10.28 Lighting Management Policy

Policy Owner	**Works Committee**
Person Responsible	**Chief Executive Officer**
Date of Adoption	**27 March 2019 - Resolution 070319**
Date of Last Review	**26 October 2022 - Resolution 101022**
Date Next Due for Review	**3 years / or earlier if required**

OBJECTIVE

The Lighting Management Policy outlines the commitment and objectives regarding management of current and proposed lighting within the Shire as it seeks to develop Astrotourism to diversify the regional economy, grow tourism and create jobs.

BACKGROUND

The inappropriate or excessive use of artificial light is known as light pollution. The International Dark Sky Association (IDA) states that components of light pollution include:

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

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.

The Shire acknowledges Astrotourism activities can be of benefit economically and to the wider community. Astrotourism can:

- Increase visitor numbers, overnight stays and visitor spending;
- Diversify and increase employment;
- Increase regional economic development opportunities for Aboriginal Astronomy enterprise, tourism business and private investment in assets such as accommodation;
- Grow community capacity; and
- Raise the awareness within a community to apply for accreditation through the IDA International Dark Sky Places (IDSP) Program, founded in 2001.

POLICY

It is the Shire's 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 within the region.

The principles can be applied to any situation where protection and conservation values of the night sky are important. Application of the principles benefit Astrotourism, astronomy, heritage, human health, safety, energy, wildlife, environment and ecology values.

GOOD LIGHTING DESIGN PRINCIPLES

1. Overview

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

Good lighting design demonstrates adoption of the following principles:

1. Eliminate upward spill light
2. Direct light downwards, not upwards
3. Use shielded fittings
4. Avoid 'over' lighting
5. Switch lights off when not required
6. Use energy efficient bulbs
7. Use asymmetric beams, where floodlights are used
8. Ensure lights are not directed towards reflective surfaces
9. Use warm white colours

2. [3]The Design Principles

Principle 1 Eliminate upward spill light

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

All light fittings should be located, aimed or shielded to avoid lighting unintended areas, especially above the horizontal plane of the light fitting (see Figure 1). Light can be prevented from shining above the horizontal plane by:

- installing light fittings with an opaque cover and flat glass, mounted horizontally on both axes, or
- mounting the light under part of a building like an awning, verandah or roof, so that light is blocked from shining above the horizontal plane, and
- designing buildings to internalise light and prevent it from escaping into the night sky.

3 Perth has the highest daily average number of bright sunshine hours in Australia. Its long-term annual average of sunshine is 8.8 hours a day (http://www.bom.gov.au/watl/sunshine/)

Figure 1 *Common aspects of light pollution*

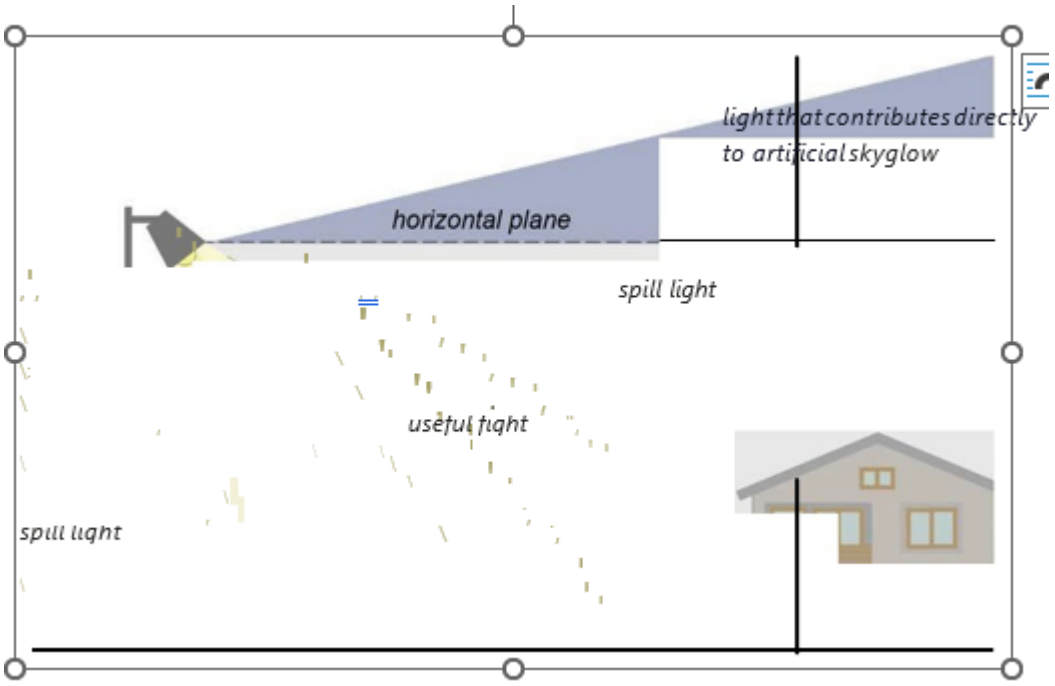
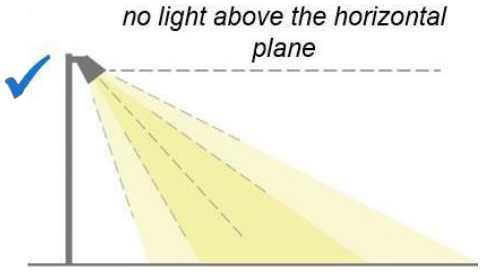
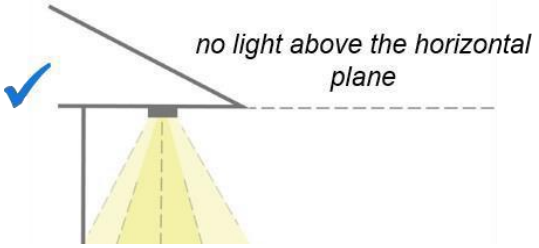


Figure 2 provides design solutions to minimise light spill above the horizontal plane.

a. *Installing shielded outside light fittings*



b. Installing outside light fittings under a building element (e.g. awning or eave)



c. Using building design e.g. verandahs and block-out blinds to control the spill of internal lighting

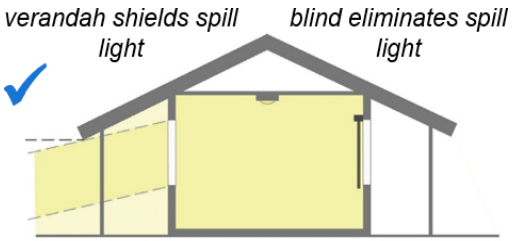


Figure 2 *Design solutions to minimise interior spill light above horizontal plane*

Adequate measures to avoid and minimise interior light escaping through windows, roof windows, sliding doors and skylights include full block-out curtains, blinds or shutters.

Suitable conditions should be imposed to manage the spill of internal light into the night sky.

Principle 2 Direct light downwards, not upwards

Wherever possible, light should be directed downwards, not upwards. This includes light used for roads, public amenities and the vertical lighting of structures such as advertising boards and building facades. If there are extenuating circumstances requiring up-lighting, it must be demonstrated that the light will not spill into the night sky. This may be achieved by using a wide overhang to 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.

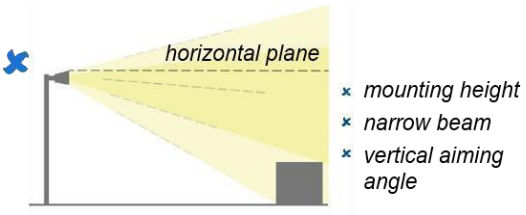
Directional fittings (for example floodlights, spotlights and sign lights) should be installed so that they do not shine directly into a neighbouring residence, onto a roadway, skyward or outside of a property boundary.

To keep glare to a minimum use higher mounting height that allow lower main beam angles that are closer to vertical.

The lighting of all-night operations such as mines, extractive industries and intermodal hubs will need to be downward facing, of a peach colour and shielded. Where strong light is needed or there are gas flares or burning associated with the development, consultation with the Shire is required to assist in identifying an appropriate way to light the development.

Figure 3 shows how mounting height, narrow beam and vertical aiming angle reduces light spill.

(a)



(b)

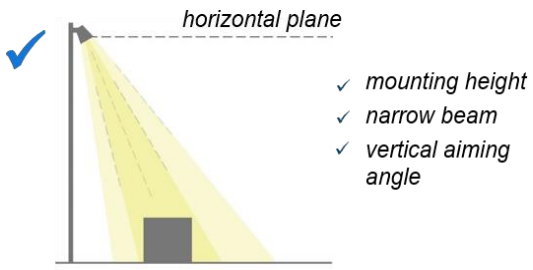


Figure 3 *Application of mounting height and vertical aiming angle to control light spill*

Principle 3 Use shielded fittings

Light fittings that are specifically designed to minimise light shining near to or above the horizontal plane should be used.

Shielded fittings are those that do not allow any light above the horizontal plane. Figure 4 shows a fitting with a bulb that is completely exposed allowing light to shine in all directions (a); a bulb that is fitted with a partial shield minimising light above the horizontal plane (b); and a shielded fitting which allows only the downward projection of light (c). The shielded fitting is the preferred design.

The effective light distribution or shielding characteristics of a light fitting can be verified by referring to manufacturer's specifications. These are available from the manufacturer or relevant sales outlet.

(a) non-shielded outside light fitting

(b) shielded outside light fitting with bulb fitted to the top

(c) shielded outside light fitting

Figure 4 *Shielding characteristics*

In some urban locations, particularly within heritage conservation areas, outdoor lights are fitted with a decorative cover. These designs may leave the bulb completely exposed and allow light to shine in all directions. To minimise light spill, the bulb should be fitted into the top of the fitting, allowing only the downward projection of light (see Figure 5).

Lighting suppliers stock a range of shielded light fittings suitable for residential, commercial and industrial

applications.

If a supplier is unable to provide a shielded fitting, a shielding device should be applied. Most outside light fittings are equipped with or are capable of being fitted with a baffle, visor or hood to ensure light is appropriately directed. (see Figures 6 and 7).

Figure 5 *Exposed bulb that allows light to shine in all directions and a fitting designed to minimise light spill by only allowing downward projection of light.*

Figure 6 *Floodlight fitted with shielding attachment*

Figure 7 *Floodlight that incorporates shielding in the fitting design (no attachment necessary)*

What is a light fitting?

A light fitting, or luminaire, 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.

(a) One light fitting

(b) Two light fittings

Where multiple light fittings are mounted on a single base, as illustrated in (b) above, these are to be counted as additional light fittings. For example, a dwelling house with seven outside light fittings may have three type (a) light fittings and two type (b) light fittings, of which two must be automatic light fittings.

Principle 4 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 bulb types produce significantly greater amounts of light while using equivalent or smaller amounts of energy. Halogen bulbs produce more light than standard incandescent bulbs for the same energy use. LED lights produce between two and five times the amount of light as incandescent bulbs. Careful selection of bulb type will ensure the amount of light produced 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.

Principle 5 Switch lights off when not required

Lights should 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 11:00pm. Light fittings with timers that switch on at dusk and switch off by 11:00pm are also encouraged.

The use of automatic light fittings is recommended. Lights that are activated by a sensor and switch off automatically after a period of time reduce the cumulative amount of light emitted from development and reduce energy waste.

Principle 6 Use energy efficient bulbs

Significantly smaller amounts of energy to Improvements in technology mean that many recently

developed bulb types use Energy efficient globes include LEDs, metal, produce the same amount of light.

halide, induction bulbs, high pressure sodium, linear and compact fluorescent. High pressure sodium lights emit a peach coloured light and are suitable for a range of applications. They are energy efficient and have a lower impact than white lights.

White lights such as LEDs, modern fluorescent lights and metal halide lights should be used where recognising colour is important, for example at pedestrian crossings, major road intersections and sports grounds. Blue-white mercury bulbs have commonly been used for roadway lighting, but they are no longer permitted in new installations. An Australian Standard (AS/NZS 1158) addresses lighting for roads and public spaces, including parks and gardens and must be applied, where relevant.

Principle 7 Use asymmetric beams (when floodlights are required)

Where floodlights are required, for example sports lighting applications and commercial stock yards, wherever possible use fittings with asymmetric beams that permit horizontal glazing. These are to be kept at or near parallel to the surface being lit, usually the ground and should only light the area that needs to be lit, preventing spill light, see Figure 8.

An asymmetric beam also allows the light fitting to be mounted on the edge of an area.

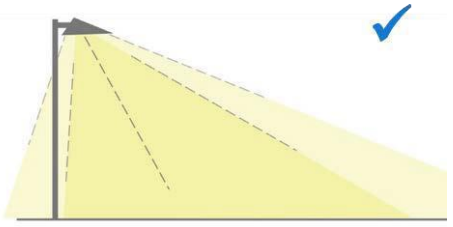


Figure 8 *Appropriate floodlighting design includes use of an asymmetric beam*

Principle 8 Ensure lights are not directed towards reflective surfaces

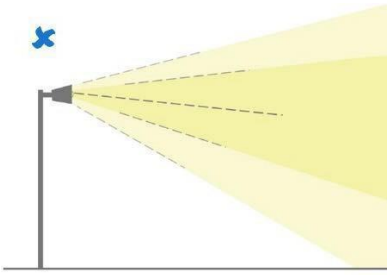
At the design stage, it is desirable that surfaces with a low level of reflectivity be installed in the vicinity of outdoor lighting, compatible with the function of the area.

Illuminance is a measure of the amount of light reflected by a surface and is determined by the reflective properties of the surface.
Where a natural grass surface is used the illuminance will be low but may be significant where the surface is relatively light in colour, for example uncoloured concrete, artificial grass with sand infill or light-coloured walls.
Table 2 provides a guide to the reflective properties of common surfaces.

Table 2 *Reflective properties of common*

and avoids the need for fittings to be tilted upwards. Flat glass light fittings should be installed with the glass horizontal to make efficient use of the brightest part of the beam and to eliminate spill light.

(a) symmetric beam distribution



(b) asymmetric beam distribution

Surface	Reflective properties
Natural grass and vegetation	Low
Painted surface (dark)	Low
Pre-coloured factory metal (dark)	Low
Brick (dark)	Low
Raw or stained timber	Medium
Stone surface	Medium
Uncoloured concrete	High
Painted surface (light)	High
Artificial grass (sand base)	High
Pre-coloured factory metal (light)	High
Brick (light)	High
Zincalume steel (Unpainted)	High

Internally lit signage contributes to the luminance component of artificial skyglow. The internationally accepted limit on illuminated signage should be implemented as provided in Table 3.

Table 3 *Maximum luminance of illuminated signage*

Illuminated area (square metre)	Maximum luminance at any point (candela per square metre)
More than 10	300
2 to 10	600
0.5 to 2	800
Less than 0.5	1000

Principle 9 Use warm white colours

Use warm coloured light bulbs and avoid using cool blue-rich high colour temperature bulbs that are the least sky-friendly.

More information on bulb types and colour temperature is provided in Table 4.

[4] IES/IDA Model Lighting Ordinance (darksky.org)

[5] CIE 150:2017 Standard Guide on the limitation of the effects of obtrusive light from outdoor lighting installations, Second Edition

[6] A brighter sign does not necessarily mean a more visible or readable sign. Informational highway signs have a maximum luminance of 90 cd/m^2. A survey of hundreds of legacy floodlit billboards in Arizona, USA indicated that most were 50-100 cd/m^2, with all externally illuminated billboards below 200 cd/m^2.

Principle 10 Ensure appropriate luminance levels of electronic message boards.
Luminance levels – During Night hours, which commence no later than on hour after sunset luminance levels shall not exceed:

(a) In urban areas (Lighting Zone 3 and 4 of the illuminated settings.
Model Lighting Ordinance4 or CIE Environmental Zone E3 or E45): 150 cd/m2 as measured under the brightest conditions of a full white display.6

(b) In suburban and rural areas (Lighting Zone 1 and 2, Environmental Zone 2): 50 cd/m2 as measured under conditions of a full white display.

(c) Electronic message boards should never be located in natural areas (Lighting Zone 0 or Environmental Zone E1).

Curfew - Electronic message boards shall be switched off completely after 11pm (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.
Luminance is measured by a Luminance Meter in accordance with manufacturer instructions.

Even in bright city areas, IDA tests in urban areas indicate that sign legibility can be maintained at luminance values will below the 300-400 cd/m that is sometimes cited as lower limit for luminance by the advertising industry. As an everyday reference laptop computer displays ca emit up to 100 – 400 cd/m and are typically operated at 100-200 cd/m in indoor illuminated settings.

Table 4 *Common bulb types and associated colour temperature*

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

Note*: With LEDs, any colour temperature can be produced, but warm colours are preferred.*

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 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 Degrees Kelvin (K). A low correlated colour temperature such as 2500K will have a warm appearance whilst 6500K will appear 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.

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 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 watt.

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 sky glow is that part of the sky glow 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 nighttime 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 a fitting is to be used which is not a shielded fitting, some form of permanent physical opaque shield 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 sky glow. The shield should be constructed to minimize 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 from 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. Generally, the higher the wattage, the brighter the light will be and the more lumens it will produce.

IMPLEMENTATION

The good lighting design principles outlined in this Policy will assist the Shire to consider the impacts of lighting associated with rural, urban or other development including roads, industry and buildings. The Shire may impose conditions in relation to design of light fittings, shielding of light, the design and operation of development and hours of lighting operation to manage contribution to artificial skyglow.

The Chief Executive Officer and Manager of Works are responsible for implementing and applying this policy.

REVIEW

Reviews of this policy are to be undertaken every three years or earlier if required.

VARIATION TO POLICY

This policy may be cancelled or varied from time to time at the discretion of Chief Executive Officer. All the organisation's employees will be notified of any variation to this policy by the normal correspondence method.

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