

# GREEN STANDARDS FOR LIGHT POLLUTION & BIRD-FRIENDLY DEVELOPMENT

By – law recommendations for the City of London

Prepared by the Ecological and Environmental Advisory Committee (EEFAC), the Advisory Committee on the Environment (ACE), & the Animal Welfare Advisory Committee (AWAC)

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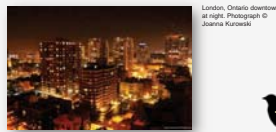
Light pollution in London, Ontario. From <http://lightpollutionmap.info>



## 1. DEFINITIONS

Definitions were derived from pre-existing standard documents of other municipalities within Ontario<sup>1-5</sup>. For the purpose of this document, terms shall be defined as follows:

- Architectural lighting** – outdoor lighting to illuminate landscaping features (e.g. trees, stones, or water), building facades, etc. (excluding signage)
- Automatic timing device** – any device which controls light fixtures to automatically turn on and off at designated times
- City** – the City of London, Ontario
- Council** – the elected municipal council of the City
- Curfew** – a time defined by the City when outdoor lighting must be reduced or switched off
- Cut-off shielding** – a luminaire having a light distribution in which zero lux intensity occurs at or above and angle of 90° nadir
- Decorative lighting** – see vanity lighting (below)
- Diode** – a device allowing one-directional flow of current
- Direct light** – light directly emitted from the installed light fixture or off of its internal reflector or luminaire
- Emergency conditions** – lighting that is only switched on during an emergency, exit paths during an emergency situation, or security lighting used solely during alarms
- Glare** – undue brightness from a light source. Light emitted from fixtures which diminish a bystander's ability to see and/or causes discomfort
- Grandfathered** – existing light fixtures which may be exempt from these recommendations (Section 6)
- Handscape** – permanent human-made elements of an outdoor landscape design
- Horizontal illuminance** – Amount of light energy landing on a horizontal surface (e.g. the ground)
- IESNA** – Illuminating Engineering Society of North America or any successor organization
- Indirect light** – light which is scattered or reflected off of other surfaces
- Lamp** – any artificial source of light
- LED (Light Emitting Diodes)** – a popular modern type of lamp
- Light fixture** – a complete lamp assembly which includes lamp, housing, reflector, mounting brackets, and/or pole socket
- Light pollution** – any adverse consequence of artificial light including, but not limited to, glare, light trespass, sky glow, energy waste, compromised safety and security, and impacts on the nocturnal environment
- Light trespass** – any light which falls beyond the property it is intended to illuminate
- Lumen** – a measurement unit that quantifies the amount of light produced by a lamp or emitted from a luminaire (distinct from 'watt', a measure of power consumption). Conversion to lux is possible
- Luminaire** – see Light fixture (above)
- Lux** – an international unit used to measure light intensity. Conversion to lumen is possible
- Official Plan** – the City of London and Planning Area's Official Plan, revised periodically
- Outdoor lighting** – any outdoor installed or portable luminaire used for flood lighting, general illumination, or advertisement
- Outdoor recreational facilities** – an outdoor space or venue used for sporting events or entertainment purposes within the city
- Over-illumination** – lighting of an area beyond that which human vision is able to differentiate
- Owner** – the registered owner according to the land registry office or the person in the actual occupation of the land
- Point illuminance** – Amount of light energy measured at a given point
- Shielded luminaire** – refers to luminaires with an adjustable mounting device allowing aim in any direction and contains a shield, baffle, or baffle to reduce direct view of lamp
- Sky glow** – any brightening of the nighttime sky caused by light directed and/or reflected upwards and/or sideways that reduces the ability to view the night sky
- Sufficient daylight** – adequate natural lighting such that exterior artificial lighting is not required (approximately 30 minutes after sunrise or 30 minutes prior to sunset)
- Vanity lighting** – lighting for the purpose of drawing attention. For example, lighting to illuminate landscaping features (e.g. trees, stones, or water), building facades, etc. (excluding signage)
- Ventilation grate** – street grates or grills which disperse air from structures under roadways and/or sidewalks to reduce heat gain in the summer and allow for passive heating in winter
- Visual markers** – a physical design visible within a bird's optical wavelength to indicate a barrier is present



London, Ontario downtown at night. Photograph by Joanna Kurek



## 2. PURPOSE & JUSTIFICATION

The City of London plans to become one of the greenest cities in Canada by reducing its impacts on the environment and its carbon footprint (direction 4, The London Plan)<sup>1</sup>. Specifically, The London Plan contains the goals of minimizing bird strikes on buildings and reducing negative environmental impacts of light pollution<sup>2</sup>. In Canada, it is estimated that 25 million birds die annually from collisions with buildings<sup>3</sup>. The purpose of this document is to provide guideline recommendations for by-law development to achieve these goals. Many specifications in this document are derived from pre-existing guidelines of other Ontario municipalities<sup>4,5</sup>, as well as from the Illuminating Engineering Society of North America (IESNA).

### 2.1 Environmental Impacts

Light pollution impacts the behaviour and survival of birds, mammals, amphibians, fish, and arthropods, and diminishes ecological health both locally and nationally<sup>6</sup>. Specific threats to wildlife include disruption of movement and migration<sup>11-14</sup>, changes in communication and reproductive behaviours (e.g. songbird call times)<sup>15</sup>, shifts in species diversity, altered interactions among species<sup>16,17</sup>, disruption of foraging behaviour, and increased mortality<sup>18-21</sup>.

### 2.2 Carbon Footprint and Cost

Goals of the current London Community Energy Action Plan<sup>22</sup> include an 80% reduction in greenhouse emissions by 2050 and energy cost savings. Policy and design standards to reduce wasted lighting energy are crucial if the City of London is to achieve these goals. Reducing wasted energy is an easy way for the City of London to reduce its carbon footprint; total wasted light energy in the United States is estimated between 80 and 225 kg of CO<sub>2</sub> annually<sup>23</sup>. The negative economic impacts of light pollution on health, wildlife, and astronomy are estimated at \$7 billion each year in the United States<sup>19</sup>.



## 3. GENERAL INFORMATION

### 3.1 Light Pollution

The City of London's Advisory Committee on the Environment (ACE), Environmental and Ecological Protection Advisory Committee (EEFAC), and Animal Welfare Advisory Committee (AWAC) (or 'we the committees') collectively recognize that it is beneficial to protect dark skies through responsible city lighting policies. We the committees recognize that other Ontario municipalities have outdoor lighting ordinances to reduce glare and light intrusion while promoting energy conservation and healthy neighbourhoods.

Light pollution has been defined as "excessive or obtrusive artificial light caused by bad lighting design"<sup>24</sup>. Proper lighting design and illumination standards can reduce light pollution by<sup>25</sup>:

- Preventing lighting in specific areas
- Limiting lighting duration
- Reducing light trespass
- Reducing light intensity

### 3.2 Bird-Friendly Design

Bird-friendly design is critical for city-wide progressive green development standards. Designs to reduce bird mortality may be similar to light pollution reduction strategies, with further inclusion of non-reflective glass and ventilation grates. In accordance with The City of London's Humane Urban Wildlife Conflict Policy, the City of London can take the following measures to reduce bird fatalities:

- Placement of bird-friendly exterior light fixtures in conjunction with glass design elements
- Adoption of a migratory bird policy<sup>26</sup>
- Provision of a comprehensive list of design-based development strategy options to architects, planners, urban designers, building owners and managers, tenants, and homeowners that can be applied to new or existing buildings
- A campaign that promotes awareness of the dangers the urban environment poses to migrating birds such as the City of Toronto's 'Lights Out Toronto' event
- Bird-friendly ventilation grates with a porosity no greater than 2 cm<sup>2</sup> or covered with netting to prevent injured birds from falling through
- If transparent noise barriers must be used, they shall have visual markers for birds to perceive and avoid them
- Eliminate reflective glass and mirrors from exterior landscape and building design. Birds are unable to distinguish between reflected and real habitat, which results in increased collision mortality



The night sky in Toronto, Ontario during a power outage in 2013 (left) and on a night with power (right). Photograph by Todd Cohen



## 4. LIGHTING DESIGN CRITERIA

All general recommendations found in Section 4.1 are applicable to all newly installed lighting fixtures. Specific design details can be found in the following sections categorized by site usage type (residential, non-residential, special consideration sites). These recommendations and criteria are amalgamated from the design guideline recommendations of the Model Lighting Ordinance<sup>27</sup>, and various Ontario municipalities (e.g. Toronto, Burlington, and Richmond Hill).

### 4.1 Hours of Operation

Recommendations for luminaire and timing of lighting are intended to reduce or eliminate unnecessary light pollution. The IESNA and other documents typically use a light curfew to achieve this. The City of London's curfew begins **10:00 PM and ends 6:00 AM**.

- Facilities requiring a curfew adjustment (e.g. restaurants, bars, sports stadiums, hospitals) will be evaluated on a case-by-case basis. During curfew, outdoor lighting must adhere to Section 4.2, bullet 5 option A or B. All residential and non-residential areas, including illuminated signs, are subject to the curfew<sup>28</sup>. Some site uses may warrant a curfew extension (e.g. recreation or entertainment) (see Section 6, General Exemptions).

### 4.2 Universal Outdoor Light Fixture Requirements

The general recommendations laid out below apply to all properties and lots.

- All outdoor light fixture installations must use shielded or cut-off fixtures
- No installed light fixtures will emit light above 90° from a direct downward plane
- Light fixture mounts/poles must have a non-reflective finish to reduce glare
- Maximum lumen levels for different light fixture heights must conform to Table 4.2
- All outdoor installed lighting (unless stated otherwise in Section 4.5) must incorporate one of the following:
  - A. An automatic switch (or automatic timing device) to extinguish all outdoor lighting curfew. These switches can include photoelectric, astronomic, programmable, or building automation systems.
  - B. Occupancy or sensor.
  - C. Battery or timer/switch/sensor

- Light trespass at the property line will not exceed 11.6 lumens / ft<sup>2</sup> for commercial/industrial property boundaries or 8.8 lumens / ft<sup>2</sup> for residential property boundaries. In the case of a mixed residential/commercial boundary, the value for the residential shall take precedence
- Adjustable, or swivel fixtures, are prohibited
- Pole heights cannot exceed: **Height = Distance from pole to property line x 4** and should not exceed height of adjacent structures. Large parking lots and parking garages with >10 parking spaces are exempt from this recommendation. If a non-residential zone light fixture must be installed higher due to safety considerations, cut-off shielding greater than 90° must be installed
- Glare onto adjacent properties, roadways, and pedestrian thoroughways is prohibited. This may require the use of additional shielding
- All light sources (a.k.a. bulbs, diodes) must be directed in such a way so that the light source is not directly visible from adjacent properties
- Openings in buildings which will contribute to light spillage must be blocked or shielded to transmit less than 10% light during the overnight hours (11 PM - 6 AM)
- The use of lasers, search lights, strobe lights, twinkle lights, or chasing lights are prohibited unless used for emergency services

Table 4.2

Mounting Height (Feet)	Mounting Height (Meters)	Maximum Single Light Fixture Lumens
6	1.83	400 – 1000
8	2.44	600 – 1600
10	3.05	1000 – 2000
12	3.66	1600 – 2400



## 4. LIGHTING DESIGN CRITERIA

### 4.3 Residential

All residential zones (R1 through R11) must adhere to the requirements listed above. If the residential zone is combined with a non-residential zone, the property is strongly encouraged to meet both residential (Section 4.3) and non-residential (Section 4.4) guidelines. Residential guidelines are as follows:

- Maximum single fixture lumen allowance at a main entrance will not exceed 1,200 lumens.
- Maximum lumen allowance for each additional fixture (excluding main entrance, driveway/parking (Section 4.5.2), and motion sensed security lighting (Section 4.5.7), is 315 lumens/fixture.
- In residential buildings with 5 or more stories, shielded directional fixtures with motion-sensors for security are not to exceed 1,200 lumens each.

Additional design criteria for specific types of sites or property uses (including parking lots and security lighting, which may be followed for residential properties) are included in Section 4.5.

### 4.4 Non-Residential

For all non-residential sites, Table 4.4 must be followed. Site total lumen allowance will be determined by number of parking spaces (if site has fewer than 10) or total square footage of hardscape. These site lumens may be divided among all light fixtures on the property, so long as they adhere to the universal guidelines noted above (Section 4.2) and any specific site guidelines below. Some specific types of site usage (e.g. sale lots or service stations) will have additional design considerations or may receive additional lumen allowance (Section 4.5).

Table 4.4

Light Code	City of London Property Zone Code(s)	Lumen Allowance	
		Lumens / parking space (for sites <= 10 parking spaces)	Lumens / m <sup>2</sup> of hardscape (sites > 10 parking spaces)
LZ-0	AG ER OS	350	0.5
	UR		
LZ-1	AG DC HER	490	1.25
	C		
	OC RO		
	RR		
	T TGS		
LZ-2	AC GI OF	630	2.5
	ASA HS OR		
	BDC LI RSC		
	CC NF NSA		
	CF CSA OB		
	CR		
	DA RF SS		
LZ-3	EX RSA	840	5
	HI RT		

Values obtained from the IESNA. This table is intended for non-residential zones only.  
 LZ1 - "Recommended default zone for wilderness areas, parks, and preserved and undeveloped rural areas."  
 LZ1 - "Recommended default zone for rural and low-density residential areas" (may include business parks).  
 LZ2 - "Recommended default zone for light commercial business districts and high density or mixed-use residential districts" (may include churches, schools, recreation facilities, light industrial zoning).  
 LZ3 - "Recommended default zone for large cities business district" (may include business zone districts, commercial mixed-use, and heavy industrial zones).



## 4. LIGHTING DESIGN CRITERIA

### 4.5 Specific Use Design Considerations and Lumen Allowance Additions

The following sections have been provided for specific-use zones and may be applicable to residential or non-residential areas.

#### 4.5.1 Entertainment Venues and Events

Entertainment venues and specific events are to be evaluated individually on a case-by-case basis.

#### 4.5.2 Parking Lots and Garages

Lighting in parking lots and garages are primarily for the safety of pedestrians. Parking structure lighting should be modulated so that they transition to match, but not exceed, adjacent roadway lighting levels at exits/entrances. All parking lots must adhere to maximum lumens at property line as described in Section 4.2.

In general, all parking lots shall have an average horizontal illuminance of no more than 25 lux with a maximum point illuminance not to exceed 40 lux. In the individualized case that a parking lot requires enhanced security due to the threat of vandalism or personal safety, the average horizontal illuminance and maximum point illuminance may be no greater than 75 lux.

These recommendations apply to any and all residential, institutional, customer, employee, or general-use parking lots.

#### 4.5.3 Outdoor Sales Lots

Sales lots are illuminated to draw attention to displayed products and/or for security purposes. The lighting requirements include a graduated illuminance level from the front (between the roadway and the front row of merchandise) to the last row. In addition to the universal guidelines presented in Section 4.2, site maximum horizontal illuminance is not to exceed:

- 100 lux at the front row
- 50 lux at all other rows
- 20 lux at all pathways/drives on the property

In addition to the lumen allowance provided in Table 4.4, outdoor sales lots used exclusively for the sale of vehicles have an additional allowance of:  
 LZ-1, additional 4 lumens / ft<sup>2</sup> hardscape  
 LZ-2, additional 8 lumens / ft<sup>2</sup> hardscape  
 LZ-3, additional 16 lumens / ft<sup>2</sup> hardscape

These recommendations apply to light fixture design in accordance to the lumen allowance for non-residential areas.



Excessive light pollution and glare



Lower light pollution with less glare

Residential lots in London, Ontario with excessive light pollution and glare (left) and relatively low light pollution and low glare (right). Photographs © Ryan Frazier 2015



## 4. LIGHTING DESIGN CRITERIA

### 4.5.4 Service Stations and Gas Stations

The purpose of lighting a service/gas station is to ensure patron safety and to draw attention and interest to the business. Over-illumination of the property is prohibited, and the illumination limits for property boundaries (Section 4.2) must be maintained. Installed fixtures are to be limited to a canopy whenever possible. In addition to adherence to the universal guidelines presented in Section 4.2, site average horizontal illuminance is not to exceed:

- 100 lux for pump island/under canopy
- 30 lux for service areas
- 20 lux for pathways/drives

In addition to the allowance provided in Table 4.4, service stations/gas stations have additional allowed lumens:

- LZ-1, 4000 additional lumens / pump
- LZ-2, 8000 additional lumens / pump
- LZ-3, 16,000 additional lumens / pump

These values are additional design criteria which need to be implemented in conjunction with the lumen allowance provided for non-residential sites.

### 4.5.5 Sports Recreational Fields

Outdoor sports fields require lighting for clear illumination of players. Sports/recreational fields have been divided into 4 classes:

- More than 5,000 attendance seats (e.g. universities, colleges, semi-pro players)
- 1,500 – 5,000 attendance seats (e.g. small universities or colleges, high-attendance high schools)
- 500 – 1,500 attendance seats (e.g. high schools, training clubs with spectator seats)
- Less than 500 attendance seats (e.g. leagues, elementary schools, little league, social events)

Using this classification system, illumination levels and lighting equipment must adhere to the IESNA Recommended Practice for Sports and Recreational Area Lighting (RP-6, latest edition). Illuminance values, fixture positioning, pole height, and curfew timing mandated in the IESNA RP-6 shall take precedence over the requirements outlined in this document.

### 4.5.6 Architectural and Vanity Lighting

Architectural lighting is used to highlight and attract attention to architectural features, heritage features, and municipal landscaping, monuments, or fountains. No fixture will be installed to emit light above the horizontal plane (e.g. directly upwards). No light fixture will be aimed at reflective or polished surfaces such as glass, smooth stone, glazed tile, etc. The maximum total illuminance shall not exceed 100 lux. Architectural/vanity lighting must be extinguished at curfew, preferably by automatic switch (Section 4.2, bullet 5, option A).

Lumens from architectural light fixtures must be included in the site maximum lumen allowance for non-residential sites (Table 4.4).

### 4.5.7 Security Lighting

Lighting to ensure the safety of pedestrians shall be used as required. Light fixtures for this purpose shall:

- Reduce brightness contrast
- Ensure no light is directed 90° above the horizontal
- Employ motion sensors (Section 4.2, bullet 5, option B)

These guidelines shall apply to all pedestrian trafficked areas and will be included in the site/lot lumen allowance.

### 4.5.8 Other

- vehicular and temporary emergency lighting required by Fire and Police Departments, or other emergency services shall be exempt from the requirements above.
- Outdoor lighting utilizing fossil fuels, including torches, lanterns, and open flames.
- Lights used by contractors, providing the lights are located on the property where such work is taking place and only during hours where work is occurring.
- Specific instances where concern for public safety conflicts with the guidelines outlined in this document will be evaluated on a case-by-case basis.



## 5. EXEMPTIONS

### 5.1 Grandfathered Lighting

All existing light fixtures in place at the time of this policy shall be grandfathered. Grandfathered light fixtures which are determined to cause excessive glare or light trespass may be required to be shielded, redirected, or removed. Any modification, relocation, repair, or reinstallation of any grandfathered light fixture must meet the design criteria laid out in Section 4. Should a property undergo a use or zoning change, all light fixtures must be updated to meet the design criteria in Section 4. All new fixtures installed after the date of this policy must meet the design criteria in Section 4.

### 5.2 General Exemptions

These guidelines do not take precedence over highway and road lighting bylaws.

#### 5.2.1 Recreational use - after 11 PM - limitation

Where an outdoor recreational use in an outdoor recreational facility continues after 11 PM, outdoor light fixtures required to be on in connection with that use are permitted, but only while that use continues.

#### 5.2.2 Entertainment event - after 11 PM - limitation

Where a concert, play or other entertainment event in a park or on other land owned by the Corporation and used for public purposes takes place or continues after 11 PM, outdoor light fixtures required to be on in connection with that event are permitted, but only while the event takes place or continues.

#### 5.2.3 Hospitals

All hospitals shall be exempt.

#### 5.2.4 Seasonal lighting

Lighting such as Christmas and other holiday lighting shall be exempt.

### 5.2.5 Temporary Exemptions

Any person may submit a written request for temporary exemption from the recommendations by completing a written request form prepared by the City. The written request should include:

- Specific exemption request
- Type and use of exterior lighting involved
- Date(s) of the event
- Duration of the event
- Location of exterior lighting
- Size, wattage, and height of proposed lighting

The owner or lease of the land upon which the prohibited light(s) will be placed shall apply to the city for an exemption. Plans for the location and fixture specifications for the specified light(s) shall be submitted with the application.

An exemption may be granted in whole or in part with terms and conditions. Any breach by the applicant of any of the terms or conditions will render the exemption null and void.



Keith Urban at Rock the Park music festival, London Ontario. Photograph © Gavin Rutten 2015



## 6. BIRD-FRIENDLY DESIGN

Mortality rates of birds are increasing due to collisions with buildings, especially during the migratory season. Each year nearly 25 million birds die in Canada from building collisions alone, making reflected light from buildings one of the most deadly threats to birds. With new guidelines in place, a building that emits reflected light which injures or kills birds is now a violation of the provincial Environmental Protection Act (EPA) and the federal Species at Risk Act (SARA). Due to these legal offenses, it is important for buildings to follow bird-friendly design guidelines across Canada.

The following strategies outline recommendations for achieving green standards for bird-friendly development, and are derived from the City of Toronto Green Development Standard: Bird-Friendly Development Guidelines (2007), City of Toronto Green Development Standard Version 2.0 (2015) and City of Toronto Bird-Friendly Development Guidelines Best Practices Glass (2016). These documents work together to reduce the threat of death from buildings by making glass less dangerous to birds and by mitigating light pollution. Options for creating visual markers, treating glass, and muting reflection shall be applied to 85% of glass features and windows for the first 12 m above grade (dimensions relate to typical tree height). Dimensions for visual markers and muting reflection applications are subject to building design and site conditions.

### 6.1 Visual Markers

Visual markers are the most effective technique to reduce window strikes and shall be used on exterior surface glass, but only railings, fly-through conditions and parallel glass within the first 12 m of the building. The distance between patterns or applications on glass must be a distance of 10 cm by 10 cm or less and at least 5 mm in diameter. Visual markers should have high contrast and be applied to low reflectance, exterior surface glass.



A window with visual marker strips and a bird collared to prevent bird strikes. Photograph from www.smith.edu/new/preventing-bird-collisions-or-econcoll/



## 6. BIRD-FRIENDLY DESIGN

### 6.2 Glass treatments

Glass treatments shall be applied above 12 m to the height of or anticipated height of the surrounding tree canopy and vegetation at maturity in sites close to natural areas such as ravines or woodlots. Glass treatments must also be applied to glass adjacent to or in the vicinity of elevated landscapes such as podium gardens and green roofs. Glass treatment options must also be applied to windbreaks, solariums, solariums and greenhouses in order to create sufficient visual markers for birds.

UV glass can be effective since birds are able to see into the UV spectrum, making UV treated glass opaque to birds but translucent to humans. Such UV glass must be tested and approved by a third party for effectiveness as outlined in the 2014 Toronto Green Development Standard version 2.0.

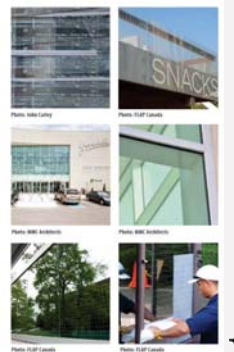
Patterned or "fritted" glass refers to glass which contains opaque or translucent images or abstract patterns. The images are created by using dots in a variety of sizes and densities which are most effective on the exterior surface of the glass. Only non-reflective glass should be used when combined with treated patterns. Pattern design should follow the outlines in 6.1: Visual Markers.

Film products refers to external film applications or laminates which contain images or patterns and can be designed to enhance the architectural design of the building. Decals with no more than 5 to 10 cm of clear spaces between patterns can be used. Decals must be located on the exterior glass.

Decorative Grilles and Louvers refer to exterior grille features which if applied must be 10 cm by 10 cm or less.

Finestration Patterns refers to multiple paned glass containing horizontal and vertical mullions. Panes must be no more than 28 cm with 10 cm or less the most effective visual marker.

Art work applied to the interior or exterior of windows can be used to provide sufficient visual markers while allowing for natural light.



Effective glass treatments for bird-friendly building design. Photographs from Toronto Bird-Friendly Best Practices Glass ©



## 6. BIRD-FRIENDLY DESIGN

### 6.3 Muting Reflections Options

**Awings and overhangs** to mute images at ground floor level.  
**Sunshades** refer to applications to reduce direct sunlight, while allowing indirect light into rooms. This feature mutes reflection thus reducing window strikes.

### 6.4 External Lighting

**Decorative Lighting** should be eliminated wherever possible. For existing buildings, decorative lighting should be projected downward and turned off during migratory season (September – November, March – May)

**Advertising Lighting** must be lit from above to reduce the volume of light being projected unnecessarily into the night sky.

**Event and Festival Lighting** such as spotlights and search lights must be prohibited during bird migration season.

**Roof Top Lighting** that should be prohibited. Vanity lighting may be allowed only if the following conditions are met:

- Exterior light fixtures are installed to prevent unnecessary light spillage.
- Vanity lighting is turned off from 11 PM - 5 AM year-round without exception utilizing an automatic device.

Overlites afterhours may be provided by a manual or occupant sensing device with a limit of 30 minutes.

### 6.5 Interior Lighting

**Bird Friendly Operational Systems and Practices** refers to the use of operating and system practices by residents, tenants, building owners, and managers to help reduce migratory bird fatalities. The following strategies can be used:

- **Installation of interior task lighting** at work stations be the recommended light source during evening work hours, increasing energy efficiency, reducing light pollution, and migratory bird fatalities. Overhead lighting be turned off at night and focused lighting such as task lighting be used during bird migration season.
- **Provision of shielding from interior generated light** with less than 10 % transmittance overnight for all fenestrations (windows, doors, skylights, curtained walls), for example blinds and curtains.
- **Motion-Sensitive Lighting** to be installed and retrofitted in lobbies, walkways, corridors, and operating systems that automatically turn off lights during after work hours.
- **Internal Location of Greenery:** Building owners and managers must locate greenery away from clear glass and minimize lighting levels through motion sensing lighting in ground floor lobbies, walkways and corridors and retrofit glass in these areas wherever possible with bird friendly window applications in order to meet the Bird Friendly Green Standard (birds drawn into cytopscapes by light pollution seek safety by flying towards greenery and are extremely dangerous in these areas.)



## 7. REFERENCES

- 1 Corporation of the City of London. 2015. The London Plan. London, ON. 463p. (Available at: [http://www.london.gov.uk/asset-upload-content/uploads/asset-upload-manager/16\\_MLO\\_FINAL\\_JUNE2015\\_PDF](http://www.london.gov.uk/asset-upload-content/uploads/asset-upload-manager/16_MLO_FINAL_JUNE2015_PDF).)
- 2 IMA-ESS. J. 2011. Model lighting Ordinance (MLO). Retrieved from <http://idatasky.org/wp-content/uploads/ima-ess-mlo.pdf>.
- 3 Corporation of the City of London. 2015. Roadway Lighting & Traffic Control - Street lights. London, ON. (Available at: <http://www.london.ca/residents/Roads-Transportation/traffic-management/Pages/Street-Lights.aspx>.)
- 4 Corporation of the City of London. 2016. Roadway Lighting & Traffic Control - Transportation Energy Optimization Plan. London, ON. (Available at: <http://www.london.ca/residents/Roads-Transportation/traffic-management/Pages/transportation%20Energy%20Optimization%20Plan.aspx>.)
- 5 Corporation of the City of Burlington. 2008. Guidelines for outdoor lighting. Burlington, ON. 22p. (Available at: <http://www.burlington.ca/uploads/2012/03/071514403/071803.pdf>.)
- 6 Corporation of the City of Mississauga. 2012. Nuisance lighting by-law 210-12. Mississauga, ON. 7p. (Available at: <http://www.mississauga.ca/files/COM/nuisancelighting2013.pdf>.)
- 7 Haskocks, P. D. 2011. Summary of lighting regulations. (Toronto Chapter, Royal Astronomical Society of Canada, Toronto, ON.)
- 8 Corporation of the City of Toronto. 2007. City of Toronto Green Development Standard: Bird-Friendly Development Guidelines. Toronto, ON. 42p. (Available at: [https://www.toronto.ca/city\\_of\\_toronto/energy\\_and\\_environment\\_guidelines.pdf](https://www.toronto.ca/city_of_toronto/energy_and_environment_guidelines.pdf).)
- 9 Corporation of the City of Richmond Hill. 2008. Chapter 100: Light pollution by-law. (Available at: [www.richmondhill.ca/documents/municipalcode/100.pdf](http://www.richmondhill.ca/documents/municipalcode/100.pdf).)
- 10 Galloway, T., O'Brien, N., & Mitchell, D. M. 2010. The economics of global light pollution. *Ecological Economics* 69, 698-695.
- 11 Patten, E. et al. 2011. The influence of artificial light on stream and riparian ecosystems: questions, challenges, and perspectives. *Ecosphere* 2, art122.
- 12 Koska, G., Berman, B., Farkas, R., & Horvath, G. 2009. Degrees of polarization of reflected light eliciting polarotaxis in dragonflies (Zygoptera), mayflies (Ephemeroptera) and tabanid flies (Tabanidae). *Journal of Insect Physiology* 55, 1157-1173.
- 13 Stone, E. L., Jones, G., & Harris, S. 2009. Street lighting disturbs commuting bats. *Current Biology* 19, 1123-1127.
- 14 Brooks, M. J., Pierce, S. M., Walsh, H. M., Aivalik, S. K., & Lim, J. D. 2001. Urban light pollution alters the diel vertical migration of *Daphnia*. *Internationale Vereinigung fur Theoretische und Angewandte Limnologie Verhandlungen* 27, 779-782.
- 15 Miller, M. W. 2006. Apparent effects of light pollution on singing behavior of American robins. *The Condor* 108, 130-139.
- 16 Davies, T. W., Bennie, J., Inger, R., Baars, N. H., & Gaston, K. J. 2013. Artificial light pollution: are shifting spectral signatures changing the balance of species interactions? *Global Change Biology* 19, 1417-1423.
- 17 Meyer, L. A., & Sullivan, S. M. P. 2013. Bright lights, big city: influences of ecological light pollution on reciprocal stream-riparian invertebrate fluxes. *Ecological Applications* 23, 1322-1330.
- 18 van Langevelde, F., Elberse, J. A., Donkers, M., Walschbe-Vries, M. F., & Goorenvliet, D. 2011. Effect of spectral composition of artificial light on the attraction of moths. *Biological Conservation* 144, 2274-2281.
- 19 Longcore, T., & Rich, C. 2004. Ecological light pollution. *Frontiers in Ecology and the Environment* 2, 191-198.
- 20 Gaston, K. J., Davies, T. W., Bennie, J., & Hopkins, J. 2012. Reducing the ecological consequences of night-time light pollution: options and developments. *Journal of Applied Ecology* 49, 1256-1266.
- 21 Gaston, K. J., Bennie, J., Davies, T. W., & Hopkins, J. 2013. The ecological impacts of nighttime light pollution: a mechanistic appraisal. *Biological Reviews* 88, 912-927.
- 22 Macdonald, C. S., Winkler, C., & Barnes, E. M. 2013. A first estimate for Canada of the number of birds killed by colliding with building windows. *Avian Conservation and Ecology* 8, 6.
- 23 Corporation of the City of London. 2014. Community Energy Action Plan. London, ON. 32p. (Available at: <https://www.london.ca/residents/Environment/Energy/Documents/Community%20Energy%20Plan.pdf>.)
- 24 Claude, L. 2008. Switch on the night: policies for smarter lighting. *Environmental Health Perspectives* 117, A28-A31.
- 25 Keller, R. J. et al. 2007. Light at night, chronodisruption, melatonin suppression, and cancer risk: a review. *Critical Reviews in Oncogenesis* 13.
- 26 Bansk, D. et al. 2012. Light pollution: adverse health effects of nighttime lighting. 27.
- 27 Wyses, C., Seimann, C., Page, M., Croger, A., & Hagerfeld, D. 2011. Circadian desynchrony and metabolic dysfunction: did light pollution make us fat? *Medical Hypotheses* 77, 1139-1144.
- 28 Anisimov, V. N. 2005. Light pollution, reproductive function and cancer risk. *Neuro Endocrinology Letters* 27, 35-42.
- 29 Cicchero, R., Fathi, F., & Sridhar, C. D. 2001. The first world atlas of the artificial night sky brightness. *Monthly Notices of the Royal Astronomical Society* 326, 689-707.
- 30 Galloway, T. 2010. On light pollution, passive pleasures, and the instrumental value of beauty. *Journal of Economic Issues* 44, 71-88.
- 31 Luyten, J. 2013. Nature's nocturnal services: light pollution as a non-recognized challenge for ecosystem services research and management. *Ecosystem Services* 3, e44-e48. doi:<http://dx.doi.org/10.1016/j.ecoser.2012.12.001>.
- 32 Milroy, B. Light pollution: responses and remedies. (Springer Science & Business Media, 2012).
- 33 Sherman, L. et al. 2011. Preventing crime: what works, what doesn't, what's promising. (University of Maryland Department of Criminology and Criminal Justice).
- 34 Monroe, E. N., & Hudson, S. A. The Chicago-Milky Way Project: Final Evaluation Report. (Illinois Criminal Justice Information Authority, 2004).
- 35 Steinbach, R. et al. 2015. The effect of reduced street lighting on road casualties and crime in England and Wales: controlled interrupted time series analysis. *Journal of Epidemiology and Community Health*. doi:10.1136/jech-2015-208012.
- 36 Corporation of the City of Richmond Hill. 1995. Chapter 1050 - Light pollution. Richmond Hill, ON. 21p. (Available at: <http://idatasky.org/asset-upload-content/uploads/2017/08/81c-Bird-Friendly-Best-Practices-Glass.pdf>.)
- 37 City of Toronto, City Planning. Bird-friendly best practices glass. 2016. (Available at: <https://www.toronto.ca/wp-content/uploads/2017/08/81c-Bird-Friendly-Best-Practices-Glass.pdf>.)



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The Summer Triangle and Milky Way, from Peppi, Ontario. Photograph © Ryan Frazer and Trevor McLaughlin 2012

