Norfolk Island Regional Council

LIGHTING MANAGEMENT POLICY

26 September 2022

Rev 1

DOCUMENT CONTROL INFORMATION

TITLE: NORFOLK ISLAND REGIONAL COUNCIL LIGHTING MANAGEMENT POLICY

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These lighting management principles and images are adapted from The Dark Sky Planning Guideline June 2016 (NSW Department of Planning and Environment © State of New South Wales and Department of Planning and Environment, 2016) and are consistent with the recommendations of the Australasian Dark Sky Alliance (ADSA) , the National Light Pollution Guidelines for the protection of Wildlife – including marine turtles, seabirds and migratory shorebirds (the Guidelines) , and the International Dark sky Association (IDA). Figures 2, 3, 5 - 10 adapted from Witherington and Martin (2003)

Document History

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Author:	Dr K Pendoley
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PENDOLEY ENVIRONMENTAL

PURPOSE

The Norfolk Island Regional Council (NIRC) Lighting Management Policy outlines the commitment and objectives regarding management of current and proposed lighting on Norfolk Island as it seeks to minimise sky glow, an initiative which will benefit the following values:

- Astronomy and Astrotourism; an increase in Astrotourists will diversify~~ing~~ the regional economy, growing tourism and creating jobs,
- Wildlife; reducing impacts on breeding, migratory and foraging behaviours, protecting *Environment Protection and Biodiversity Conservation Act 1999* listed species,
- Heritage; enhance the visibility of the night sky for traditional activities including indigenous astronomy and Polynesian navigation,
- Energy consumption; better planning for light at night will lead to reduced energy consumption, reduced energy costs and potentially reduced maintenance costs,
- Reduced greenhouse gas emissions.

BACKGROUND

The inappropriate or excessive use of artificial light is known as light pollution. The International Dark Sky Association (IDA) recognises the following four main aspects of light pollution:

- Skyglow – brightening of the night sky over inhabited areas;
- Glare – excessive brightness that causes visual discomfort or temporary "night" blindness;
- Light trespass – light falling where it is not intended or needed;
- Clutter – bright, confusing and excessive groupings of light sources[1].

Widespread pollution of the night sky by light, and the potential risks this poses to all living things, is emerging as an issue of concern worldwide. A global increase in light pollution was recognised by Kyba et al (2017) who found an annual increase in outdoor light pollution of 2.2% between 2012 and 2016. In Australia the annual increase was ~1% over the same time frame. This growth is expected to continue into the future with the electrification of developing countries globally.

The impacts of light pollution on the core "dark sky" values are summarised below.

Astronomy and Astrotourism

Skyglow impacts the view of the night sky. The International Astronomical Union describes that "wasteful light from artificial sources emitted upward (at horizontal angles and higher) is scattered by aerosols such as clouds and fog or small particulates like pollutants in the atmosphere. This scattering forms a diffuse glow that can be seen from very far away. Skyglow is the most commonly known form of light pollution."[2]

Good lighting design principles are important considerations to manage skyglow to enable Astrotourism development which can be of benefit economically and to the wider community by increasing visitor numbers and spending, diversifying and increasing employment and raising the

[1] https://www.darksky.org/light-pollution/ (accessed 20 December 2018)
[2] IAU Office for Astronomy Outreach, https://www.iau.org/public/images/detail/light-pollution-brochure/ (accessed 26 April 2018)

awareness within the community about the IDA International Dark Sky Places (IDSP) Program and the social and economic benefits associated with this accreditation.

Norfolk Island is unique in its comparative international advantages for Astrotourism activities due to:

- *Extremely low levels of artificial light pollution;*
- *Clear skies;*
- *Recognition by professional and amateur astronomers of the superior value of the Southern Hemisphere night sky compared to the northern hemisphere sky;*
- *Relative ease of access from Australia and New Zealand;*
- *Natural beauty and attractiveness of Norfolk as a destination in and of itself;*
- *Potential for excellent astrophotography opportunities island-wide.*

Wildlife

Artificial light can disorient flying birds and subsequently cause their death through collision with infrastructure. Birds may starve as a result of disruption to foraging, hampering their ability to replace used energy reserves to prepare for breeding or migration. High mortality of seabirds occurs through grounding of fledglings as a result of attraction to lights.

The biological issues associated with the brightening of the sky are being recognised by a growing body of literature that is linking exposure to artificial light at night (ALAN) to a range of impacts on flora, fauna, microorganisms (Gaston et al, 2017) and increasingly, human health (AMA, 2016; Lunn et al, 2017).

Light is recognised as a potential source of impact on wildlife under the *Environment Protection and Biodiversity Act 1999* (EPBC Act, Cth) and a risk factor for migratory birds under international agreements such as JAMBA, CAMBA, ROKAMBA, Bonn Convention, Ramsar Convention on Wetlands and Agreement on the Conservation of Albatrosses and Petrels (ACAP).

Norfolk Island is recognised for its diverse and unique bird fauna and has a role in the conservation of a wide range of EPBC Act listed species. Furthermore, these species are increasingly a focus of ecotourism on the island. The protection of this fauna from impacts, including light, will not only meet international regulatory obligations but also support the continued growth of ecotourism opportunities for the island.

Heritage

Humanity evolved under dark starlit skies, inspiring science, religion, philosophy, art and literature. Ancient Polynesian explorers have traditionally used the stars to navigate the oceans while the annual movement of stars provides a narrative on social order, seasonal changes in food supplies, navigation, kinship and spirituality for Indigenous Australians.

Norfolk Island's strong links to its Polynesian culture, both prehistoric and current, are integral to daily life on the island and together with the island's connection to its European colonial heritage, provides a rich and unique cultural experience for residents and visitors alike. Experiencing the dark skies that both the Polynesian and colonial settlers lived under is crucial to our understanding of this period in the island history.

Energy consumption

Excess or poorly directed light is wasted light. There is a financial and environmental cost associated with this wasted light. The energy required to generate the wasted light costs money while excess greenhouse gases are released into the atmosphere when generating the electricity to produce the wasted light.

Sustainable practices in resource and energy consumption are an integral component of the Norfolk Island community. Economic and environmental drivers support a strong culture of reduce, reuse, recycle and in minimising energy consumption. Continued actions to control and minimise night time lighting of public areas on Norfolk Island will help reduce energy costs, minimise island contributions to greenhouse gas emissions and provide a public demonstration of support for sustainable practices across the community.

POLICY

It is the NIRC policy to implement the following good lighting design principles to maintain and improve the quality of the dark night sky in its efforts to develop Astrotourism and Ecotourism, protect heritage values of the dark sky and wildlife, and reduce energy consumption and greenhouse gas emissions. The principles should be applied to any outdoor situation where light is:

- currently being used,
- being replaced, or
- planned for installation as part of a new development.

Application of the principles will benefit tourism, astronomy, heritage, human health, safety, energy, wildlife, environment and ecological values.

GOOD LIGHTING DESIGN PRINCIPLES

OVERVIEW

This part sets out the design principles that must be considered in the preparation, design and assessment of any development.

Good lighting design demonstrates adoption of the following principles (Figure 1):

1. **Start with natural darkness and add light only for specific purposes.**
2. **Use adaptive light controls to manage light timing, intensity and colour.**
3. **Shield lights and light only the area intended, to avoid light spill.**
4. **Use the lowest intensity lighting appropriate for the task.**
5. **Use non-reflective, dark-coloured surfaces.**
6. **Use lights with reduced or filtered blue, violet and ultra-violet wavelengths.**

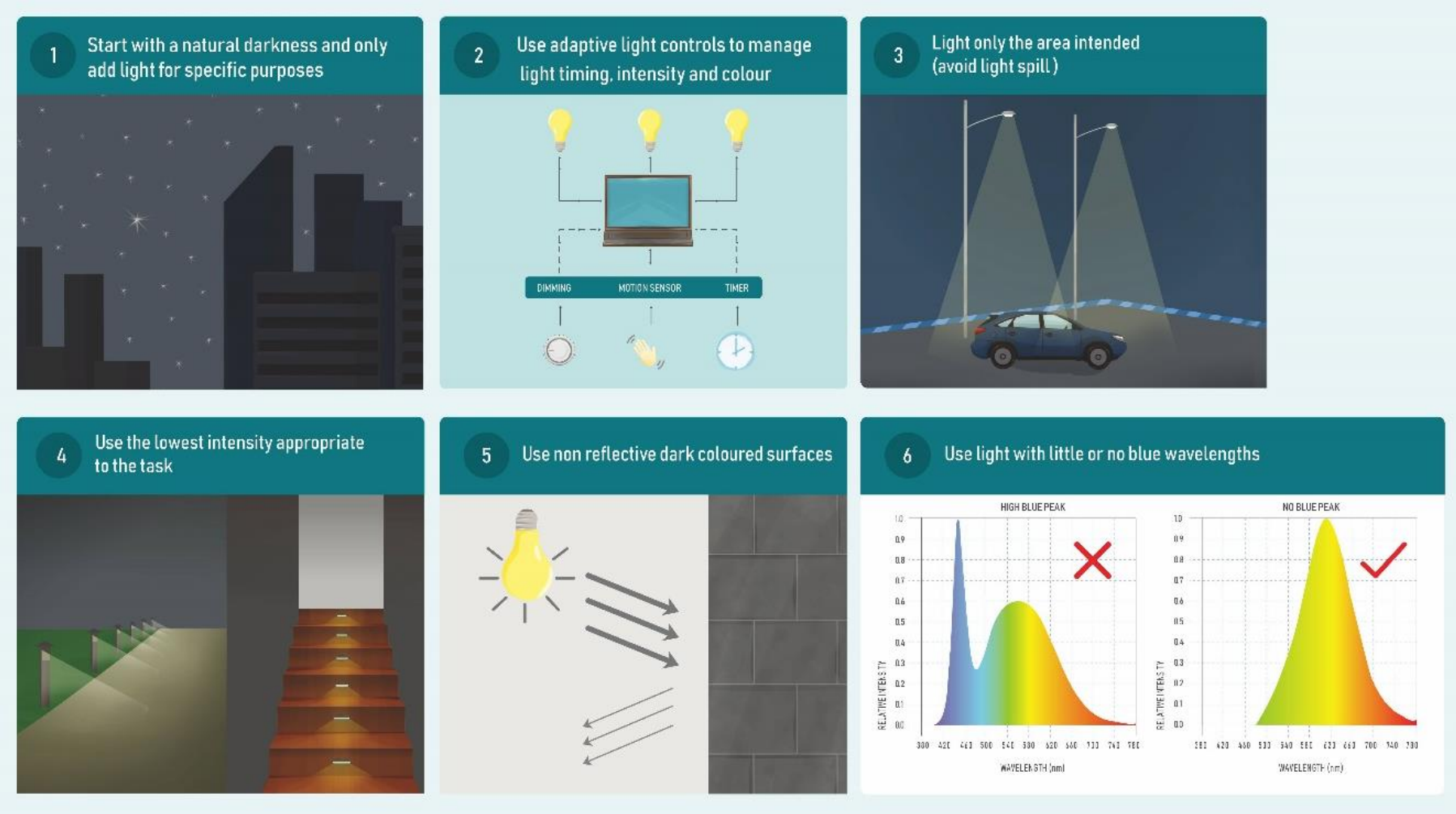

Figure 1: Good lighting design principles

THE DESIGN PRINCIPLES

Principle 1 Start with natural darkness and add light only as needed

The starting point for all lighting designs should be natural darkness. Artificial light should be added only for specific and defined purposes (lighting objective).

For new projects determine if lights are needed at all and then add exactly the amount of lighting needed as a minimum and only install that. For retrofitting projects (e.g. when replacing legacy lighting with new technology such as LEDs) the same process should be carried out with existing lighting critically assessed for its value and practical need.

Consider when lights are needed and illuminate an area only when and where people are present. Consider the need for lighting very late at night and in places that people do not frequent after dark.

Principle 2 Use adaptive light controls to manage light timing, intensity and colour

Recent advances in Smart Control technology provide a range of novel and powerful options for better controlled and targeted light management. With the introduction of Smart Controlled LED lights, lighting can be manipulated remotely and programmed for specific applications.

Smart Control and LED technology allows for:

- remotely managing lights (computer controls);
- instant on and off switching of lights;
- control of light colour;
- dimming, timers, flashing rate, motion sensors; and
- well defined directivity of light.

Adaptive controls should maximise the use of latest lighting technology to minimise unnecessary light output and energy consumption.

These controls allow lights to be switched off when not required to light a task or an area for safety or security purposes.

The concept of a curfew with further limitations on lighting levels between agreed hours is encouraged. Examples include extinguishing or dimming advertising and decorative lighting after 9:00pm. Light fittings with timers that switch on at dusk and switch off by 9:00pm are also encouraged.

Principle 3 Light only the area required

Focus light onto the area it is needed:

- eliminate upward light spill;
- direct light downwards, not upwards or sideways;
- use shielded fittings;
- use asymmetric beams in floodlights.

Eliminate upward spill light

Spill light is light that falls outside the area that is intended to be lit. Spill light can cause glare and wastes energy. Spill light above the horizontal plane of a light fixture contributes directly to artificial skyglow.

All light fittings should be located, aimed or shielded to avoid lighting unintended areas next to or above the light fitting (Figure 2). Light can be prevented from shining above the horizontal plane and up into the sky by

- mounting the luminaire horizontally relative to the ground and not at an angle (e.g. street lights);
- using a shielded fixture that recesses the globes inside a cover and preventing light escaping horizontally;
- mounting the light under part of a building like an awning, veranda or roof, so that light is blocked from shining above the horizontal plane.

Some examples of good and bad applications of light use and shielding options are shown in;

- Figure 3; signs
- Figure 4; building facades
- Figure 5; unshielded, partially shielded, fully shielded examples
- Figure 6; eaves
- Figure 7; balconies
- Figure 8; poles
- Figure 9; walkways
- Figure 10; buildings
- Figure 11; parking lots.

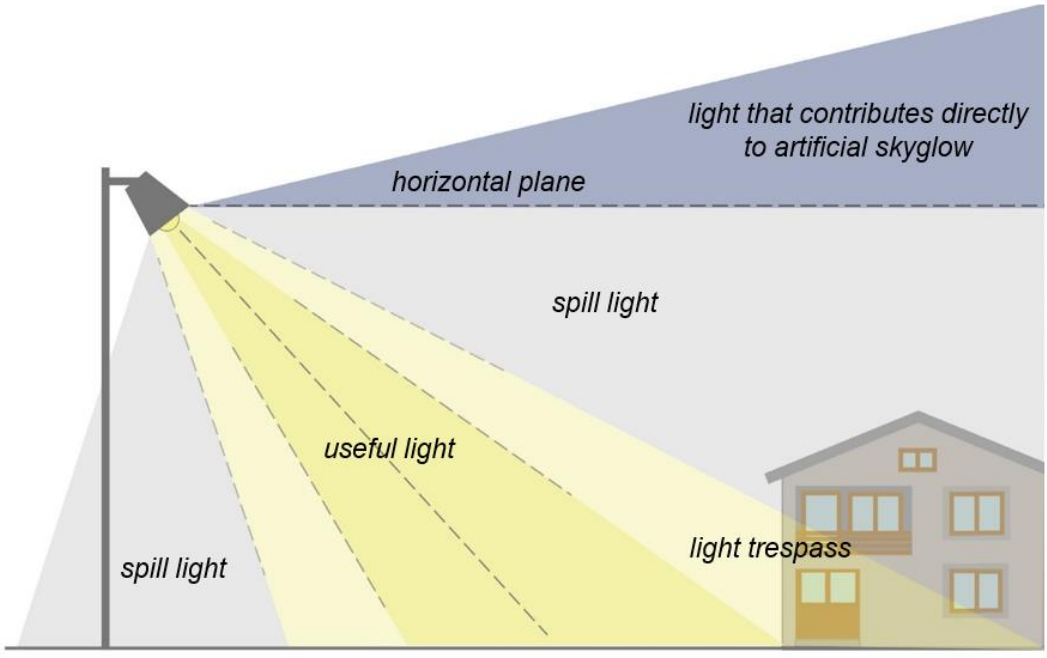

Figure 2: Common aspects of light pollution

Direct light downwards, not upwards or horizontally

Light should be directed downwards, never upwards or horizontally (Figure 2). This will be most pertinent to road lighting, commercial advertising boards (e.g. accommodation, Figure 3) and building facades such as the KAVHA buildings (Figure 4). Lighting must not spill into the night sky or if this is unavoidable the timing of the illumination must be limited by curfews.

The control of upward light spill can be achieved by using a wide overhang at the top of the building that stops the light shining directly into the night sky, or relocating the lights to shine down the building façade to achieve the same effect.

Directional fittings (for example floodlights, spot lights and sign lights) should be installed so that they do not shine directly into a neighbouring residence, onto a roadway, or a pathway, skyward or outside of a property boundary.

Avoid aiming or installing unshielded lights at eye level where the glare can temporarily blind pedestrians or drivers, causing 'night' blindness and potentially leading to accidents.

Figure 3: Examples of good and bad sign lighting,

Figure 4: Examples of bad and good aiming angle for a building facade

Use shielded fittings

Light fittings that are specifically designed to minimise light shining near to or above the horizontal plane should always be used. It is important to assess the line of sight of a light in its specific setting,

e.g. a bollard light on a walkway must be installed so that it does not cause blinding glare to pedestrians or to drivers.

Shielded fittings are those that do not allow any light above the horizontal plane. Figure 5 shows an unshielded fitting with a bulb that is completely exposed allowing light to shine in all directions; a partially shielded fitting with a bulb that allows some horizontal light to escape; and a fully shielded fitting which allows only the downward projection of light. The fully shielded fitting is the preferred design.

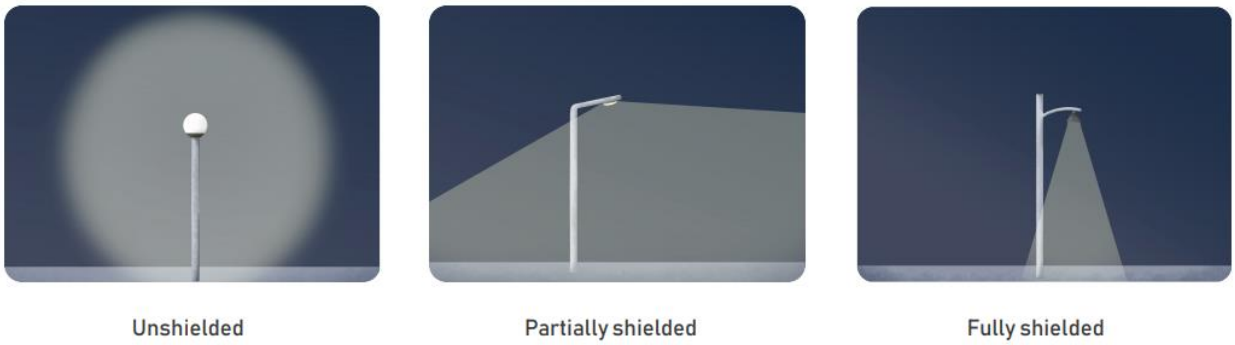

Figure 5: Shielding characteristics of light fittings

Figure 6: Examples of bad and good under eave lighting

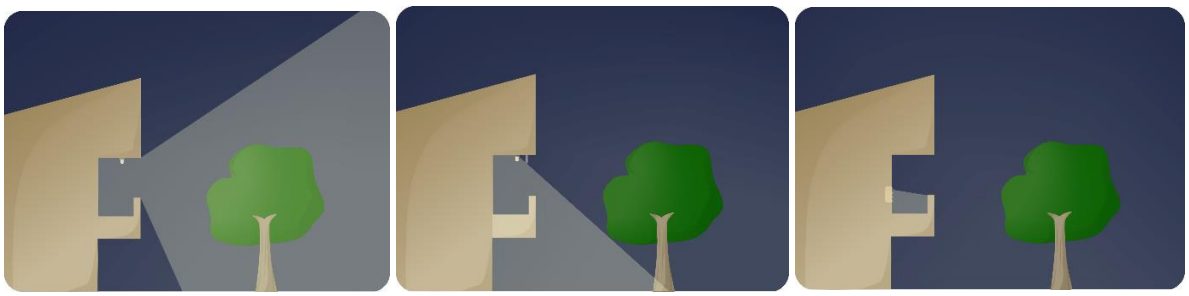

Figure 7: balconies, left to right; poor, better, best

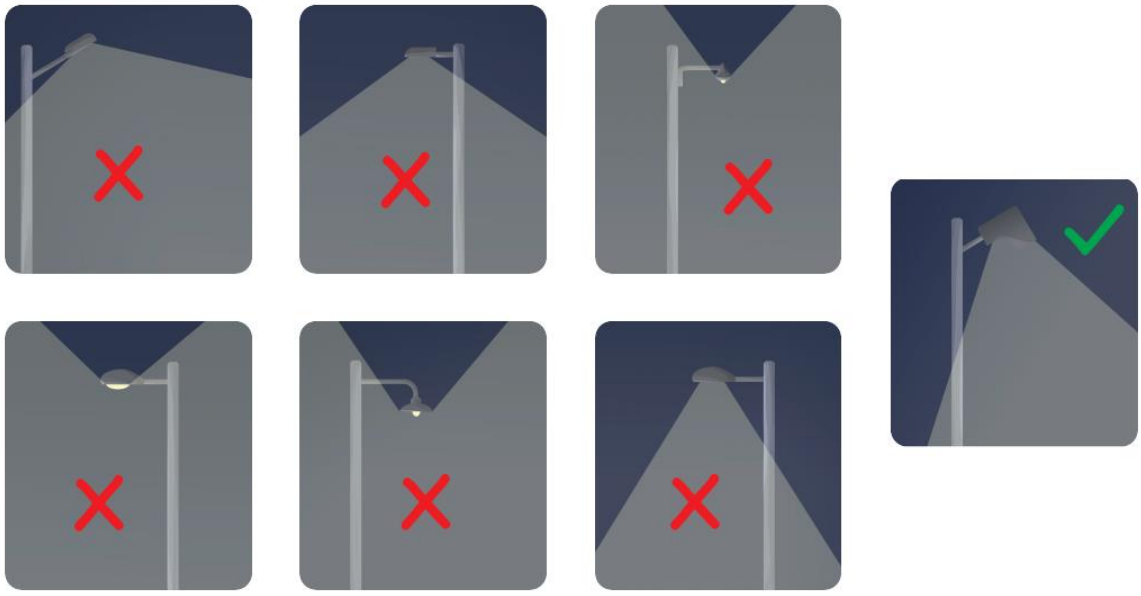

Figure 8: Examples of bad and good pole lighting

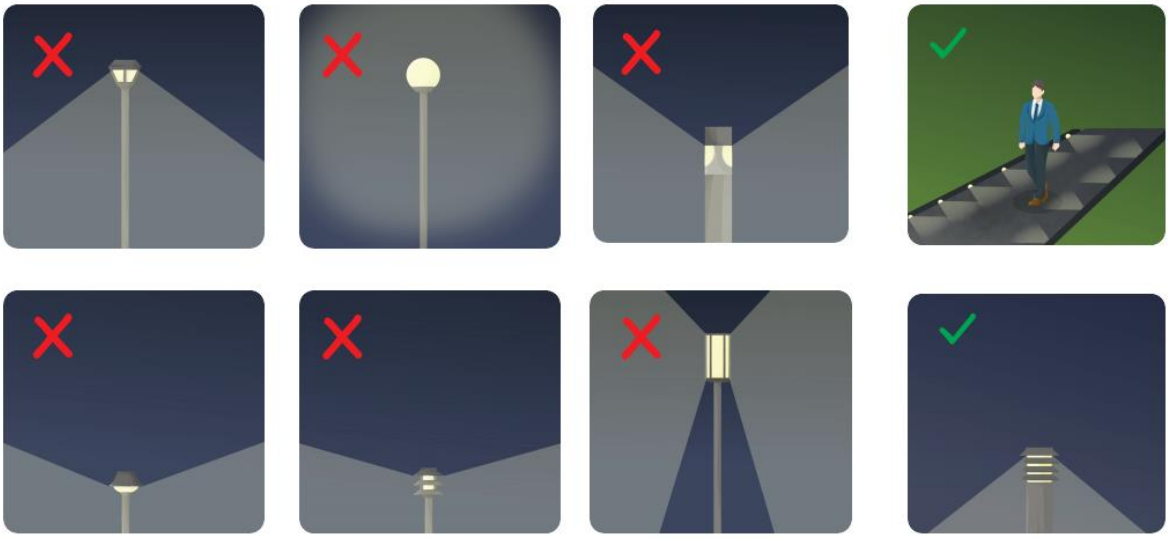

Figure 9: Examples of bad and good walkway lighting

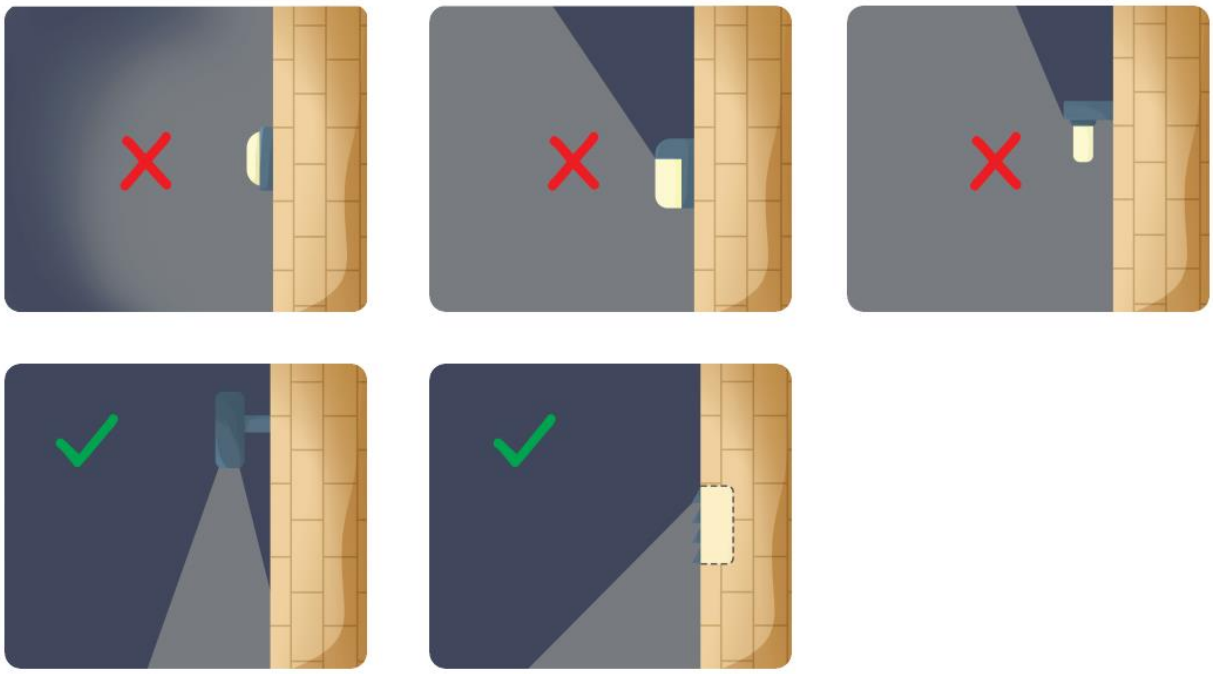

Figure 10: Examples of bad and good building lighting

Figure 11: Recommended parking lot lighting

Sometimes outdoor lights are fitted with a decorative cover. These designs often leave the bulb completely exposed and allow light to shine in all directions. To minimise light spill the light source should be fitted into the top of the fitting, allowing only the downward projection of light. Spherical ball lighting common on entry pillars provides no shielding at all and should be replaced.

If a light does not incorporate a shielded fitting, a shielding device should be applied. Most outside light fittings are capable of being fitted with a baffle, visor or hood (Figure 11).

Figure 12: Floodlight that incorporates shielding in the fitting design (left) and floodlight fitted with shielding attachment (right)

Use asymmetric beams to target floodlights

Where floodlights are required, for example sports lighting (e.g. bowling club, tennis club) use fittings with asymmetric beams that permit horizontal glazing. These are to be kept parallel to the ground, and should light only the area that needs to be lit, preventing spill light; see Figure 13.

An asymmetric beam also allows the light fitting to be mounted on the edge of an area, and avoids the need for fittings to be tilted upwards.

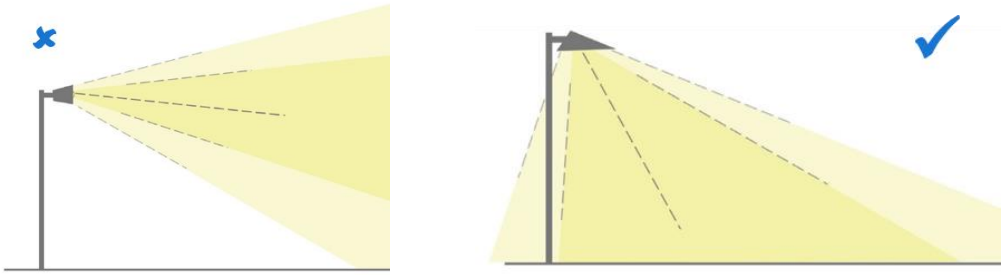

Figure 13: Appropriate floodlighting design includes use of an asymmetric beam

Principle 4 Minimise light intensity

Avoid 'over' lighting

Lighting levels should be appropriate for the activity. To avoid 'over' lighting, select an appropriate bulb type and light the task, rather than the environment.

Improvements in technology mean that many new light sources produce significantly greater amounts of light while using equivalent or smaller amounts of energy. LED lights produce between two and five times the amount of light as incandescent bulbs; consequently it is important to ensure the appropriate bulb energy output is selected that is appropriate for the activities.

The amount of light produced (lumen), rather than the amount of energy used (watt) is the most important consideration in ensuring that an area is not over lit.

Use energy efficient bulbs

With advances in technology traditional light sources such as incandescent, metal halide, mercury vapour, halogen, high pressure sodium, linear and compact fluorescent are increasingly being phased out in favour of energy efficient LEDs. The energy and associated cost savings from using LEDs are substantial. The use of well managed LEDs is supported and encouraged.

Principle 5 Avoid directing lights onto reflective surfaces

Illuminance is a measure of the amount of light reflected by a surface and is determined by the reflective properties of the surface. For example, a natural grass surface will have a low reflectance while a smooth shiny white painted surface will reflect light strongly into the atmosphere. Light coloured sandy or rock surfaces will reflect light more strongly than dark rough surfaces and directing light at them should be avoided or minimised.

Principle 6 Minimise blue content of light

Use warm yellow/orange/amber coloured light bulbs and avoid using cool bright white, blue-rich high colour temperature bulbs. The blue wavelengths in bright white lights are the least dark sky friendly and the most disruptive to wildlife. LEDs, modern fluorescent lights and metal halide lights can be used where recognising colour is important, for example at pedestrian crossings, major road intersections and sports grounds. Australian Standard (AS/NZS 1158) addresses lighting for roads and public spaces, including parks and gardens and can be used as a guide, where relevant.

The superior energy efficiency of LEDs is behind the drive by governments to ban current inefficient lights including incandescent mercury vapour. It is important to note that historically LEDs have been manufactured using a blue LED that is modified with various phosphors to produce different shades of white, from warm white at 2200 K to bright cool white at 10,000K. Blue light has the greatest impact on dark skies and must be avoided. Typically, the amount of blue light in an LED decreases with decreasing colour temperature (measured as degrees Kelvin), hence the recommendation that LEDs of 3000K or less be used for outdoor lighting. More information on bulb types and colour temperature is provided in Table 4. The blue content in “standard” LED lights is shown in Figure 13.

Table 4: *Common bulb types and associated colour temperature*

Bulb type	Colour temperature	Colour appearance	Best lighting
Full spectrum fluorescent, LED	5000K	Cool	Least preferred
Cool white fluorescent, LED	4100K	Cool	
Metal halide, LED	4000K	Cool	
Soft white fluorescent, LED	3500K	Intermediate	
Warm white fluorescent, tungsten halogen, LED	3000K	Warm	
Standard incandescent, LED	2700K	Warm yellowish	
High pressure sodium, LED	2200K	Warm amber	Most preferred

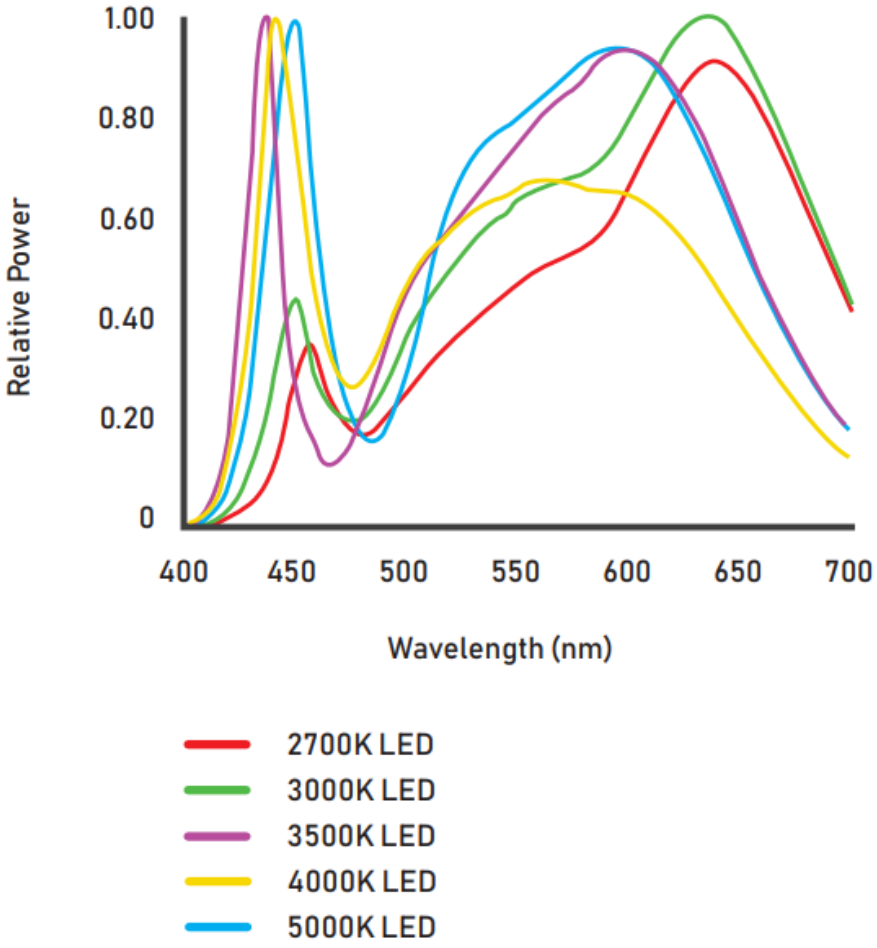

Figure 14: Variation in blue content, (~450 nm peak) as a function of colour temperature, in "standard" LED lights. Lights with the least amount of blue light are recommended. (Source; with permission of Ian Ashdown)

Principle 7 Ensure appropriate luminance levels of electronic message boards

Luminance levels - During the night hours, which commence no later than one hour after sunset, luminance levels shall not exceed[3]:

(a) In urban areas: 150 cd/m^2 as measured under the brightest conditions of a full white display.
(b) In suburban and rural areas: 50 cd/m^2 as measured under conditions of a full white display.
(c) Electronic message boards should never be located in natural areas.

Curfew - Electronic message boards shall be switched off completely after 10pm (or 30 minutes after the close of business for on-premises signs, whichever is later), and remain off until one hour before sunrise. Electronic message board applications for traffic and safety information shall be exempt from curfew.

[3] IES/IDA Model Lighting Ordinance (darksky.org)
[3] CIE 150:2017 Standard Guide on the limitation of the effects of obtrusive light from outdoor lighting installations, Second Edition

GLOSSARY

Artificial skyglow is the part of the skyglow that is attributable to human-made sources of light.

Baffle is an opaque or translucent element to shield a light source from direct view, or to prevent light reflecting from a surface like a wall.

Brightness is the strength of the visual sensation on the naked eye when lit surfaces are viewed.

Bulb is the source of electric light and is a component of a light fitting, not a light fitting on its own.

Candela is the unit of intensity of light. A candle emits light with a luminous intensity of approximately one candela.

Colour temperature is the perceived colour of a light source ranging from cool (blue) to warm (yellow), measured in Kelvin (K). A low correlated colour temperature such as 2500K will have a warm yellowish appearance whilst 6500K will appear bright white and cold.

Horizontal plane, in relation to the light fitting, means the horizontal plane passing through the centre of the light source (for example the bulb) of the light fitting.

Illuminance is the amount of light reflected from a surface.

Incandescent bulb is a bulb that provides light by a filament heated to a high temperature by electric current.

Intensity is the amount of energy or light in a given direction.

Kelvin (K) has nothing to do with heat but merely with the colour output of the light, if it is warm white or cool white. The higher the number of Kelvin, the 'colder' or 'cooler' the light is and it is usually white colour, the lower the number of Kelvin is the 'warmer' and more yellower the light is.

Light is the radiant energy that is visible to humans and animals. Light stimulates sight and makes things visible.

Light fitting is the complete lighting unit. It includes the bulb, elements designed to give light output control, such as a reflector (mirror) or refractor (lens), the ballast, housing and the attached parts.

Light pollution means the brightening of the night sky caused by artificial light.

Lumen is the unit of luminous flux which is the light emitted by a bulb. Lumens are a measure of light output from a bulb. The quantity of lumens produced by a bulb is independent of the wattage. Some types of bulb are more energy efficient than others and produce more lumens per watt.

Luminance is the amount of light emitted in a given direction by the light source or illuminated surface and is measured in candelas per square metre.

Luminance meter is a single element detector that measures photometric brightness (the amount of light that strikes a surface) in lumens.

Lux is the unit of measure of illuminance, equal to one lumen per square metre.

Natural skyglow is that part of the skyglow which is attributable to radiation from celestial sources and luminescent processes in the Earth's upper atmosphere.

Mounting height is the height of the fitting or bulb above the ground.

Outdoor lighting is the night-time illumination of an area by any form of outside light fitting.

Outside light fitting means a light fitting that is attached or fixed outside or on the exterior of a building or structure, whether temporary or permanent.

Reflected light is light that bounces off a surface. Light coloured surfaces reflect more light than darker coloured surfaces.

Shielded light fitting means a light fitting that does not permit light to shine above the horizontal plane. If using a fitting which is not a shielded fitting, some form of permanent physical opaque shield must be used to provide the shielding requirement. This can be a cover or part of a building. Care must be taken to also shield adjacent surfaces, if they are lightly coloured, to prevent excessive reflected light from adding to skyglow. The shielding should be constructed to minimise emissions in the 10 degrees below horizontal.

Skyglow is the brightness of the night sky caused by the cumulative impact of reflected radiation (usually visible light), scattered from the constituents of the atmosphere in the direction of observation. Skyglow comprises two separate components: natural skyglow and artificial skyglow.

Spill light is light that falls outside the boundaries of the object intended to be lit. Spill light serves no purpose and, if directed above the horizontal plane, contributes directly to artificial skyglow.

Wattage is the amount of electricity needed to light the bulb. Other factors held equal, generally, the higher the wattage, the brighter the light will be and the more lumens it will produce.

IMPLEMENTATION

This Policy will assist the NIRC to consider the impacts of lighting associated with rural, urban or other development including roads, industry and buildings when considering replacing existing lighting infrastructure, installing new lighting infrastructure and planning new developments. The NIRC may impose conditions in relation to the design of light fittings, shielding of light, the design and operation of development and hours of lighting operation to manage contribution to artificial skyglow.

GOVERNANCE REFERENCES

EPBC Act	
JAMBA, CAMBA, ROKAMBA , RAMSAR, BONN CONVENTION, ACAP	

POLICY ADMINISTRATION

Review Cycle	Annual	Next Review	
Department	NIRC Management Team and its employees		

Version	Decision Reference	Synopsis
1.	Council Meeting Date and Item	Policy adopted, altered or repealed