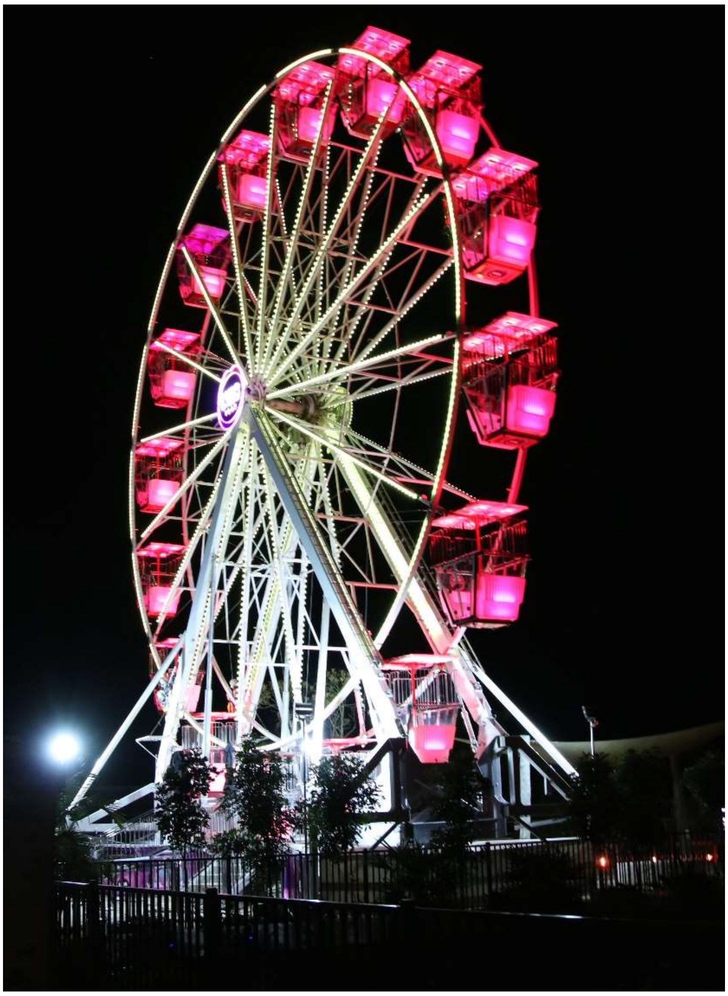
Lighting, Art + Science
Lighting and Electrical Consultants

Lighting, Art & Science Pty Limited
ABN 86 152 715 921
Master Security License: 410812303
PO Box 373, CROWS NEST 2065
+61 2 9436 0998
mail@laands.com.au

Obtrusive Light Assessment Sydney Zoo, Bungarribee Ferris Wheel



Prepared by:

Lighting, Art and Science

for

Sydney Zoo

Lighting, Art & Science Pty Limited
ABN 86 152 715 921
Master Security License: 410812303
PO Box 373, CROWS NEST 2065
+61 2 9436 0998
mail@laands.com.au

Table of Contents

1. INTRODUCTION

I am a lighting designer of 45 years experience in the design and assessment of external lighting installations.

I have been involved with the writing of the Australian Standard AS/NZS4282 *Control of the obtrusive effects of outdoor lighting* and am currently the chair of the standard committee.

My CV is included as Annexure A.

We have been engaged by Sydney Zoo to prepare an assessment of the obtrusive light impacts of the night-time operation of the Ferris Wheel at Sydney Zoo.

The assessment will review the specific requirements of Clause C47 of the Development Consent:

"Lighting
C47. The Applicant shall ensure the lighting associated with the Development:
(a) complies with the latest version of *AS 4282 (INT) - Control of Obtrusive Effects of Outdoor Lighting*; and
(b) is mounted, screened and directed in such a manner that it does not create a nuisance to surrounding properties or the public road network."

C47A. Prior to the commencement of operation of the permanent ferris wheel on the site, the Applicant must prepare and submit a lighting report to the satisfaction of the Planning Secretary. The lighting report must:
(a) provide details of the proposed lighting and illumination of the ferris wheel; and
(b) demonstrate ferris wheel lighting will comply with the requirements of AS 4282 (INT) - Control of Obtrusive Effects of Outdoor Lighting.

C47B. Within three months of the commencement of operation of the permanent ferris wheel the Applicant must prepare and submit a report to the satisfaction of the Planning Secretary verifying that light spillage from the ferris wheel will not cause any adverse amenity impacts on nearby residential areas.

2. THE FERRIS WHEEL

The Ferris Wheel is hired and may be replaced from time to time. We have ben informed that the general size of the Ferris Wheel will be consistent, though the detail of the structure, cars and lighting may vary slightly from model. The assessment has therefore been made for a generic Ferris Wheel rather than the specific model installed at the time of the inspection. The existing wheel has been used as a typical example.

Details of the Ferris Wheel dimensions are included in Annexure B.

The structure of the wheel and the support structure are lined with colour change, individual light with lensed covers. We assume that the light source is LED.

The lights can be programmed so that they can change colour, flash and do concentric bursts in and out.

2.1 Lighting equipment

The Ferris Wheel is a standard design, and the lighting is part of the package.

The lighting comprises:

a) 1400 addressable RGB/W screw in lighting modules. The lights distributed around the wheel facing outwards with 832 on each face on the spokes, 384 on the rim beam and 184 on the circle. Less than half the lights are visible from any particular viewing location as some will face in the other direction. Some will also face at oblique angles which will reduce the impact form that viewing location.
   The lights are 1 Watt LED and are remote controllable via a plug and play control system. Details of the lights are included in Annexure C.
b) At the base of the Ferris Wheel there are 4, 150Watt LED floodlights that light the entry area and surrounds. The face downward and are required for safe operation of the

Ferris Wheel. Due to the surrounding buildings and fence, these lights are not visible from outside the site. Details of the lights are included in Annexure C.

c) The gondolas have a small internal light that makes the body of the gondola glow. These have an insignificant impact on the obtrusive light contribution.

d) The lighting effects are pre-programmed to give a continuous sequence of lights and colours. The operator only has control by three off/on switches which control:

- Both faces the rim beam and the spoke lights
- The Gondola Lights
- The 4 floodlights at the base.

3. STANDARDS

The relevant version of the Australian Standard for this assessment is AS/NZS4282:2019 *Control of the obtrusive effects of outdoor lighting*.[1]

The Standard recommends specific limits for light technical parameters relating to lit vertical surfaces.

By its nature light cannot be simply stopped on property boundaries. If you can see across a boundary, then light must cross that boundary.

Any additional lighting will have some effect on the neighbouring residences that view the site. The important test is one of reasonableness for both parties. Because an object is visible does not necessarily mean that it has a significant impact on the amenity of people at that location.

Some light trespass is a natural consequence of living in an urban environment. The standard addresses the need, in an urban environment, is to prevent people from being subjected to an unreasonable amount of spill lighting while still allowing reasonable external lighting installations and the operation of a night city.

Different people have different expectations of what is an acceptable level of light trespass. Some people appear to be quite sensitive to light spill whilst others actually prefer a low level of spill light as it can give a feeling of safety.

It is not uncommon for objections to lighting being related to a philosophical opposition to the lighting or something associated with the lighting e.g. a complaint to playing field lighting may principally be a complaint about parking.

AS/NZS 4282:2019 allows a quantitative assessment of the impact of the lighting and is designed as a benchmark of what is reasonable.

AS/NZS4282 *Control of the obtrusive effects of outdoor lighting*, gives recommendations for the levels of spill light that a person should reasonably be expected to accommodate as a consequence of living in an urban environment.

The standard is not mandatory as it is not called up in legislation but is normally applied either as a consent condition for a development or a contractual requirement.

It should be noted that the scope of the standard is limited to the impact on residential properties, drivers and to some extent the impact on sky glow and observatories. There is no limit for the impact on commercial properties. The standard does not delineate between commercial and industrial sites.

The standard sets light technical parameter limits based on the ambient lighting conditions and time of night. The higher the ambient conditions the higher the allowable obtrusive lighting limit. This is because the sensitivity of peoples eyes adapts to the ambient conditions and the impact of the lighting is related to the brightness with respect to the ambience rather than the absolute brightness.

There is a curfew period recommended in the standard after which the allowable levels are significantly reduced. The default curfew period is between11:00pm and 6:00am, however the consent authority has the power to change the times.

AS/NZS 4282 nominates 11 Environmental Zones – see Table 1.

Zones	Description	Examples
A0	Intrinsically dark	UNESCO Starlight Reserve. IDA Dark Sky Parks. Major optical observatories No road lighting -unless specifically required by the road controlling authority
A1	Dark	Relatively uninhabited rural areas No road lighting - unless specifically required by the road controlling authority
A2	Low district brightness	Sparsely inhabited rural and semi-rural areas
A3	Medium district brightness	Suburban areas in towns and cities
A4	High district brightness	Town and city centres and other commercial areas Residential areas abutting commercial areas
TV	High district brightness	Vicinity of major sports stadium during TV broadcasts
V	Residences near traffic routes	Refer AS/NZS1158.1.1
R1	Residences near local roads with significant setback	Refer AS/NZS 1158.3.1
R2	Residences near local roads	Refer AS/NZS 1158.3.1
R3	Residences near a roundabout or local area traffic management device	Refer AS/NZS 1158.3.1
RX	Residences near a pedestrian crossing	Refer AS/NZS 1158.4
Source:	AZ/NZ 4282 – Table 3.1	

Table1: *Environmental Zones Identified in AS/NZS 4282:2019*[1]

Based on the definition of the environmental zones the appropriate zone the area immediately adjacent to the Zoo site on north east and west would be A2 whereas the residential properties considered in the assessment would be A3.

The industrial areas surrounding the site would be A4.

AS/NZS4282 has additional requirements for lit vertical surfaces that may be relevant to this assessment:

"3.3.5.2 Applicable Environmental Zone

Where an illuminated vertical surface is viewed against a background that is of a different environmental zone to the lit surface, the environmental zone, for the purpose of the application of the limits in table 3.5, shall be taken as the lower of the two environmental zones.

Where the illuminated vertical surface is viewed against a black background, sea or sky the maximum applicable environmental zone shall be A2."[1]

"3.3.5.4 Signs, Facades and artwork with dynamic content

Where the graphical content or colours can change, the dwell time of the image shall be 10 seconds or more, and the average luminance shall change by less than 30% on the change of the image." [1]

The Ferris Wheel does not fall neatly into the categories of lighting in the standard.

The standard deals with:

- lighting installations, which are generally installations for sports lighting, floodlighting or path and area lighting.
- lit vertical surfaces which is predominately internally and externally lit signage and also the lighting of facades. These are generally large area sources.

The Ferris Wheel does not fall neatly into the requirements for either as the lights are marker lights and are not trying to illuminate an area, nor are they a large area source such as a sign.

We have therefore selected the light technical parameters that we believe are applicable to the nature of the Ferris Wheel lighting.

4. UNITS OF MEASUREMENT

The standard uses several light technical parameters in the assessment.

4.1 Luminous Flux

The ***Luminous Flux*** is a measure of the total amount of light that leaves a light source.

The luminous flux is the radiant flux that is emitted within the visible spectrum, between 380 (violet) and 740 (red) nanometres. The human eye does not have uniform sensitivity across the viable spectrum, and it is more sensitive to green and orange light than to blue and red light. The luminous flux is the product of the radiant flux and the sensitivity of the eye.

The luminous flux is measures in ***lumens*** (lm)

4.2 Illuminance

The ***Illuminance*** is a measure of the amount of light that falls on a surface. For obtrusive light the illuminance in calculated in the vertical plane and is an indicator of the light that is entering a building through the windows illuminating the vertical surfaces within a room.

Illuminance is measured in ***lux*** (lumens/m2)

The illuminance assessment considers only that light resulting from direct illuminance from the installation; that is the light that comes directly from the light fittings.

In all installations there is also indirect light that is reflected off the ground, walls of building, objects in the lit area and in some cases reflections from clouds.

The standard only addresses direct illumination effects. This is due to the standard being designed to determine compliance or non-compliance and the difficulty of including consistent indirect lighting contributions.

Direct illumination can be readily and reliably calculated.

The indirect contribution is affected by colours (e.g. the colour of adjacent buildings), whether trees have leaves, the weather etc. Although the contributions from these indirect components are real, they are also changeable and cannot be reliably calculated. This makes it very difficult to make a quantitative assessment of the total impact of any installation.

4.3 Luminous Intensity

Luminous Intensity is the light leaving a source in a given direction and is measured in ***candelas***. (lumens/steradian)

Luminous Intensity emitted by luminaires – This is is used as a measure of the brightness of the light source or the resulting glare. This is governed by the brightness of the light source, the glare control of the light fitting and the viewing angle.

Theoretically this affect does not reduce with distance; however, with a very small light source the perception will reduce as the image of the light on the eye becomes smaller than the size of the light receptors in the eye. In addition, if the distance is long enough there will be a reduction in the brightness due to the permeability of the air.

Although it is not a formal Glare Index, it was included in the standard as a simple indication of the glare caused by the lighting installation and an indication of the level of distraction or discomfort the lighting might cause. The luminous intensity relates to a specific direction and will depend on the light distribution of the light fitting and the direction of view.

While the luminous intensity is a good indicator of glare with small light sources, such as sports field lighting, the correlation breaks down as the size of the light source increases.

For this reason, the luminous intensity is not applied as a limit for lit vertical surfaces such as signage.

The luminous intensity is still required to calculate the vertical illuminance.

4.4 Luminance

The ***luminance*** is the light that leaves the area of a surface in all directions. It is measured in ***candela/m² (cd/m²)***. The eye sees by distinguishing the difference in luminance between the different objects and surfaces.

AS/NZS4282 recommends limits on the luminance of lit vertical surfaces.

4.5 Threshold Increment

Threshold increment – This is a measure of the disability glare that results from the light sources with application to the reading of signs, signals by the drivers of vehicles etc.

4.6 Upward Light Ratio (ULR)

Upward light ratio limits the light emitted into the sky to limit the impact on sky glow.

It is defined as;" the proportion of the flux of a luminaire and/or installation that is emitted at or above the horizontal, excluding reflected light, when the luminaire(s) is/are mounted in its installed position(s). ULR= upward flux/total flux from the luminaire". [1]

5. ASSESSMENT CRITERIA

The applicable assessment criteria in this situation are:

5.1 Vertical Illuminance

The standard specifies that the vertical illuminance be assessed at the property boundary of a residential site that is impacted by the lighting installation. This criterion only applies to residential sites and not commercial or industrial sites.

Where the site adjoins an environmentally sensitive are the assessment plane for vertical illuminance is assessed at the property boundary. We have assumed that the parkland surrounding the site is environmentally sensitive.

5.2 Luminance Intensity

Luminous Intensity is relevant as it is necessary to calculate the illuminance, however as the lights are discrete and small the luminous intensity of the individual lights will fall well below the limit in the standard.

5.3 Luminance

Luminance is used for the assessment of large area sources, such as illuminated signs as it is a better indicator or glare in these situations than luminous intensity. As the lights are small compared to the space between them luminance is not relevant.

5.4 Threshold Increment

Threshold increment is based on the illuminance at a drivers eye compared to the ambient lighting conditions. It reduces as the direction of the light source diverges from the driver's direction of view. In this situation the Ferris Wheel is far enough away from the surrounding roads that the illuminance at the eyes of the drivers and the displacement from the direction of view of the drive, would be negligible compared to the impact of the streetlighting.

5.5 Upward Light Ratio (ULR)

The upward light ratio for an internally lit vertical object, such as the marker lights is generally 50%. This is allowable. The ULR will be less as it includes the floodlights at the base of the Ferris Wheel that are directed downwards. As a result, the average ULR will be less than 50%

5.6 Dynamic Content

Clause 3.3.5.2 relates to the luminance of the surface and as we have previously concluded that luminance is not relevant in this situation, neither is this clause.

Clause 3.3.5.4 of the standard states that Signs, facades or artworks with dynamic content must have a dwell time of greater than 10 seconds and a maximum change in average luminance between images of 30%.

The 10 second dwell time requirement is derived from the impact of signs on drivers. If a sign or image is changing quickly there is a tendency for the sign to capture a drivers attention and take it from the road while waiting for an update of the information.

This usually relates to large signs that are adjacent to the road. The Ferris Wheel is so far from the road that it will have negligible impact on the attention of drivers. It will be of similar magnitude to a TV within a house when viewed from the road.

The limit on the change of average luminance is designed to prevent people's rooms within a house changing colour and brightness as the sign changes from one image to another. The Ferris Wheel is so far from any residence that this will be imperceptible.

5.7 Applicable Limits

Based on these conditions, the appropriate light technical parameters from the standard are shown in table 2. The full relevant tables from the standard are included as Annexure D.

Ambient Zone	**Vertical Illuminance (lux)**		**Luminous Intensity (cd)**	
	Non-curfew	**Curfew**	**Curfew**	**Non-curfew**
A2	5	1	7500	12500
A3	10	2	12500	25000
A4	25	5	25000	50000

Table 2 – Compliance Parameters from AS/NZS4282:2019[1]

The standard has two levels of criteria with the lower limits applying to a curfew period between 11:00pm and 6:00am. Whilst assuming that the operation will be limited to non-curfew times, we have assessed lighting for both curfew and non-curfew conditions.

6. SITE INSPECTION

The site and the surrounding area were inspected on the evening of 31st May 2022 between 8:00 and 9:30pm. The clear sky and new moon removed the impact of the moon and reflected light from the clouds. This meant that provided we could minimise the impact of local light sources, the measured vertical illuminance would be representative of the impact of the Ferris Wheel.

As the Ferris Wheel has a variety of colours and patterns a series of measurements were taken for different arrangements and the maximum reading used for the assessment.

Measurements were taken with a Konica-Minolta CL-300A Chroma Illuminance Meter, calibrated by UNSW on 28th January 2022.

The locations of the measurement and calculation points are indicated in Annexure E.

6.1 Property Boundaries

The illumination was measured at two locations on the site (M1 & M2). This gave a basis for the calculation of the vertical illuminance at other boundaries and locations remote to the site depending on the angle from which the wheel is viewed. The other locations (C1 to C8) could not be measured as they illumination levels were too low to measure and in many locations the view of the Ferris Wheel was either partially or completely obstructed by trees or buildings. The vertical illuminance was calculated in these locations ignoring the obstructions.

Location M1 was on the property boundary while locations C1 and C2 are calculated. The measurement at M1 was partially obstructed by trees. We estimated approximately 30% obstruction and the vertical illuminance was increased on a pro-rata basis to compensate.

The measurements at M2 were higher as there was as internally illuminated artwork near the Ferris Wheel and it also included the direct and indirect light from the floodlighting at the base of the Ferris Wheel. Neither of these light sources would be visible from outside the site due to the surrounding buildings and the landscaping.
No adjustment was made to these measurements so the calculations are conservative.

6.2 Residential areas

The area to the north of the Zoo Site is parkland. The nearest residential sites are in Velocity Place. There is no visibility of the Ferris Wheel from ground level in these areas due to the topography of the land and the dense trees. There may be some vision of the Ferris Wheel from the upper stories. The distance from the property boundary of these sites to the Ferris Wheel is approximately 820 metres (Point C3).

The Ferris Wheel is visible from the park in Steeltrap Drive as this is mor elevated, however this is 1120 metres from the Ferris Wheel (Point C4).

The east side of Doonside Road is Industrial/Commercial and does not have limits relating to vertical illuminance.

6.3 Impact on traffic

There are some glimpses of the Ferris Wheel between the trees driving south on Doonside Road. The road is approximately 430 metres (Point C5) from the Ferris Wheel and the views are almost perpendicular to the road and would not represent a distraction to the drivers.

There is a view of the Ferris Wheel from the intersection of the Great Western Highway and Doonside Road when facing west. (Point C6)

There are distant views of the Ferris Wheel heading east.

The Ferris Wheel can be seen from the M7 overpass but again the distance is greater than 1050 metres (Point C8).

When leaving Rudders Street onto the Great Western Highway the Ferris Wheel is directly in the line of sight of the driver, however the distance to the Ferris Wheel is greater than 390 metres and is almost completely obstructer by structures.

7. METHODOLOGY

The normal method assessment of the lighting impact is by calculation. The standard was originally written to limit the impact of sports lighting and flood lighting. In these situations, there are a precise number of lights with fixed aiming locations and there is photometric data available to enable the calculation. Calculations also make it simpler to exclude the contribution of the ambient light.

In this situation however there is no photometric data available for the lights and there is a large number of lights to include in a calculation model. As the distribution and output of the light would have to be assumed it could lead to a compounding of errors.

As there is sufficient distance between the measurement points or calculation points and the Ferris Wheel, the Ferris Wheel can be treated as a single light of the same light output as the whole structure from the angle of view. This mean that the vertical illuminance can be calculated using the inverse square law whereby the illuminance reduces in proportion to the inverse of the distance squared.

The calculation also produces a luminous intensity for the whole structure which can be divided by the number of lamps, visible from an observation point, to give the luminous intensity of the individual light sources.

8. CALCULATIONS

The results of the measurements and calculations are shown in Tables 3 & 4 together with the relevant limit from the standard.

Measurement of calculation point	Measured or calculated vertical illuminance	Environmental Zone	AS/NZS4282 Non-curfew limit	AS/NZS4282 Curfew limit
M1	0.7 (adjusted)	A2	5	1
M2	5		Within the site	
C1	0.6	A2	5	1
C2	0.1	A2	5	1
C3	0.004	A3	10	2
C4	0.002	A3	10	2
C5	0.05		No Limit	
C6	0.02		No Limit	
C7	0.02		No Limit	
C8	0.01		No Limit	

Table 3 – Vertical Illuminance levels

Parameter	Calculated Luminous intensity	Environmental Zone	AS/NZS4282 Non-curfew limit	AS/NZS4282 Curfew limit
Luminous intensity of a source	10.5 candelas	A2	12500	7500

Table 4 – Luminous Intensity

9. CONCLUSION

In response to the requirements of the development consent:

9.1 Clause C47(a) and C47A(b)

Based on our measurements and calculations it the vertical illuminance and luminous intensity generated by the Ferris Wheel lighting at residential boundaries will be less than a 0.5% of the curfew limit in the standard.

The boundaries of the parkland also meet the curfew limits.

The vertical illuminace at various driver locations where the Ferris Wheel may be visible and again extremely small.

Many of the locations that were calculated in reality have no direct vision of the Ferris Wheel due to obstructions.

9.2 Clause C47(b)

As detailed in the above report the distance from the Ferris Wheel to the roads and residences and the shielding provided by the surrounding buildings and trees mean that it is my considered opinion that the levels of illumination from the Ferris Wheel could not be reasonably considered a nuisance to residents or an unreasonable distraction to drivers.

9.3 Clause C47A(a)

Details of the lights are provided in Clause 2.1 and Annexure C.

9.4 Clause C47B

I as informed that at the time of the inspection, the Ferris Wheel had been operational for various periods over the last 2 years. Specifically at the time we inspected the Ferris Wheel it had been on site and operational for over 3 months.
We are instructed that should permission be granted to the zoo to place the Ferris wheel on site permanently, the Ferris Wheel we inspected would be retained as the permanent fixture.

The assessment we have performed is based on visual inspection, measurement, and calculations.

We have also been informed by Sydney Zoo that they have received no complaints about the lighting of the Ferris Wheel whilst it has been in operation.

Due to the fact we have been able to inspect the Ferris Wheel on site and the fact that it has been in operation for over 3 months, we therefore believe that our assessment meets the requirements of clause C47B in that it is our conclusion that light spillage from the Ferris Wheel will not cause any adverse amenity impacts on nearby residential areas.

Peter McLean

B.E, M.Bdg. Sc, LFIES(Aust & NZ), FIE(Aust)

10. REFERENCES

1 *AS/NZS 4282:2019 Control of the obtrusive effects or outdoor lighting* Standards Australia Feb 2019

11. ANNEXURES

11.1 Annexure A – Peter McLean CV

Lighting, Art + Science
Lighting and Electrical Consultants

Lighting, Art & Science Pty Limited
ABN 86 152 715 921
Master Security License: 410812303
PO Box 373, CROWS NEST 2065
+61 2 9436 0998
mail@laands.com.au

Curriculum Vitae

NAME: Peter McLean

DATE OF BIRTH: 15th October 1950

NATIONALITY: Australian

QUALIFICATIONS:
BE (Electrical Engineering)
M Bdg Sc (Sydney University)
Fellow of the Institution of Engineers, Australia, CPEng(Ret)
Life Fellow of the Illumination Engineering Society of Aust & NZ
Cert IV Security Risk Analysis – Class 2A Security License

Peter McLean has more than 45 years experience in the design of specialist lighting installations, both external and internal. Peter combines the technical knowledge of lighting, luminaires and light sources with the aesthetic understanding of the way light behaves under different circumstances that can only be gained from experience. Peter's experience has given him the ability to balance the needs for functionality in meeting light technical parameters, suitability in meeting the levels of protection, strength and robustness, while still creating public areas that are comfortable and inviting.
Peter has also lectured in undergraduate, masters and professional development courses at University of Sydney, Queensland University of Technology, University of Technology Sydney and City University, Hong Kong.
Peter is proficient in the use of several high level software packages for the calculation and modelling of internal and external lighting and streetlighting including AGI32, Lumen Designer and Perfectlite.

EMPLOYMENT HISTORY
11/2011 – Senior Engineer– Lighting Art + Science Pty Ltd
Having sold the business Peter continues to work as a senior engineer and lighting consultant to the firm.

03/1998 - Director – Lighting Art + Science Pty Ltd
Specialist Lighting and Electrical Consultancy
During this period he designed many internal and external lighting installations including the Lighting of the Civic Place, Newcastle, Newtown Peace Park. StreetScape upgrades for Kogarah Council, Bilson's Ampersand Restaurant on Cockle Bay and the Sydney in Spring lighting in Martin Place. He also designed the external lighting of the Fox Family Entertainment Precinct and Studio Tour at Moore Park, Sydney, the NBC Today Pavilion at Homebush Bay, and the lighting of the SOCOG, Look of the Games elements for the Olympics venues.

He has recently completed the lighting of the Qantas/British Airways First Class lounge in Singapore, the Station and precinct lighting for the Liverpool to Parramatta Transitway and the Harbour Bridge Pylon Museum and is currently involved in the refurbishment of the King Street Court complex in Sydney and the upgrade of Darlinghurst Road, Kings Cross.

1987-1998 Director - Barry Webb & Associates Pty Ltd
Responsible for a wide range of Electrical Engineering and Specialised Lighting staff and their associated projects. Throughout this time I have remained involved in the detailed design of projects.
EXPO 88 – Brisbane Site lighting and 5 pavilions
Crown Casino – Melbourne
The lighting and effects in the Main Atrium and the Western Entry.
No 1 O'Connell Street, Sydney
The lighting of the entry lobby, ground floor lift lobbies, Wintergarden, retail and external night image for No 1 O'Connell Street
The Exterior Lighting of Darling Harbour and the Chinese Gardens
The Sydney Bicentennial Decorations,
The Circular Quay and Macquarie Street Upgrade
The exhibition lighting in the Powerhouse Museum

1983-1987 Associate - Barry Webb & Associates Pty Ltd

1979-1983 - Grade 4 Engineer Electricity Commission of New South Wales
Power Plant Design

1973-1979 - Grade 1-4 Engineer NSW Department of Public Works
Government Architects Branch

Awards
J.P Turnbull Award for services to the Illuminating Engineering Society
University of Sydney Building Science Prizes 1976, 1977

Meritorious Lighting Awards
EXPO 88 Site and Site Lighting
Macquarie Street Upgrade, Sydney
Powerhouse Museum
Sydney Bicentennial Decorations
Crown Casino, Main Atrium and Western Entry
Melbourne Town Hall Floodlighting

Certificates of Commendation
Federation Pavilion - Daylighting
No 1 O'Connell Street Neon Roof Lighting

Lecturing
Peter teaches lighting for:
Principles of Lighting Course at Petersham College of TAFE
All subjects in the one year course (3 hours a week)
From 1980 to 1986
University of Sydney – Post graduate diploma and masters program (Sydney)
- Interior Lighting (from 1998)
- Design of lighting of Roads for pedestrian traffic (from 2006)
- Design of lighting of Roads for Vehicular traffic (from 2006)
- Decorative Floodlighting (from 2002)
- Emergency Lighting in Buildings (from 1998)
- Lighting Economics (from 1998)

• Electricity in Buildings (1998 to 2005 and 2009)
• Lighting for Facilities Managers (2005)
• Daylighting case studies (2006)
• Lighting Controls (from 2006)
• Lighting of Heritage Buildings (1998)
• Lighting Energy Regulations in the Building Code of Australia
(from 2007)
• Lighting Software
• Public Domain and Streetscape Masterclass (2008)
• Lighting Calculation Methods (2014)
• Floodlighting (2014)

University of Technology Queensland – Department of Physics and City University Hong Kong
• Sustainable Lighting (2005-2014)
• Lighting Design Techniques (2005-2014)
• Luminaire Design (2005-2014)

University of Technology, Sydney - Architecture School
• Lighting and Luminaire Design for Architects
One Semester course of lectures + Tutorials (2006 & 2007)

Lighting Innovations Centre
In 2004 Peter spoke on Lighting Design Techniques in all capital cities of Australia as part of the Lighting Innovations Centre – Best Practices in Lighting Seminars series 1.
In 2006 Peter wrote the paper on Energy Efficient Lighting design and presented at the Sydney and Canberra seminars as part of the Lighting Innovations Centre – Best Practices in Lighting Seminars series 2.

Engineers Australia
In 2005 Peter spoke on Sustainable Lighting Design in all capital cities of Australia as part of the Engineers Australia Seminar series on Energy Efficiency in Buildings.

Standards committees
AS1680: Interior Lighting Code
AS/NZS: 3827 Lighting systems performance-accuracies and tolerances (Chairperson)
AS4282: Obtrusive effects of outdoor lighting (Chairperson)

Papers:
Peter McLean -*Energy Efficient Artificial Lighting*
BEDP Environment Design Guide DES 7
(1995 reviewed 2000)

Peter McLean -*Dark Skies, Perception of Safety and Aesthetics*, IES National Convention, Sydney 2003

Peter McLean -*Lighting Energy Regulation in the Building Code of Australia*, IES National Convention, Broadbeach 2004

Peter McLean -*Artificial Lighting Design Techniques – Sustainability by Quality Design*
BEDP Environment Design Guide DES 61
(2004)

Peter McLean –*Electric Lighting Design and Simulation*
Best Practices in Lighting Seminars
Sydney, Canberra, Melbourne, Brisbane, Cairns, Darwin, Adelaide and Perth 2004

Peter McLean -*Energy Efficient Lighting – Quality vs Quantity*, Lux Pacifica Cairns 2005

Peter McLean -*Lighting the Way or Lighting that Works*
RAIA NSW country Members Conference, Coffs Harbour 2005

P.C. Thomas, Ernest Donnelly, Peter McLean -*Energy Efficiency and*

the BCA for Class 5-9 Buildings
Engineers Australia, Energy Efficiency Workshops, Sydney, Canberra, Melbourne, Brisbane, Darwin, Adelaide and Perth 2005
Peter McLean –*Understanding how to get good lighting solutions within the framework of the BCA*
Best Practices in Lighting Seminars Series 2
Sydney, Canberra, 2006
Peter McLean & Warren Julian – The relevance of current Standards when using LEDs in public lighting – Lighting in Australia August-September, 2013

Selected Projects List

Sport and recreation

Harrington Park, sports facilities
Centennial Park netball courts
Wagga Wagga Aquatic Centre
MLC Aquatic Centre
Tumbalong Park area lighting - Darling Harbour
Glebe Park and Federation Park Sports Lighting
Ropes Crossing oval and tennis courts
Charlestown Oval soccer facility
Bankstown Soccer Complex, Rooty Hill
Prince Alfred Park Tennis Facility and Skateboard Ramps
SOPA Skateboard Ramps
Harrington Park Sports Oval and Tennis Courts
Mackey Park – Marrickville
Rushcutters Bay Oval
Heffron Park Sports Facility
LED upgrade of Sydney Olympic Park and Bicentennial Park public domain lighting

Peer Review:
Woollahra Ovals 2 & 3
Redfern Oval
Christison Park – Rushcutters Bay

External and Public Domain Lighting

World Expo '88, Brisbane (Site & Sitescape)
Sydney Olympic Venues – Lighting of Look of the Games structures
Fox Studio Moore Park - External and Public Domain lighting of the Family Entertainment Precinct and Studio Tour
Darling Harbour, Sydney
Macquarie Street and Hyde Park, Sydney
Parliamentary Zone Lighting, Canberra
Pyrmont Bay and Pyrmont Park Redevelopment external lighting
Sydney Bicentennial Decorations 1988
City of Sydney –Priority One Projects
Concepts for Chinatown
Concepts for Park Street
Concepts and documentation for the Spanish Quarter
Newcastle –Civic Square
Kogarah Council Streetscapes
Newtown Peace Park
Quay Street – Haymarket
Faulconbridge Pedestrian Bridge
Mudgee Main Street Project
Gulgong Main Street Project
Maitland Heritage Mall – Upgrade
Ballina Town Centre

Armidale Town Centre relighting
Liverpool to Parramatta Transitway – Stations, precincts and carpark lighting
Darlinghurst Road, Kings Cross – lighting upgrade
Armidale Town Centre relighting
Prince Alfred Park
Former Water Police Site
Campbell Parade East, Bondi
King Street Mall, Rockdale
Ropes Crossing Town Centre
WestConnex M8 – Feature lighting
WestConnex Rozelle Interchange – Feature Lighting
WestConnex M6 and Bicentennial Park- Feature Lighting

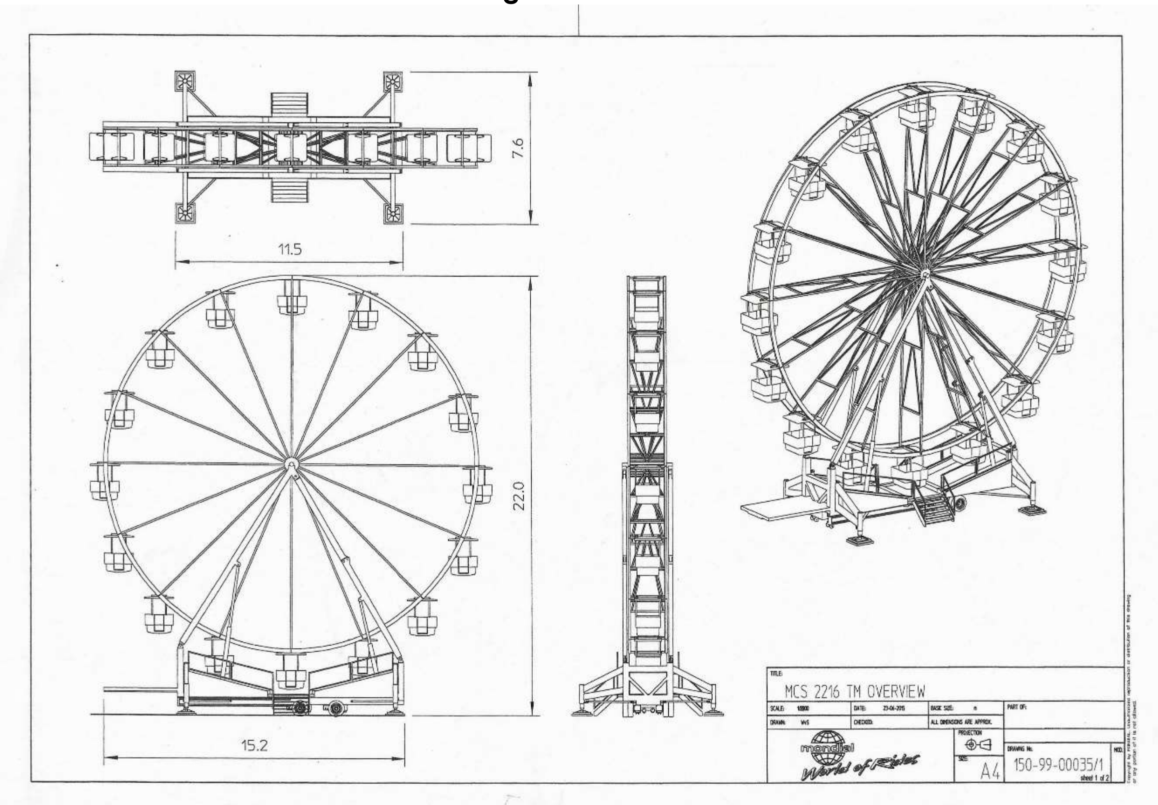
Monuments and Ceremonial Structures and Public Art

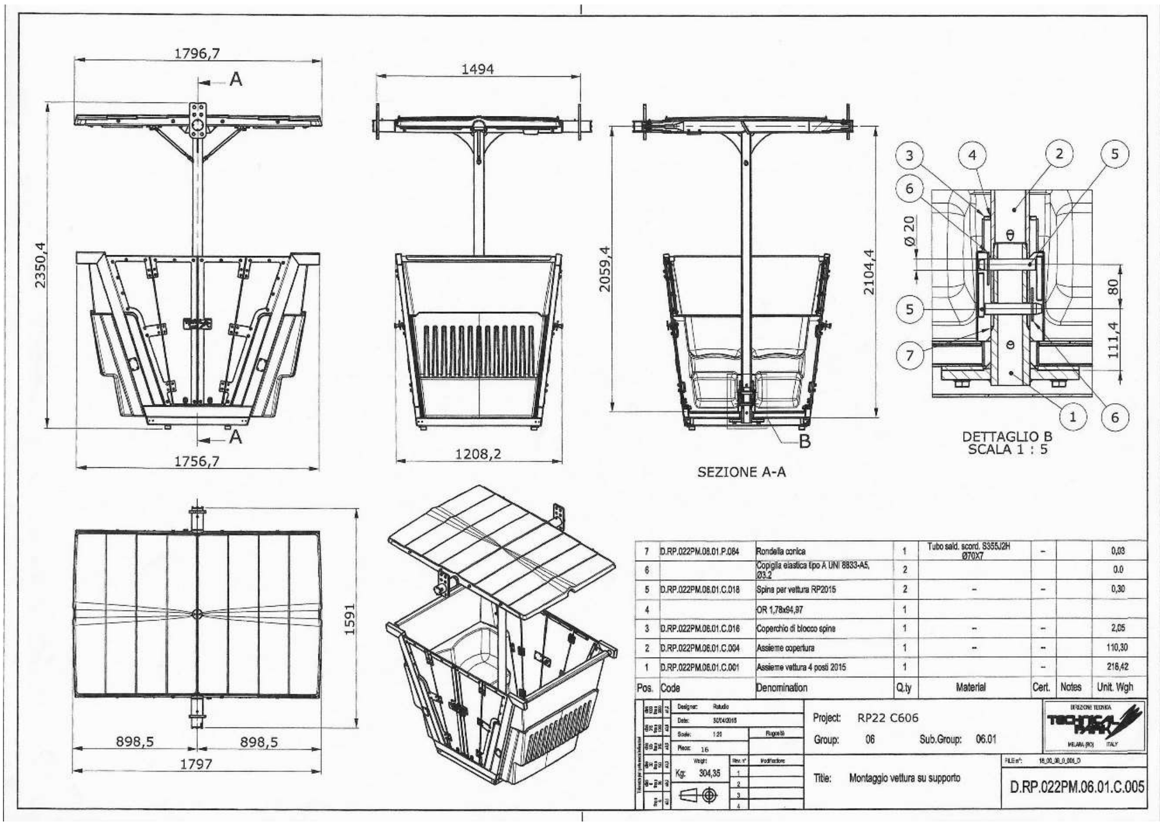
Federation Pavilion – Centennial Park, Sydney
Australian Memorial to the Australian Forces – Canberra
Australian Memorial to the Vietnam Forces – Canberra
Australian Memorial to the Nurses – Canberra
Edward 'Weary' Dunlop Memorial – Melbourne
Sydney Olympic Logo Sculpture – Darling Harbour
Queen Victoria and Prince Albert – Queens Square
Australian Memorial to the Nurses – Canberra
Discobolus – Sydney Olympic Park
'Look of the Games' structures and signage – All Sydney Olympic Venues
The monument to the Volunteers – Sydney Olympic Park
Quay Street, Haymarket
Douglas Lane Steps, Sussex Street
NEC Today Pavilion, Sydney Olympics
Information Pavilion, Chinatown
Lighting of James Angus Sculptures in 1 Bligh St, Sydney, Darlinghurst Road, Kings Cross and Federation Square, Perth

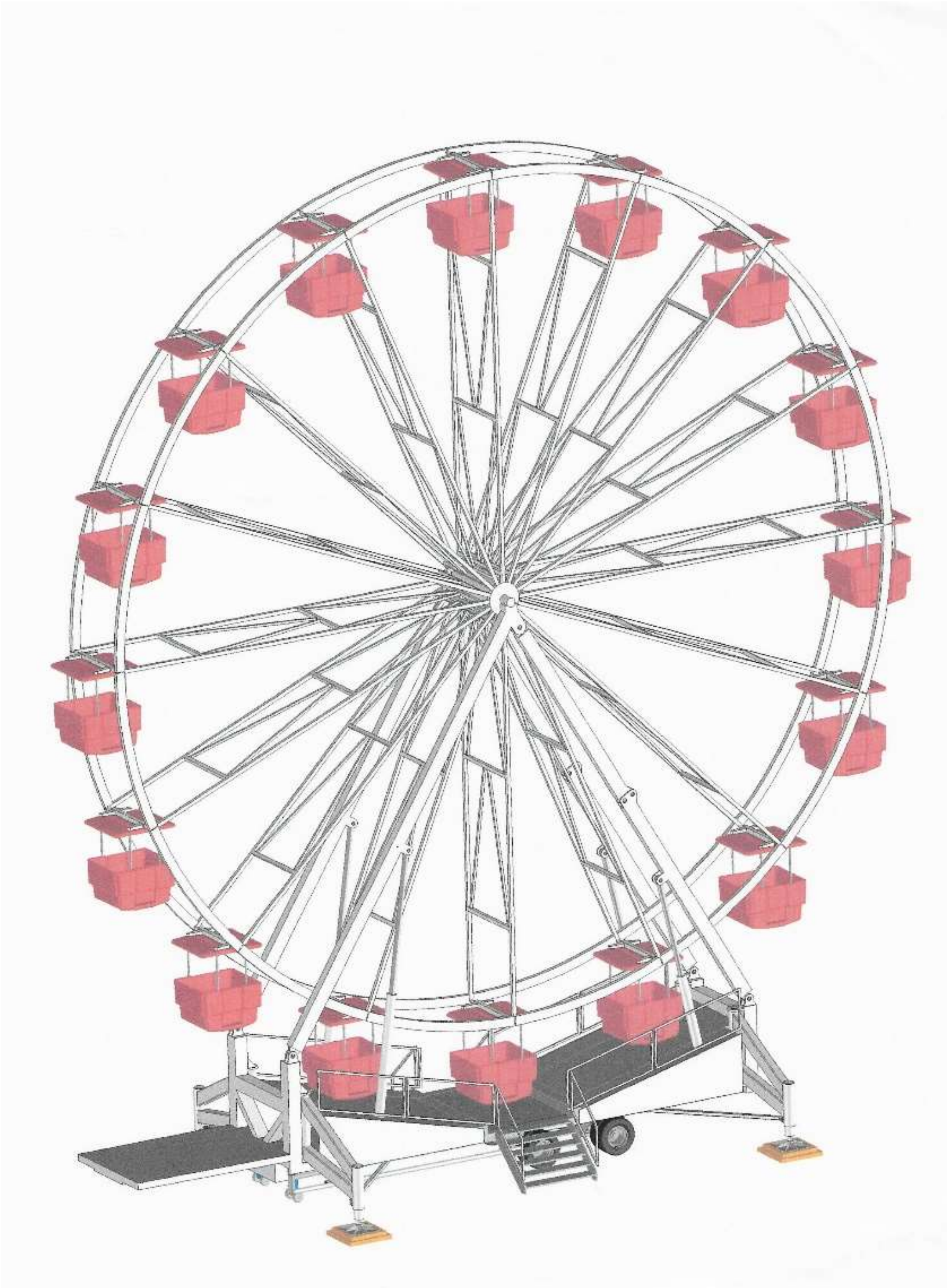
Special Lighting Attractions

Bicentennial Decorations –Sydney CBD
Roof Lighting, No 1 O'Connell Street
EXPO 88
EXPO 88 Pavilions for
Australia
Australia Post
Queensland Newspapers
IBM
Crown Casino – Main Atrium
Crown Casino - Western Entry
Sydney in Spring floral sculpture, Martin Place
Quay Street – Sydney
NBC pavilion – Sydney Olympic Park

11.2 Annexure B – Ferris Wheel Drawings

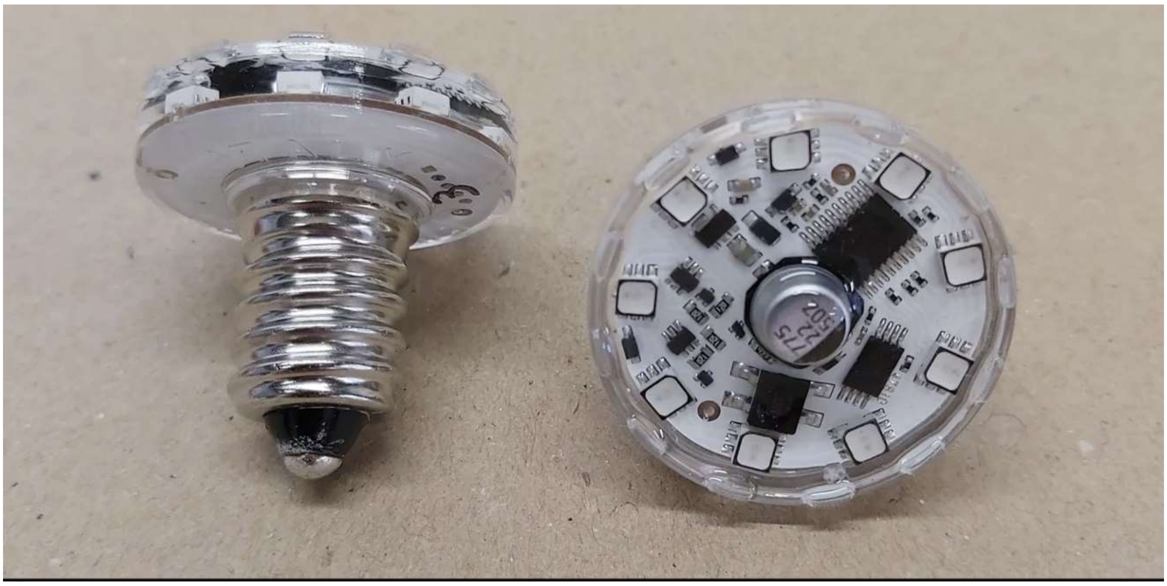






11.3 Annexure C - Lighting Equipment

a) Colour Change Lights

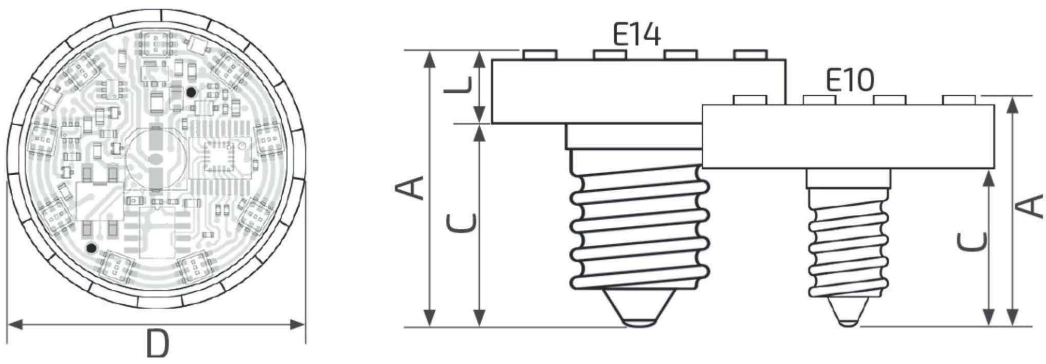


Fun-LED spares

OPERATIVE MODE	LED - n°	Wire Connection - n°	Supply Voltage - Volt	Rated Power - Watt	LED Colour	Socket - E10	Socket - E14
Plug&Play (PP)	9	2	24V AC	0,62	RGB/White	✓	✓
Remote Controllable (RC)	9	2	32V DC	0,96 **(1)**	RGB	✓	✓

(1) – Recommended maximum power.

SIZES



b) LED floodlights

NOX15V2

ML-NOX15V2

150 Watt LED floodlight with offset bracket

Product code/Category

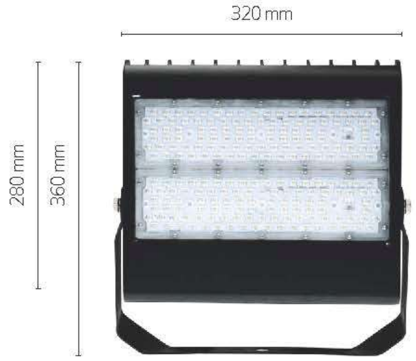
ML-NOX15V2 / Floodlights

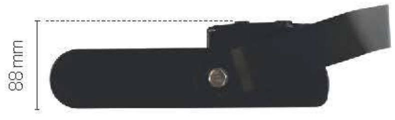
Product information

The NOX15V2 floodlight is our latest development of this iconic LED floodlight range. Featuring an ultra-efficient offset bracket that installers demand, super slim body and illumination specifications that lead the category, NOXV2 is the brightest choice by far. Supported by a M-Elec 3 year warranty (+2 years for PLI-lodge online).

Total power consumed:	150W*
Lumen output:	19500lm (WW) | 20250lm (W)
Colour temperature:	3000K (WW) | 5700K (W)
IP rating:	IP65
Impact rating:	IK08
CRI:	71+
Max. projected area:	200m²
Max. mounting height:	35m
Efficacy:	135-141lm/W
Beam angle:	120 x 90 degrees
Dimmable:	Yes (0-10V)
Power supply:	100-277V AC 50/60Hz
Average life:	50,000hrs**
Dimensions:	Width 320mm | Height 280mm (360mm) | Depth 88mm
Weight:	6.1kg
Construction:	Aluminium body, PC lens
Kit includes:	1 x LED floodlight, flex & plug
Compliance:	AS/NZS 60598.1, AS/NZS 60598.2.5

* Total power consumed including driver
**Average life is calculated on expected average lifespan





5

3 YEAR WARRANTY + 2 PLI

11.4 Annexure D – Extracts from AS/NZS4282:2019

TABLE 3.2

MAXIMUM VALUES OF LIGHT TECHNICAL PARAMETERS

Zones	Vertical illuminance levels (E_v) lx		Threshold increment (TI)		Sky glow
	Non-curfew	Curfew	%	Default adaptation level (L_{ad})	Upward light ratio
A0	See Note 1	0	N/A	N/A	0
A1	2	0.1	N/A	N/A	0
A2	5	1	20%	0.2	0.01
A3	10	2	20%	1	0.02
A4	25	5	20%	5	0.03
TV	See Table 3.4	N/A	20%	10	0.08
V	N/A	4	Note 2	Note 2	Note 2
R1	N/A	1	20%	0.1	Note 3
R2	N/A	2	20%	0.1	Note 3
R3	N/A	4	20%	0.1	Note 3
RX	N/A	4	20%	5	Note 4

NOTES:

1 For A0, E_v shall be as close to zero as practicable without impacting safety considerations.

2 Refer to AS/NZS 1158.1.1.

3 Refer to AS/NZS 1158.3.1.

4 Refer to AS/NZS 1158.4.

5 N/A means 'Not Applicable'.

6 For an internally illuminated sign in an A2 zone, $L_{ad} \leq 0.25$ cd/m².

TABLE 3.5

MAXIMUM AVERAGE LUMINANCE OF SURFACES (cd/m²)

Application conditions	Environmental zones				
	A0	A1	A2	A3	A4
See Clause 3.3.5.4	0.1	0.1	150	250	350

11.5 Annexure E – Measurement and Calculation Points

Issue	Amendment	Date
P1	PRELIMINARY ISSUE	07-06-22

NTS@A3

T:\Projects\L173\L173H - Sydney Zoo Ferris Wheel\L173H--DG\L173H Site Surrounds A.dwg - EL-01 - 07/06/2022 - 11:49:39 AM

Notes:
1. The services shown on this drawing have been coordinated with Dial Before You Dig and survey information available at the time of documentation. The contractor shall make their own Dial Before You Dig enquiry and trace the existing services to determine the final routes of all new in ground conduits and pits prior to excavation.

Lead Consultant

Client
SYDNEY ZOO

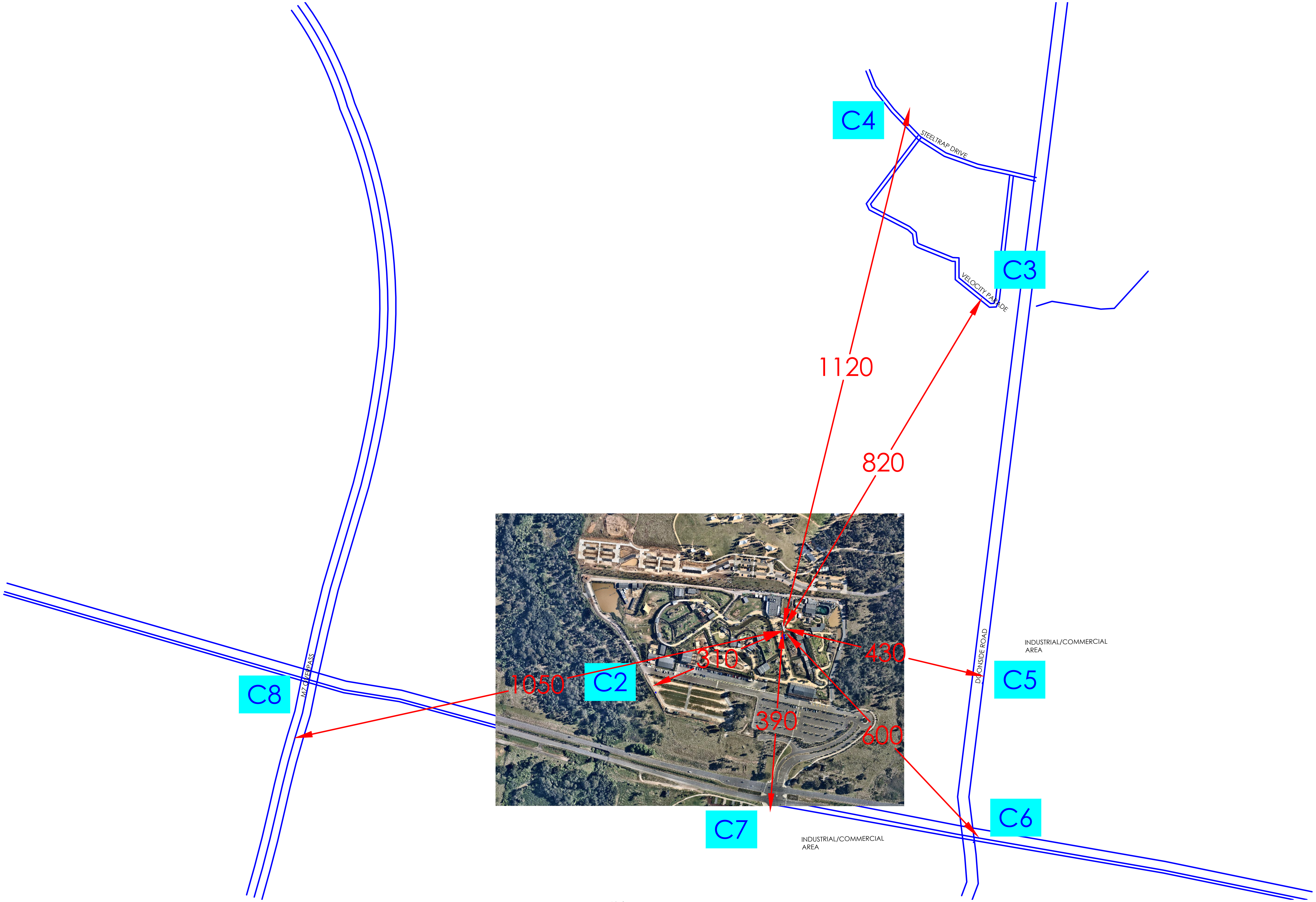
LAS
Lighting, Art + Science
Lighting Consultants, Electrical Engineers
Level 1, 41 Hume St, Crows Nest NSW 2065
p: +61 2 9436 0998
e: mail@laands.com.au

Project SYDNEY ZOO
FERRIS WHEEL OBTRUSIVE LIGHT

Drawing MEASUREMENT LOCATIONS

Drawn PMc | Approv. PMc | Date JUNE | Scale NTS@A3

Project No L173H | Drawing No EL_01 | Rev P1



Notes:

1. The services shown on this drawing have been coordinated with Dial Before You Dig and survey information available at the time of documentation. The contractor shall make their own Dial Before You Dig enquiry and trace the existing services to determine the final routes of all new in ground conduits and pits prior to excavation.

Issue	Amendment	Date
P1	PRELIMINARY ISSUE	07-06-22

NTS@A3

T:\Projects\L173\L173H - Sydney Zoo Ferris Wheel\L173H--DG\L173H Site Surrounds A.dwg - EL-02 - 07/06/2022 - 1:44:55 PM

Lead Consultant

Client
SYDNEY ZOO

Lighting, Art + Science
Lighting Consultants, Electrical Engineers
Level 1, 41 Hume St, Crows Nest NSW 2065
p: +61 2 9436 0998
e: mail@laands.com.au

Project SYDNEY ZOO
FERRIS WHEEL OBTRUSIVE LIGHT

Drawing SITE SURROUNDS

Drawn PMc Approv. PMc Date JUNE 2022 Scale NTS@A3

Project No L173H Drawing No EL-02 Rev P1