Av	Av/Min	Av	Av/Min	Av	Av/Min	Av	Av/Min	Av	Av/Min	Av	Av/Min	Av	Av/Min	Av	Av/Min
GE SCO (per DOT Apr05 file)	1.3	4.3	1.7	3.4	1.7	3.4	1.5	3.0	1.5	5.0	1.4	4.7	1.3	4.3	1.3	4.3	1.5	4.1
GE FCO (177305.ies)	1.2	4.0	1.6	2.3	1.6	2.7	1.5	2.5	1.6	5.3	1.4	4.7	1.3	6.5	1.3	4.3	1.4	4.0
Cooper FCO (OVF2S3D.ies)	1.3	4.3	1.7	2.4	1.7	2.8	1.5	3.0	1.6	5.3	1.4	3.5	1.3	4.3	1.3	4.3	1.5	3.7
AEL Series 125 FCO (AEL12965.ies)	1.1	3.7	1.5	3.0	1.5	3.8	1.4	3.5	1.4	4.7	1.2	4.0	1.2	6.0	1.2	6.0	1.3	4.3
AEL DuraStar 30 FCO (LTL13698.ies)	1.2	3.0	1.5	2.1	1.6	3.2	1.4	2.8	1.5	5.0	1.3	4.3	1.3	4.3	1.2	4.0	1.4	3.6
Hubbell RL Series FCO (HP03065.ies)	1.1	3.7	1.5	2.1	1.5	3.0	1.4	2.8	1.4	7.0	1.3	6.5	1.2	6.0	1.2	6.0	1.3	4.6
Holophane Mongoose FCO (49395.ies)	1.2	12.0	1.6	3.2	1.6	4.0	1.4	3.5	1.5	7.5	1.3	4.3	1.3	6.5	1.3	6.5	1.4	5.9

NYCDOT standards: average illuminance, 1.2-1.7 fc, av/min uniformity not to exceed 3.0:1

NOTE: Hubbell RL prorated from 400W per advice from manufacturer.

04-Nov-08

"Competition" street
(Visual calculations)

Average footcandles and av/min uniformity

150-watt Cobras, Full-cutoff vs. Semi-cutoff

	Av	Min	Av/ Min
SCO Cooper (OVZ15SxxE.ies)	0.7	0.3	2.3
SCO GE (177249.ies)	0.7	0.3	2.3
FCO AEL DuraStar 30 (LTL13698.ies)*	0.8	0.4	2.0
FCO Cooper (OVF15SxxD.ies)	0.8	0.5	1.6
FCO Cooper (OVH15SxxD.ies)	0.9	0.3	3.0
FCO GE (177292.ies)	0.8	0.3	2.7
FCO Holophane Mongoose (49419.ies)	0.8	0.4	2.0
FCO Hubbell RL (HP03173.ies)	0.8	0.5	1.6
FCO Hubbell RM (HP03116.ies)	0.7	0.4	1.8

Competition standards: average illuminance, 1-2 fc
av/min uniformity, not to exceed 4:1
(no standard for max/min uniformity)
street width: 42'
pole spacing: 236' (118' staggered)

NOTE:

All luminaires are mounted at 30' (standard per NYC Design Criteria) on 8' arms (per Streetlight Design Competition).

*Pro-rated from 250W

04-Nov-08

Transportation Committee
of the New York City Council
November 6, 2008, Hearing

Statement of Gail Clyma re Int. 806

I'd like to commend Councilmember Lappin for recognizing the potential of LED technology to reduce the amount of electricity consumed by our New York City streetlighting system.

As you may know, the City converted all its traffic signals to LED lighting several years ago. Development of the higher wattage LED's needed for streetlighting has been proceeding at a brisk pace. The promise of energy savings has prompted the U.S. Department of Energy to take an active role in coordinating these efforts and establishing guidelines and performance standards for this new technology. In August the U.S. Department of Energy proposed that in order to qualify for Energy Star designation, LED streetlights would need to be fully shielded. Although this requirement will not be finalized until next month, I hope it will be incorporated into this legislation. [Energy Star specs] [point to provision]

In my comments regarding Councilmember Gerson's bill, I mentioned the concern about use of bluish tinted metal halide bulbs in streetlights. This is an even greater issue with LED's. Therefore, even though it is not a requirement for Energy Star streetlights, I strongly recommend that a provision to address this issue be added to Resolution 806.

Light sources are characterized by something called Correlated Color Temperature, which is measured in degrees of "Kelvin." On the upper part of the first Energy Star page, you will see a provision that residential downlights be allowed Correlated Color Temperatures--CCTs--of no more than 3500 Kelvin. Since such fixtures can be turned off by residents, while streetlights cannot, I would recommend that LED streetlights be allowed no more than 3000 Kelvin. LED streetlights now being used in experimental programs are commonly around 6000 or 8000 Kelvin.

In the commentary I gave you earlier regarding the blue tint of metal halide lighting, you will see that it takes only a fraction as much metal halide light as high-pressure sodium light to suppress production of the cancer-fighting hormone, melatonin. So even though the Energy Star folks have not written a provision to limit Correlated Color Temperature of LED streetlights, I hope you will consider adding one to this bill.

ENERGY STAR® Program Requirements for Solid State Lighting Luminaires

Proposed Category "A" Additions

Category A: Near-term Applications

Surface and pendant-mounted downlights

Comments on Surface and pendant-mounted downlights:

- The existing criteria specifically address recessed downlights. Given the photometric similarity amongst downlight applications surface and pendant-mounted downlights are being added to the criteria.

Application Requirements	
Minimum Light Output	≤ 4.5" Aperture: 345 lumens (initial) > 4.5" Aperture: 575 lumens (initial)
Zonal Lumen Density Requirement	Luminaire shall deliver a minimum of 75% of total lumens within the 0-60° zone (bilaterally symmetrical).
Minimum Luminaire Efficacy	35 lm/W
Allowable CCTs	2700 K, 3000 K and 3500 K for Residential products

Outdoor pole/arm-mounted area and roadway luminaires

Comments on beam uniformity metric:

- Goniophotometry measures luminous intensity only. Luminous flux can be derived from intensity data using zonal constants (a trigonometric function).
- Illuminance is also derived from intensity. The cosine law (a modified version of the inverse square law) states that illuminance = intensity x cos Θ / distance^2, i.e., higher intensity is required at higher vertical angles than at nadir to produce equivalent illuminances across the luminaire beam spread. Therefore, when concerned with regulating illuminance uniformity, it is more relevant to address intensity than luminous flux.
- Note also that luminous flux and intensity are not corollaries. Whereas zonal lumens represent a total and must sum to 100%, luminous intensity is an infinite measure and specific to the angle of measurement. This "disconnect" between flux and intensity underlies, in part, IESNA nullifying its luminaire cutoff classifications (superceded by the Luminaire Classification System, per IESNA TM-15-07).

Application Requirements	
Minimum Light Output	Luminaire shall deliver a minimum of 2,300 lumens (initial).
Zonal Lumen Density Requirement	Luminaire shall deliver 100% of total lumens within the 0°- 90° zone, with a maximum of 10% of total lumens delivered within the 80°- 90° zone (bilaterally symmetrical).
Beam Uniformity	IES Outdoor Luminaire Classification Type II/III

	Maximum intensity (in candelas, cd) to be produced in the 55°- 65° zone (vertical), at a horizontal angle per IESNA TM-15 definitions, with the following requirements: • 10% - 35%† of the max. cd in the 0°- 25° range • 35% - 60%† of the max. cd in the 25°- 45° range • 35% - 95%† of the max. cd in the 65°- 75° range • ≤5%† of the max cd in the 80°- 90° range IES Outdoor Luminaire Classification Type IV Maximum intensity (cd) to be produced in the 55°- 65° zone (vertical), with the following requirements: • ≤50%† of the max. cd in the 0°- 40° range • ≤5%† of the max cd in the 80°- 90° range IES Outdoor Luminaire Classification Type V Maximum intensity (cd) to be produced in the 55°- 65° zone (vertical), with the following requirements: • 10% - 35%† of the max. cd in the 0°- 25° range • 35% - 60%† of the max. cd in the 25°- 45° range • 35% - 95%† of the max. cd in the 65°- 75° range • ≤5%† of the max cd in the 80°- 90° range †All percentages are ±5% (Refer to IESNA TM-15-07 for luminaire classifications distribution types)
Minimum Luminaire Efficacy	50 lm/W

Outdoor pole/arm-mounted decorative luminaires

Application Requirements	
Minimum Light Output	Luminaire shall deliver a minimum of 2,300 lumens (initial).
Zonal Lumen Density Requirement	Luminaire shall deliver a minimum of 85% of total lumens within the 0°- 90° zone (bilaterally symmetrical).
Minimum Luminaire Efficacy	40 lm/W

Outdoor wall-mounted area luminaires ("wall packs")

Application Requirements	
Minimum Light Output	Luminaire shall deliver a minimum of 1,300 lumens (initial).
Zonal Lumen Density Requirement	Luminaire shall deliver 100% of total lumens within the 0°- 90° zone, with a maximum of 10% of total lumens delivered within the 80°- 90° zone (bilaterally symmetrical).
Minimum Luminaire Efficacy	40 lm/W

Some Examples of Good and Bad Lighting

SELENE NY
Sensible and Efficient Lighting to Enhance the Nighttime Environment

New York State Affiliate of the
International Dark-Sky Association

TO:

Light Pollution:

Railroad crossing sign virtually disappears in glare from misdirected, unshielded floodlights.

What is it?

Why should it be curbed?

How can you help?

What is light pollution?

All of the following are forms of light pollution:

Glare:
Light shining directly into your eyes, causing discomfort and reducing your ability to see.

Light trespass:
Light falling where it is not needed or wanted --for example, spilling over onto your property or into your home.

Waste:
Lighting that's on when it needn't be; lighting that's excessively bright; unshielded lighting that spills out and upward instead of being directed at its intended subject.

Sky glow:
The result of upward-shining light, which is reflected off moisture and dust particles in the atmosphere to illuminate the nighttime sky and wash out all but the brightest stars.

Why should it be curbed?

Wasted light wastes money.
It has been estimated that a third of outdoor lighting spills out and upward, totally wasted; a conservative calculation of the cost comes to around $4.5 billion annually. Added to that figure is the waste from excessively bright lighting and the 100% waste from lighting that's on when it needn't be. You are paying the price through higher taxes for public lighting and inflated costs for consumer products and services.

Wasted light causes unnecessary air pollution.
Most electricity for lighting is generated by burning coal and oil. Every year this process spills out billions of tons of sulfur dioxide (an ingredient of acid rain), carbon dioxide (a greenhouse gas), and smog-causing nitrogen oxides.

Wasted light squanders irreplaceable natural resources.
The annual waste just from unshielded lighting has been estimated at more than 8 million tons of coal or 30 million barrels of oil.

Light pollution creates unnecessary hazards.
Glare from bad roadway and roadside lighting that blinds a motorist, even momentarily, can be fatal; older Americans are particularly at risk. The eye takes time to adjust from excessive brightness (common at gasoline service stations) to less bright areas (as you pull out onto the darker roadway). Impaired vision during such "transient adaptation" can pose hazards for pedestrians as well.

And while outdoor lighting may reduce the *fear* of crime, it can also attract criminals, illuminating their tasks and creating deep shadows to hide in. In 1977 and again in 1997, investigations by the U.S. Justice Department concluded that there is no meaningful evidence that street lighting affects the level of crime.

Light pollution can harm plants and animals.

All earth's creatures have evolved over thousands of years by adapting to a world that is dark at night. The loss of true darkness can alter the growth cycle of trees, weakening them and making them more susceptible to disease and severe weather. Birds, fish, frogs, moths, and plankton are just some of the animals whose behavior has been shown to be affected by increasing nighttime light--often with disastrous results.

Sky glow is obliterating the stars.
Satellite images show one huge blob of light running down the Eastern seaboard almost solidly from Maine to Virginia; the epidemic of wasted uplight has become so severe that two thirds of Americans can no longer see the Milky Way. A *dark* sky full of shimmering stars is a thing of great beauty--a source of inspiration and information to diverse cultures across the centuries. Shouldn't we preserve it for ourselves and for our children?

How can you help?

1. Learn more about the problem. (See information sources below.)

2. It's easy to eliminate any light pollution that may be coming from your property.

   ☞ If an outdoor light is aimed down and the bulb fully recessed inside a cap or shield, stray rays will not escape into the sky or onto your neighbor's property.

   ☞ If you have any dusk-to-dawn lighting, a motion-sensor control will save money on your electric bill *and* be more effective at discouraging intruders.

3. Encourage your neighbors and the businesses you deal with to do the same!

4. Contact your state and local government representatives and let them know you support legislation and building code amendments requiring fully shielded lighting.

For additional information:

International Dark-Sky Association
3225 North First Avenue
Tucson, AZ 85719
520/293-3198
www.darksky.org

SELENE is IDA's affiliate in New York State. The word means "moon" in Greek; we use the letters to stand for Sensible and Efficient Lighting to Enhance the Nighttime Environment. Visit us on the Web at www.selene-ny.org.

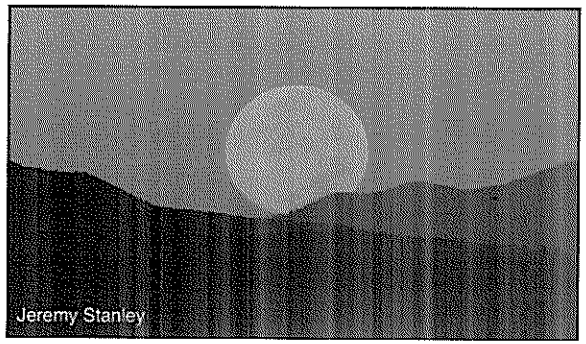
To obtain additional copies of this leaflet, please e-mail us at info@selene-ny.org.

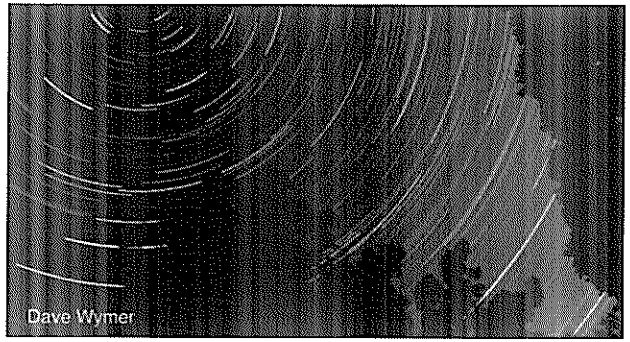
To easily compare operating costs of different lights, try the online calculator at http://www.netacc.net/~poulsen/lightcost.html.

Biological clock and circadian rhythm

Animals and plants live by a rhythm which is attuned to our planet's 24-hour cycle. This is an inherited trait, which is passed on through the genes of a species. Humans may notice a change in their circadian rhythm when they travel by airplane between several time zones, characterized by sleepiness, lethargy, or a general sense that something is "off."

Wildlife and fish experience this same disorientation of time when there is too much artificial light at night. Behavior governing mating, migration, sleep, and finding food are determined by the length of nighttime. Light pollution negatively disrupts these age-old patterns. See inside for details about the ill-effects of light pollution on our environment and wildlife.





The International Dark-Sky Association (IDA), is an educational organization that seeks to preserve the natural night skies worldwide. Light pollution is an increasing problem threatening astronomical facilities, ecologically sensitive habitats, all wildlife, our energy use as well as our human heritage. Light pollution is excessive and inappropriate artificial light. The four components of light pollution are often combined and overlapping:

- **Urban sky glow**—the brightening of the night sky over inhabited areas.
- **Light trespass**—light falling where it is not intended, wanted, or needed.
- **Glare**—excessive brightness which causes visual discomfort. High levels of glare can decrease visibility.
- **Clutter**—bright, confusing, and excessive groupings of light sources, commonly found in over-lit urban areas. The proliferation of clutter contributes to urban sky glow, trespass, and glare.

Keeping lights on in unoccupied buildings, outdoor lights pointing up to the sky or unshielded lights create sky glow. Visit the IDA Web site at *www.darksky.org* to learn more about the causes of light pollution and what you can do to keep the skies dark.

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Fax +1 520-293-3192
www.darksky.org
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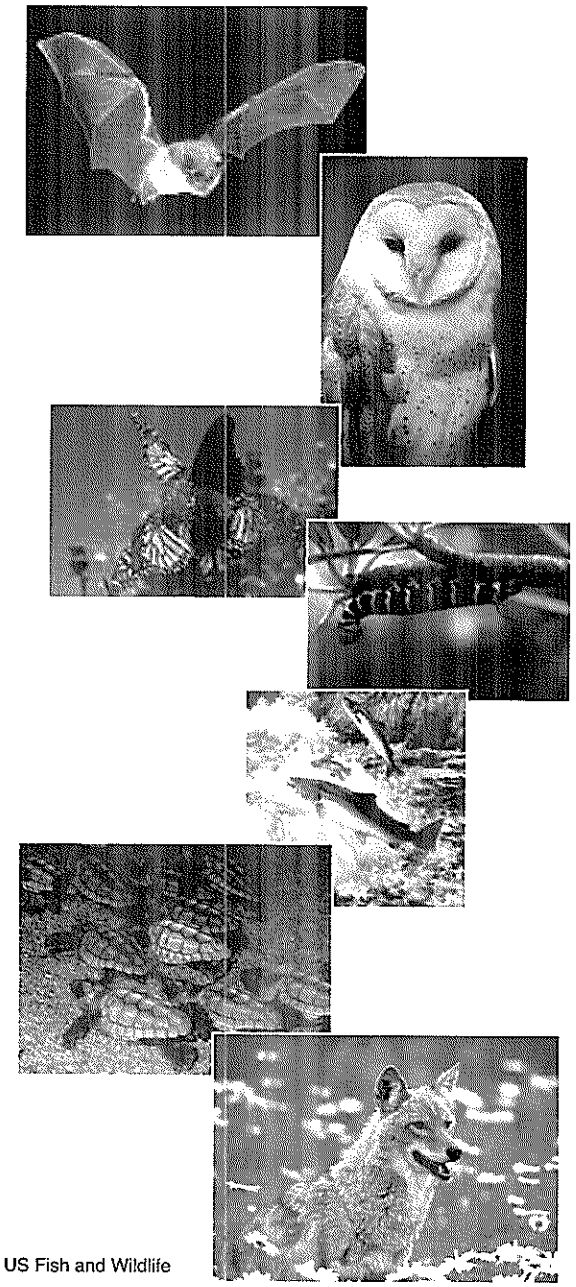
This brochure was made possible by funding from the Gildea Foundation

International Dark-Sky Association

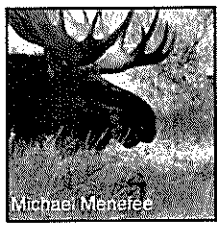
To preserve and protect the nighttime environment and our heritage of dark skies through quality outdoor lighting.

Light Pollution and Wildlife



US Fish and Wildlife

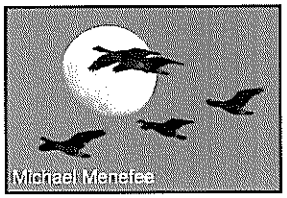
Mammals



The bright lights from cities and towns cause nocturnal mammals across the globe to experience a loss of their night ecosystem. Examples of these affected mammals are bats, raccoons, coyotes, deer and moose. These species can experience:

- A decline in reproduction, leading to a shrinking population
- Difficulty foraging for food due to too much light
- Exposure to predators that would otherwise be unable to see them
- Increased mortality caused by impairment of their night vision

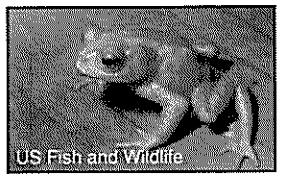
Birds



Many species of birds migrate or hunt at night This dependence on darkness makes them extremely vulnerable to bright lights in areas that are naturally dark. Birds can be drawn to light sources and become fixated on the beam. This confusion causes a variety of negative effects, such as:

- 100 million birds a year throughout North America die in collisions with lighted buildings and towers
- Not wanting to fly back into the dark, they continue to fly in the light's beam until they are exhausted, fall or become prey
- The artificial lights can also cause migrating birds to wander off course and never reach their natural destination
- Marine birds have been known to collide with lighthouses, wind turbines and drilling platforms at sea

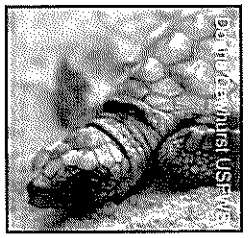
Amphibians



The haze from sky glow extends far beyond the borders of an urban city, impacting the environment for miles, including wetlands, the natural habitat of amphibians. It causes amphibians, and other creatures of the marshes, to become confused and disoriented, causing:

- A decrease in reproduction, resulting in lower populations
- Reduced foraging for food and lower body weight
- Confusion of natural instincts that protect against predators and the elements

Reptiles



Reptiles are greatly affected by light pollution. For example, female sea turtles like to nest on remote and very dark beaches. Coastal lights interfere with their ability to find a safe nesting area for their eggs. Sea turtle hatchlings crawl instinctively toward the relative safety of the ocean because of its reflection of the moon and stars. For centuries, this reflection was the brightest point of light on a beach. Artificial lights can confuse the hatchlings and cause them to crawl away from the ocean and onto roads or into communities. If they do not find their way back to the ocean, they could become fatally exhausted or dehydrated. Nocturnal reptiles can also become disoriented by the artificial light invading their homes and experience a change in natural behaviors. These behaviors might include:

- Appetite problems resulting in decreased weight
- Decrease in mating, resulting in diminished populations
- Increased vulnerability to natural predators and unusual ones like cars and humans

Insects

Moths and other insects are attracted to artificial lights and may stay near that light all night. This activity around the light:

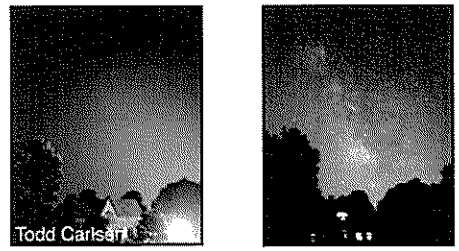
- Expends too much energy and interferes with mating and migration, causing population reduction
- Makes them easy prey for bats and other nocturnal predators, further reducing their numbers
- Impacts all species who rely on insects for food or pollination

There are solutions

IDA believes that there are solutions to these issues:

- Shield your outdoor lighting
- Only use the light when you need it
- Use timers and dimmers
- Shut off the lights when you can
- Use only enough light to get the job done
- Use long wavelength light with a red or yellow tint to minimize impact

A shielded light uses less wattage and saves you money. Work with your neighbors and local government to keep the skies natural. This is a win-win situation for everyone. You save money while simultaneously reducing the impact of artificial light at night.



Before and during the East Coast blackout, 2003

Transportation Committee
of the New York City Council
November 6, 2008, Hearing

Statement of Gail Clyma re Int. 757

I'm delighted to see not one but two bills dealing with streetlighting on your agenda this morning. Streetlights are a major cause... in many areas *the* major cause...of light pollution, a problem I've been working on for 15 years.

In case this issue is new to you, light pollution is outdoor lighting that is misdirected, excessive, or unnecessary. Such lighting results in disabling glare, trespass onto other properties, waste, and sky glow--that is, the illumination of the night sky so that there appear to be only a handful of stars over New York City.

In addition to creating unnecessary hazards for drivers and pedestrians, light pollution can harm plants and animals. This should not be surprising if we keep in mind that *every living thing* on this earth evolved over thousands of years by adapting to a world that was truly dark at night. And a growing body of evidence is demonstrating that human beings are not exempt from this damage; the link between light at night and breast cancer is particularly strong.

As you may know, a bill that would require shielding of streetlights and other publicly funded lighting has been stalled in the New York State Legislature for a number of years. I was a constituent of Assemblyman Pete Grannis, the prime sponsor of this bill until he was appointed DEC Commissioner last year, and worked closely with his staff.

The principal opponent has been New York City's Department of Transportation, which insisted for years that fully shielded streetlights could not match the performance of the drop-lens cobra-head types now on City streets. Finally this spring they accepted our evidence to the contrary, but they are still fighting because they just don't like any sort of legislation that affects them. The evidence is too complicated to describe in the 3 minutes allotted, but I'd be more than happy to review this with you when time is available.

There are a several problems with language in the existing draft of Resolution 757. Since I was involved in revising and refining the State bill over the years, I thought it might be helpful to adapt that language for New York City. The resulting draft is the next item in your packet, and I hope you will find it useful.

One addition, an issue that is not in the State bill, is a proposed prohibition of streetlights having metal halide bulbs. These bulbs, which have a bluish tint, have been widely used in lighting funded by Business Improvement Districts. They are a bad choice for many reasons, not least that they're an even greater health threat than the gold-to-amber high-pressure sodium bulbs now more widely used.

Artificial Night Lighting and Human Health:
Cause for Concern

When Peter Jennings reported on "World News Tonight" in 2003 that nighttime lighting might be harmful to human health, it was surely news to almost all his listeners. But the possibility of a link between light and breast cancer had been noted as early as 1990.

An analysis of more than 10,000 breast cancer patients done that year showed that profoundly blind women were only half as likely to develop the disease as sighted women. Subsequent research in Sweden and Norway indicated that cancer incidence for people who were visually impaired but able to detect light was virtually identical to the general population, whereas people unable to detect light had only 70% of that cancer risk. Among profoundly blind men there was lower incidence of cancers of the prostate, stomach, colon, rectum, skin, and lung; among women, fewer cancers developed in the breast, ovaries, and stomach.[1]

The apparent role of light in development of such cancers pointed to the hormone melatonin, which is produced by the pineal gland in response to the body's circadian rhythm, or biological clock. It is present even in algae and has existed in plants and animals for over three billion years. Light-dark cycles cause melatonin levels to rise at night in darkness and fall during daylight, but exposure to artificial light at night can suppress melatonin production--except in the profoundly blind.

Melatonin has anti-oxidant properties that may even slow the aging process. It induces sleep, boosts the immune system, lowers cholesterol, protects the body's cardiovascular system, and indirectly regulates the pituitary hormones that control endocrine glands such as the thyroid, pancreas, ovaries, testes, and adrenals. Researchers believe that lowered melatonin levels permit increased uptake of linoleic acid by cancer cells, which enhances their growth.

In 2002 an important piece in the light-health puzzle dropped into place with the discovery of previously unknown neural receptors in the eye. These "retinal ganglion cells," which are separate and independent from the rods and cones that provide vision, trigger the circadian clock that controls melatonin production.

The search for understanding of the light-cancer connection has been pursued in the laboratory as well as in large-scale analyses of medical records. An important insight came from Dr. David Blask of the Bassett Research Institute, where lab animals were implanted with cancer cells and divided into two groups--one exposed to light around the clock and the other kept in total darkness at night. Inadvertently, however, some animals from the latter group were exposed to a very small amount of light coming under the door at night. Tumors in these animals grew almost twice as fast as tumors in animals getting a night of total darkness; in fact, that bit of light at night produced a tumor growth rate virtually identical to that in animals exposed to bright, round-the-clock light.[2] A subsequent Blask study reported in 2005 showed that blood from women exposed to bright nighttime light stimulated growth of human breast tumors that had been implanted in laboratory rats.[3]

Important retrospective epidemiologic studies reported in the Journal of the National Cancer Institute and elsewhere examined breast cancer incidence among more than 78,000 women participating in the long-term Harvard Nurses' Health Study. Nurses who worked at least three nights per month for 30 years or more had a 36% higher breast cancer risk.[4] A separate analysis of the same 78,000 women indicated a 35% increase in risk of colorectal cancers among nurses who worked rotating night shifts for 15 years or longer.[5] A smaller survey of women's sleep habits and bedroom lighting environment showed that graveyard shiftwork was associated with 60% higher incidence of breast cancer; there was also an indication of increased risk among subjects with the brightest bedrooms.[6] And groundbreaking Israeli research found that incidence of breast cancer among women living in areas of the country with the brightest nighttime lighting was 73% higher than in areas with the lowest lighting.[7]

While correlations between cancer incidence and exposure to light at night may not prove a causal connection, the complementary laboratory work reinforces the evidence that it is only prudent to prevent even small amounts of outdoor lighting from entering bedroom windows.

1. Feychting M, Osterlund B, Ahlbom A
Reduced cancer incidence among the blind.
Epidemiology Sep 1998, 9(5):490-4.

2. Dauchy RT, Blask DE, et al.
Light contamination during the dark phase in photoperiodically controlled animal rooms: Effect on tumor growth and metabolism in rats.
Laboratory Animal Science Oct 1997, 47:511.

3. Blask DE, Brainard GC, et al.
Melatonin-depleted blood from premenopausal women exposed to light at night stimulates growth of human breast cancer xenografts in nude rats.
Cancer Research 2005, 65:11174-11184.

4. Schernhammer ES, Laden F, Speizer FE, Willett WC, Hunter DJ, Kawachi I, et al.
Rotating night shifts and risk of breast cancer in women participating in the Nurses' Health Study.
Journal of the National Cancer Institute 2001, 93:1563-8.

5. Schernhammer ES, Laden F, Speizer FE, Willett WC, Hunter DJ, Kawachi I, et al.
Night-shift work and risk of colorectal cancer in the Nurses' Health Study.
Journal of the National Cancer Institute 2003, 95: 825-828.

6. Davis S, Mirick DK, Stevens RG
Night-shift work, light at night, and risk of breast cancer.
Journal of the National Cancer Institute 2001, 93:1557-62.

7. Kloog I, Haim A, Stevens RG, Barchana M, Portnov BA
Light at Night Co-distributes with Incident Breast but not Lung Cancer in the Female Population of Israel.
Chronobiology International 2008, 25(1):65-81.

For a more detailed discussion of the issues, including an extensive bibliography, see also:

Pauley SM
Lighting for the human circadian clock: Recent research indicates that lighting has become a public health issue.
Medical Hypotheses 2004, 63:588-596.

Gail Clyma
Revised 28 Oct 08

1. Definitions.

For purposes of this section, the following terms shall have the following meanings:

(a) "Light bulb" shall mean the component of a light fixture that produces light; referred to in the trade as "lamp."

(b) "Light fixture" shall mean a complete lighting unit, including a bulb or bulbs together with the parts designed to distribute the light, to position and protect the bulbs, and to connect the bulbs to the power supply; referred to in the trade as "luminaire."

(c) "Light fixture, fully shielded" shall mean a light fixture constructed and installed in such a manner that all light emitted by it, either directly from the bulb or a diffusing element, or indirectly by reflection or refraction from any part of the fixture, is projected below a horizontal plane through the fixture's lowest light-emitting part.

(d) "Streetlight" shall mean a light fixture, together with its supporting pole or post, intended to illuminate a roadway.

(e) "Continuous roadway lighting design" shall mean a lighting plan that estimates light on a roadway from calculations utilizing factors including, but not limited to, a particular light fixture, mounting height, or pole spacing, in order to meet a specified goal such as minimum lighting level, uniformity, or small-target visibility. Lighting placed only at intersections or other potentially hazardous locations shall not be considered continuous.

(f) "Lumen" shall mean the unit of measurement used to quantify the amount of light produced by a bulb or emitted from a fixture (as distinct from "watt," a measure of power consumption).

(g) "Metal halide bulb" shall mean a bulb in which light is produced by passing electric current through metal halides and a mixture of mercury and other vapors. Such bulbs produce substantially less light per watt consumed than the high pressure sodium bulbs more commonly used for streetlighting.

(h) "Glare" shall mean light emitted by a fixture that causes reduced visibility or momentary blindness by shining directly into the eyes of the viewer.

(i) "Light trespass" shall mean light falling where it is not wanted or needed from a source on another property.

2. **Requirements.**

(a) The City of New York shall not install or cause to be installed any new or replacement streetlight fixture unless it is fully shielded, except that a historic-style decorative fixture may emit up to two percent of its total lumens above the horizontal plane.

(b) Streetlights on state or federal roadways within the City shall be subject to the provisions of this section if any City funds are used to install or replace such streetlights.

(c) Streetlights installed by or for any Business Improvement District shall be subject to the provisions of this section if any City funds are used to purchase electricity for them.

(d) No new or replacement streetlight fixture subject to the provisions of this section shall utilize a metal halide bulb.

3. **Exemptions.**

The following situations shall be exempt from the requirements of subdivision two of this section:

(a) The light fixture is a replacement for a fixture that is part of a continuous roadway lighting design;

(b) The light fixture is a historic-style decorative fixture which is part of a continuous roadway lighting design where the replacement of fixtures piecemeal with compliant fixtures would unacceptably degrade the aesthetic characteristics of the existing lighting design;

(c) Situations where there are special requirements, such as tunnels and underbridge lighting, provided, however, that all such lighting shall be selected and installed to shield the bulb or bulbs from direct view and to minimize upward lighting, glare, and light trespass to the greatest extent possible; and

(d) Situations where a written determination with findings has been made that a specified exemption to any requirement of subdivision two of this section is necessary and appropriate for a compelling safety interest that cannot be adequately addressed by any other method. This determination shall be made by the Commissioner of Transportation or his or her designee, and a copy of each such determination shall be filed at the office of the mayoral deputy whose responsibilities include oversight of the Department of Transportation.

4. **Effective date.**

This act shall take effect on the one hundred eightieth day after it shall have become a law, provided, however, that it shall not apply to projects for the installation or replacement of streetlight fixtures which had received final design approval prior to the effective date of this act.

Why Metal Halide Lighting Is a Bad Idea

In recent years, more and more fixtures using Metal Halide technology have been appearing in outdoor lighting applications...particularly streetlights and parking lots...that have traditionally used High Pressure Sodium lamps.

Lighting manufacturers, utilities, and designers are all partial to Metal Halide (MH) for their own reasons. MH lamps don't last as long as High Pressure Sodium (HPS), so manufacturers get to sell more of them. MH lamps put out less light per watt than HPS, so utilities get to sell more electricity. And since MH light is bluish-white rather than the gold-to-amber of HPS, sky glow from the unshielded fixtures favored by many lighting designers--though actually greater for MH--is not so readily connected to the source.

For everybody else, Metal Halide lighting is a bad idea!

Light output, lamp life, and mercury content

A 400-watt MH lamp puts out less than half as much light as a HPS lamp of the same wattage. In addition to higher electric costs, this lower efficacy of course means that MH adds unnecessarily to air pollution and global warming.

Depending on wattage, a typical MH lamp may not last even half as long as HPS. This means added costs not just for the lamps themselves but for the labor involved in more frequent replacement.

In addition to producing less light and not lasting as long, MH lamps contain a good deal more mercury than HPS lamps. In combination with the shorter lamp life of MH, this creates a "double whammy" effect. Mercury is a potent neuro-toxin that persists indefinitely in the environment, and we should be reducing its use as much as possible.

Here are some specifics:

Light Output, Rated Life, and Mercury Content[1]

	400-watt Lamp		250-watt Lamp	
	HPS	MH	HPS	MH
Light output (av. lumens)	45,000	20,500	26,100	14,100
Rated life (av. hours)	24,000+	15,000	24,000+	10,000
Mercury content (mg)	15	81	15	38

Glare

The bluish light of MH causes the pupil of the eye to contract, reducing the amount of light that reaches the retina. Think of the greater intensity of glare you experience from oncoming headlights with the blue tint that have appeared in recent years. Glare from outdoor lighting impairs our ability to see at night and constitutes a safety hazard.

"Sky glow"

Sky glow is the result of artificial outdoor lighting that is directed upward and outward. When this light is scattered and reflected by dust, molecules, and moisture in the atmosphere, the brightening of the night sky washes out all but the brightest stars. Because blue light is much more subject to this "Rayleigh scatter" than yellow or red light, MH fixtures typically produce about three times as much sky glow as HPS fixtures with the same lumen output.

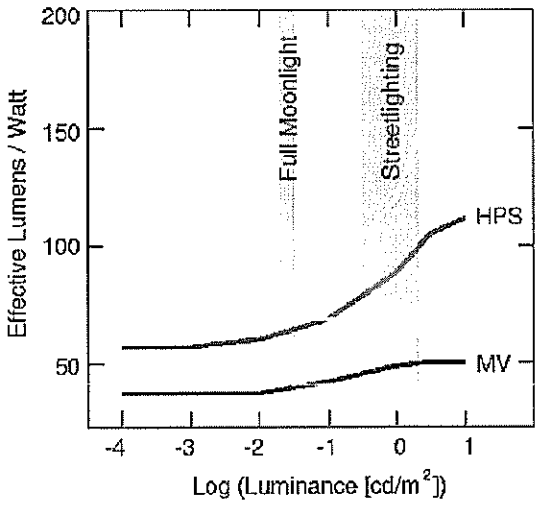
Human health

A growing body of evidence has demonstrated that exposure to light at night lowers production of the hormone melatonin. Reduced melatonin levels are associated with higher incidence of breast cancer. Nurses who work overnight shifts are at 60% greater risk of developing this dread disease[2], and groundbreaking Israeli research found that incidence of breast cancer among women living in areas of the country with the brightest nighttime lighting was 73% higher than in areas with the lowest lighting[3]. Another study showed that blood from women exposed to bright nighttime light stimulated growth of human breast tumors that had been implanted in laboratory rats[4].

While any type of nighttime lighting can suppress melatonin production, blue light causes the greatest reduction[5]; by one report, it takes *only a fifth as much* MH light as HPS light to decrease melatonin output.

"Effective" light levels

MH lighting is sometimes defended on grounds that less of it is required to provide a given level of visibility. However, this phenomenon is very much a function of the ambient lighting levels to which one's eye is adapted. "Effective lumens" for HPS do decline relative to MH as ambient lighting levels decline, but HPS retains its advantage for all luminance levels relevant for streetlighting. It is not until illumination becomes as low as or lower than full moonlight (about a tenth of the lowest levels encountered in roadways or parking lots) that MH begins to exceed HPS effectiveness[6].



Summing up

Compared to HPS, a MH bulb...

- Provides less light per watt of electricity consumed
- Does not last as long
- Contains significantly more mercury
- Creates more hazardous glare
- Produces about 3 times as much sky glow for the same light output
- Suppresses melatonin production with much less light
- Provides less visibility per watt at lighting levels typically used for streets and parking lots.

For all these reasons, HPS should be used in preference to MH for outdoor lighting applications except where color rendering is critical.

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1. Data courtesy Long Island Power Authority. Lumens and lamp life are for horizontal burn.

2. Davis S, Mirick DK, Stevens RG
Night-shift work, light at night, and risk of breast cancer.
Journal of the National Cancer Institute 2001, 93:1557-62.

3. Kloog I, Haim A, Stevens RG, Barchana M, Portnov BA
Light at Night Co-distributes with Incident Breast but not Lung Cancer in the Female Population of Israel.
Chronobiology International 2008, 25(1):65-81.

4. Blask DE, Brainard GC, et al.
Melatonin-depleted blood from premenopausal women exposed to light at night stimulates growth of human breast cancer xenografts in nude rats.
Cancer Research 2005, 65:11174-11184.

5. Brainard GC, Hanafin JP, et al.
Action Spectrum for Melatonin Regulation in Humans: Evidence for a Novel Circadian Photoreceptor.
Journal of Neuroscience 2001, 21(16):6405-6412.

6. Chart from "Outdoor Lighting Code Handbook," International Dark-Sky Association 2002, adapted from Adrian W, *The influence of the Spectral Power Distribution for Equal Visual Performance in Roadway Lighting Levels* in Proceedings: Vision at Low Light Levels, EPRI 1999, Palo Alto, CA, p. 85.

Gail Clyma
15 Sep 08

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 757 Res. No. _____

☑ in favor ☐ in opposition

Date: 11/6/08

(PLEASE PRINT)

Name: Leo Smith

Address: 1060 Marston, Sotfield CT

I represent: International Dark Sky Assoc

Address: Tucson, AZ

Please complete this card and return to the Sergeant-at-Arms

Appearance Card

I intend to appear and speak on Int. No. 757 Res. No. _____

☑ in favor ☐ in opposition

Date: _____

(PLEASE PRINT)

Name: MICHAEL DEMMA

Address: _____

I represent: SELF

Address: 80 N. MOORE ST NYC 10013

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THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 757+806 Res. No. _____

☐ in favor ☐ in opposition

Date: 11/6/08

(PLEASE PRINT)

Name: David Wolock

Address: DOT

I represent: Deputy Commissioner of External Affairs

Address: _____

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 806 Res. No. _____

☒ in favor ☐ in opposition

Date: 11/06/08

(PLEASE PRINT)

Name: DAN MINER

Address: 66-33 YELLOWSTONE BLVD, FOREST HILLS, 11375

I represent: SIERRA CLUB NYC

Address: _____

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 757 Res. No. _____

☒ in favor ☐ in opposition

Date: 11/6/08

(PLEASE PRINT)

Name: Glenn Phillips

Address: 535 DEAN ST. BROOKLYN

I represent: New York City Audubon Society

Address: 71 W. 23rd Street, NY 10010

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 757/806 Res. No. _____

☐ in favor ☒ in opposition

Date: 11/6/08

(PLEASE PRINT)

Name: JENNIFER BRONS

Address: 21 UNION ST, TROY, NY 12180

I represent: LIGHTING RESEARCH CENTER
RENSSELAER POLYTECHNIC INSTITUTE

Address: (SEE ABOVE ADDRESS)

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

PANEL 2

Appearance Card

I intend to appear and speak on Int. No. 757 805 Res. No. _____

☑ in favor ☐ in opposition

Date: 4 Nov 08

(PLEASE PRINT)

Name: GAIL CLYMA

Address: 1 GRACIE TERR NEW YORK 10028

I represent: _____

Address: _____

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 757+806 Res. No. _____

☐ in favor ☐ in opposition

Date: 11/6/08

(PLEASE PRINT)

Name: Steven Galgano

Address: DOT

I represent: Executive Director of Engineering

Address: _____

THE COUNCIL
THE CITY OF NEW YORK

Panel 1 w/ Lev Smith

Appearance Card

I intend to appear and speak on Int. No. 757 Res. No. _____

☒ in favor ☐ in opposition

Date: NOV 6 08

(PLEASE PRINT)

Name: Susan Harder

Address: 440 Kent Ave Brooklyn

I represent: Int. Dark Sky

Address: _____

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☒ in favor ☐ in opposition

Date: _____

(PLEASE PRINT)

Name: Paul Schubert

Address: 147 Beach 113th

I represent: Rockaway Residents

Address: Community Organizer

Please complete this card and return to the Sergeant-at-Arms

Final ✓

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 757 Res. No. _____

☑ in favor ☐ in opposition

Date: 11. Dec. 08

(PLEASE PRINT)

Name: Lauren Schuster

Address: 9 Murray St. NY NY 10009

I represent: NYPIRG

Address: 9225 Byrne Ave SI, NY 10314

Please complete this card and return to the Sergeant-at-Arms