Part of Energy Queensland

Standard for Public Lighting Design

STNW3471

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Abstract: This standard outlines Energy Queensland's requirements for the design of Public Lighting. This manual includes fundamental design principles and concepts.

Keywords: Public Lighting, Luminaire, Light Emitting Diode (LED), Column, i-table, photometric, STNW3471

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1 Purpose and Scope

The purpose of this manual is to provide the designers of Public Lighting schemes for the Electricity Supply Industry in Queensland with the concepts and fundamental design principles for the development of appropriate lighting schemes on public roads and public spaces.

Public lighting design, installation, maintenance and recovery are an integral role of Distribution Network Service Providers (DNSPs) in Queensland. In partnership with other Public Bodies, public lighting is installed and maintained at an agreed category of lighting and funding.

Whilst the design is considerably linked to the Australian Standard *AS/NZS1158* series, unique requirements identified by Public Bodies and private enterprises are referenced. The manual is not a substitute for the *AS/NZS1158* series but serves as a basis for public lighting design for the DNSPs in Queensland.

Historically High Pressure (HPS) and Mercury Vapour (MV) luminaires have been used for minor road applications. It is recognised however that these technologies are being phased out or no longer available. Accordingly designs incorporating mercury vapour (MV) or high pressure sodium (HPS) lamps in Queensland will not continue. Instead, designs for roadway lighting should incorporate LED luminaires.

This manual also includes fundamental information relating to the principles of public lighting design for those involved with the process of obtaining public lighting design services.

Public lighting for the purposes of this manual shall include the following:

- Carriageway lighting including major roads, motorways, minor roadways
- Public spaces including park pathways, stairs
- Other lighting including pedestrian crossings, external car parks and transport interchanges.
- Application of Residual Current Circuit Breakers with Overcurrent (RCBO) protection in high risk locations on conductive streetlight poles.

When preparing public lighting designs, this manual is to be read in conjunction with the:

- *AS/NZS1158* series (design standards),
- Public Lighting Construction Manual (materials, construction practices for both lighting and electrical installations),
- Standard Conditions for Provision of Public Lighting Services (funding arrangements, responsibilities and specific use of materials and relationships with Public Bodies),
- Design brief (details the specific requirements of the Public Body)

1.1 Disclaimer

This document has been developed using information provided by the DNSPs' construction and design staff and as such is suitable for most situations encountered. The requirements of the relevant Australian Standards, Acts and Regulations and all other statutory bodies are regarded as accepted minimum requirements for the establishment of these Public Lighting designs.

Where this document exceeds those requirements, this document is to become the accepted minimum.

Where a Public Body elects to either amend or carry out the Public Lighting design, or alternatively allows a developer/consultant to carry out the design the DNSP takes no responsibility as to the design's compliance with the *AS/NZS 1158* Series.

It is acknowledged that the AS/*NZS1158* series may be updated at any time. Retrospective design changes to meet with these changes may not be undertaken to existing installations.

The DNSPs will not accept any liability for work carried out to a superseded standard. The DNSPs may not accept any work carried in accordance with the current standard requirements.

The DNSPs' manuals are subject to ongoing review. If conflict exists between manuals, the requirements of the most recent manual are to be adopted.

Whilst care has been taken in the preparation of the Public Lighting Design Manual, the DNSPs do not guarantee that the information contained in the Public Lighting Design Manual is accurate, complete or up to date at the time of publication. To the extent permitted in the relevant legislation, the distributor will not be responsible for any loss, damage, cost or expense incurred as a result of any error, omission or misrepresentation in relation to the information contained in the Public Lighting Design Manual.

1.2 Safety

In all activities undertaken, the safety of our employees, contractors, customers and the community is paramount. Safety is our number one value and there is a commitment to ensuring that "safety must come first" to achieve a no injuries workplace. In accordance with legislative requirements, we have developed Policies, Standards and Work Practices that our workers are required to follow to ensure the safety of themselves, other workers, customers and the community. We trust that designers will appreciate the need to prepare public lighting designs that have considered controlled risks consistent with our safe systems of work for both the installation and maintenance of public lighting schemes.

2 References

2.1 Legislation, regulations, rules, and codes

Electrical Safety Code of Practice – Works, 2020 (Queensland Government)

Environmental Protection Act, 1994 (Queensland Government)

Queensland Electricity Act, 1994 (Queensland Government)

Queensland Electricity Regulation, 2006 (Queensland Government)

Queensland Electrical Safety Act, 2002 (Queensland Government)

Queensland Electrical Safety Regulation, 2013 (Queensland Government)

Queensland Work Health and Safety Act, 2011 (Queensland Government)

Queensland Work Health and Safety Regulation, 2011 (Queensland Government)

Queensland Transport Infrastructure Act 1994 (Queensland Government)

Queensland Transport Operations (Road Use Management) Act 1995

National Electricity Rules

2.2 Energy Queensland controlled documents

QPLC_Manual_Issue_12.pdf

Public Lighting - Standards Conditions for Public Lighting Services

2.3 Other sources

AS/NZS 4282 – Control of Obtrusive Effects of Outdoor Lighting

AS/NZS 1158 – Lighting for Roads and Public Spaces

AS/NZS 1170 – Structural Design Actions

AS/NZS 1798 – Streetlight Poles and Bracket arms – Recommended Dimensions

AS/NZS 3000 – Wiring Rules

CASA Manual of Standards Part 139 – Aerodromes

Crime Prevention Through Environmental Design – Guidelines for Queensland

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this standard, the following definitions apply.

Aeroscreen Luminaire	A luminaire where the intensity at or near the horizon is restricted in accordance with the requirements of the aviation authorities. They are commonly called 'full cut-off luminaires' describing luminaires that emit no light above the horizontal plane.
Arrangement	The layout, in plan, of the luminaires in a lighting scheme, e.g. single sided, staggered, opposite or central along roadways.
Carriageway	That portion of the road devoted to the use of vehicles, inclusive of shoulders and auxiliary lanes. Note: An undivided road, either one or two-way, comprises a single carriageway. A road divided longitudinally by a median or similar comprises two separate carriageways.
Conflict Points	Roadway features that influence the passage of motorists and pedestrians and that require particular attention when preparing the lighting design e.g. chevrons, pedestrian refuges, gore points at off/on ramps.
Distribution Network Service Provider	Corporations that are responsible for electricity distribution in Queensland e.g. Energex Limited and Ergon Energy Limited.
Funding Arrangements	The determination of who provides the funding for the installation. In the case of a rate 1 installation, the electricity distributor funds the design and

	construction of the installation. In the case of a rate 2 installation, the Public Body or developer funds the design and construction of the installation.
Glare	Conditions of vision in which there is discomfort or a reduction in the ability to see, or both, caused by an unstable distribution or range of luminance, or extreme contrasts in the field of vision.
High Risk Location	A location within 100 m of the following locations, public beaches and foreshores, aquatic centres, water recreation areas, public swimming pool, schools, day care centres and shopping centres.
Illuminance	The physical measure of illumination. It is the luminous flux arriving at a surface divided by the area of the illuminated surface.
Lamp	The generic term for the light source in a luminaire.
Lighting Column	A vertical structure of any appropriate material, which, is designed to support luminaires either directly or by use of outreach arms or mounting frames.
Luminance	The physical quantity corresponding to the brightness of the surface (lamp, luminaire or reflecting material such as the road surface) when viewed from a specified direction.
Luminaire	Apparatus which distributes, filters, or transforms the light transmitted from one or more lamps and which includes, except for the lamps themselves, all the parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting them to the electrical supply.
Metered Lighting	Lighting on private roads, walkways, open areas etc., that are not dedicated public roads.
Mounting Height	The vertical distance between the photometric centre of a luminaire and the surface which is to be illuminated e.g. the road surface.
	Outreach The distance, measured horizontally, from the photometric centre of a luminaire to: (a) for lighting columns with outreach arms, the centre of the vertical section of the pole (b) for bracket arms, the mounting plate by means of which the bracket arm is secured to the pole, or wall or other supporting surface.
Public Body	Organisations defined as Road Controlling Authorities and include Local Government, Department of Transport and Main Roads or other Queensland Government Departments and Queensland Public Authorities as approved by the Queensland State Government.
Public Lighting	(Road Lighting) Lighting for any roadway, pathway or dedicated public thoroughfare, park or precinct (Lighting provided in accordance with the AS/NZS 1158 series).
Rate 1	Unmetered Lighting (non-contributory) Public lighting supplied, installed, owned and maintained by the Electricity Entity. The tariff includes components supply and installation and recovery over time.

Rate 2	Unmetered Lighting (contributory) Public lighting owned and maintained by the Electricity Entity.
Rate 3	Unmetered Lighting supplied, installed, owned and maintained by the Public Body. Supply is unmetered and has a fixed wattage and must comply with the AS/NZS 3000 Wiring Rules. Beyond the Point of Supply, reticulation is owned and maintained by the consumer.
Roadway Width	The traverse distance between the outer road kerb-lines or edges (for divided roads, this will apply to the two carriageways plus the intervening median strip). Roadway width is used only for the lighting of curves.
Tilt (Upcast) Angle)	The angle by which the axis of the fixing spigot entry is tilted above the horizontal when the luminaire is installed.

3.2 Abbreviations

This list does not include well-known unambiguous abbreviations, or abbreviations defined at their first occurrence within the text.

DNSP	Distribution Network Service Provider
LED	Light Emitting Diode
RCBO	Residual Current Circuit Breakers with Overcurrent Protection

4 Basic Lighting Concepts

4.1 Objectives of Public Lighting Design

The design objectives shall conform to those specified in the *AS/NZS1158* series and the requirements of the Public Bodies and other requesting organisations.

The aim for road and public space lighting schemes can include any or all of the following:

- Facilitation of safe movement of vehicles and people
- Discouragement of illegal acts
- Contributing to the prestige and amenity of an area through increased aesthetic appeal
- Minimum light spill and glare

Good lighting can prevent crashes by serving the motorists and at the same time assisting to protect otherwise unprotected cyclists and pedestrians. Lighting levels on roadways at night need to provide adequate visual acuity for the driver of a vehicle and/or pedestrians. This enables an individual to detect movement of other vehicles and pedestrians along the carriageway or within the road reserve.

Lighting is designed and installed based on the requirements of the responsible Public Bodies including Queensland Local Authorities, Queensland Department of Transport and Main Roads and other Queensland government departments. Lighting designs are to be completed considering safety to the public and construction/maintenance staff, state and federal environmental requirements, material and installation to facilitate aesthetics and optimum costs.

Lighting designs must also consider both the initial installation cost (reduced number of luminaires spaced optimally) and the subsequent running costs (lowest lamp wattage possible).

4.2 Geometry and Terminology

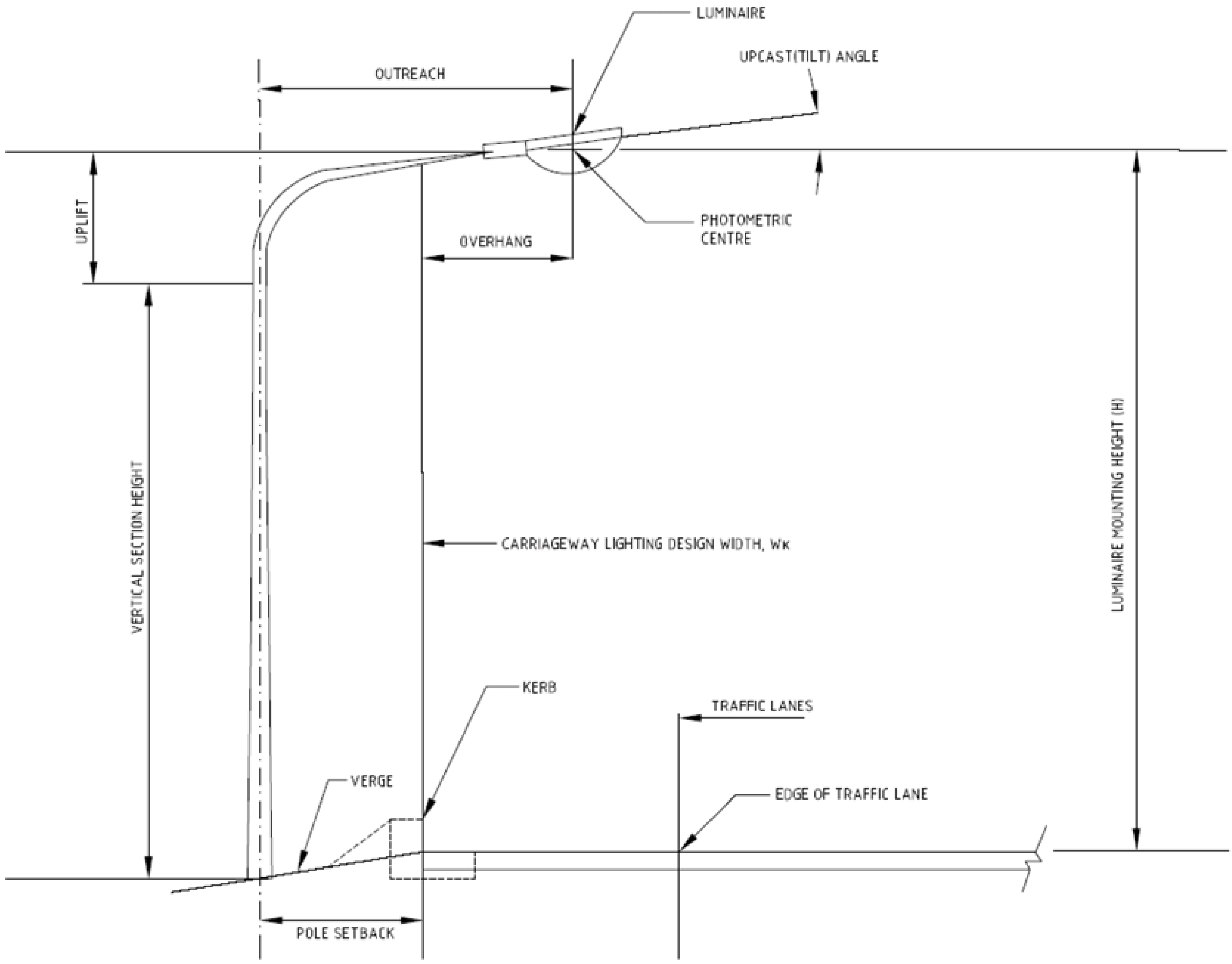


Figure 1: Geometry and Terminology used in a Typical Road Lighting Installation

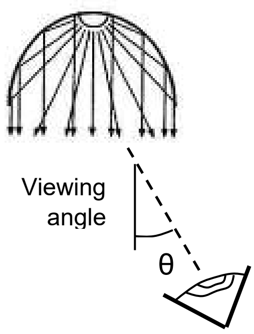
Table 1: Key Lighting Terminologies and their Application

Term	Description	Application
Mounting Height	The vertical distance from the roadway surface to the photometric centre of the luminaire.	The most suitable standard height at which the luminaire's lighting performance can be most efficiently utilised within construction constraints.
Outreach	Outreach is measured horizontally from the centreline of the pole to the photometric centre of the luminaire.	The most suitable standard horizontal distance that places the luminaire at a lateral point across the road where the luminaire performance can be most efficiently utilised
Pole setback	The horizontal distance between the edge of the kerb (or edge of the traffic lane if no kerb) and the centre-line of the lighting pole, measured normal to the direction of traffic.	The dimension specified by the road controlling authority as being that required reduce the possibility of vehicle impact. It is relative to the road speeds, pole type and whether the road is curved or straight, proximity to intersections.
Upcast (tilt angle)	The angle between the axis of the fixing spigot entry is tilted above the horizontal when the luminaire is installed.	The angle at which the luminaire's lighting performance can be most efficiently utilised.
Carriageway width (W_k)	The portion (width) of the roadway that is devoted to the use of vehicles	The kerb-to-kerb width of that part of the carriageway which is used for calculation or assessment of road lighting.
Overhang	Overhang is measured horizontally from the edge of the kerb to the photometric centre of the luminaire	This is a critical dimension used in design software applications in determining carriageway luminance and illuminance.

4.3 Photometric Quantities and Units

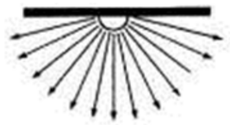
4.3.1 Key Lighting Quantities

Luminous Intensity



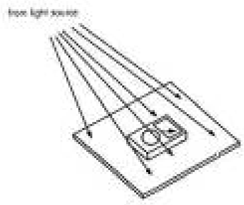
The perception of a light source intensity measured in candelas (cd) as perceived from a defined observer position.

Luminous Flux



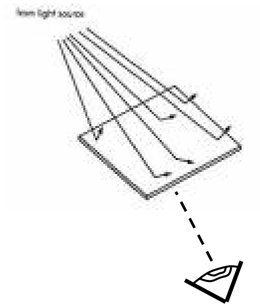
Total amount of light emitted by a light source (lumens)

Illuminance



Light falling onto a specified flat surface measured in lux (lx or lm/ m^2)

Luminance



The perception of the surface brightness measured in cd/m^2 as perceived from a defined observer position.

Figure 2: Typical Road Lighting Quantities

4.3.2 Technical Parameters

Table 2: Typical Road Lighting Technical Parameters

Term	Symbol	Description	Application
Luminance	$\bar{L}$ (cd/m^2)	The average intensity of light reflected off the surface of the road	Sections of carriageway between intersections
Illuminance	E_h (lx)	E_h is the level of illumination arriving at a horizontal plane.	Major road intersections and conflict points
	E_v (lx)	E_v is the level of illumination arriving at a vertical plane.	External car parks, pathways, stairways, public precincts, cycle ways, pedestrian crossings etc.
Uniformity	U_O	Ratio of minimum carriageway luminance over the average carriageway luminance calculated within a specified area	Straight sections of carriageway
	U_L	Ratio of minimum carriageway luminance over the maximum carriageway luminance along a line-of-sight down a length of carriageway	Straight sections of carriageway
	U_{E1}	Ratio of the maximum to minimum illumination levels within a specified area	Intersections
	U_{E2}	Ratio of the maximum to average illumination levels on the roadway	Over the whole of the roadway

4.3.3 Horizontal Plane and Vertical Planes

Illuminance is the quantity of light falling on a surface and is measured in lux. There are two aspects of illuminance - vertical and horizontal.

Horizontal illuminance (Eh) is the value of illuminance on a designated horizontal plane or at level ground.

Vertical illuminance (Ev) is the value of illuminance on a designated vertical plane typically at a height of 1.5m above ground (including 'at-ground' level for category PX).

Figure 3: Horizontal and Vertical Illuminance Planes

4.3.4 Uniformity

Levels of illumination along the carriageway will vary as a result of luminaire mounting height, luminaire spacing and luminaire output. It is important that the contrast between the illumination levels along the carriageway be minimised. The motorist's eyes should not have to adjust too much for the variations.

Uniformity is measured as a ratio between road surface illumination levels e.g. max. to min. or max to average.

Uniformity values vary for various roadway elements. These are identified in Table 2.

Uniformity is as important as providing enough illumination.

Figure 4 shows a typical luminaire isolux diagram and identifies the basic illuminance levels that are considered in the various uniformity calculations.

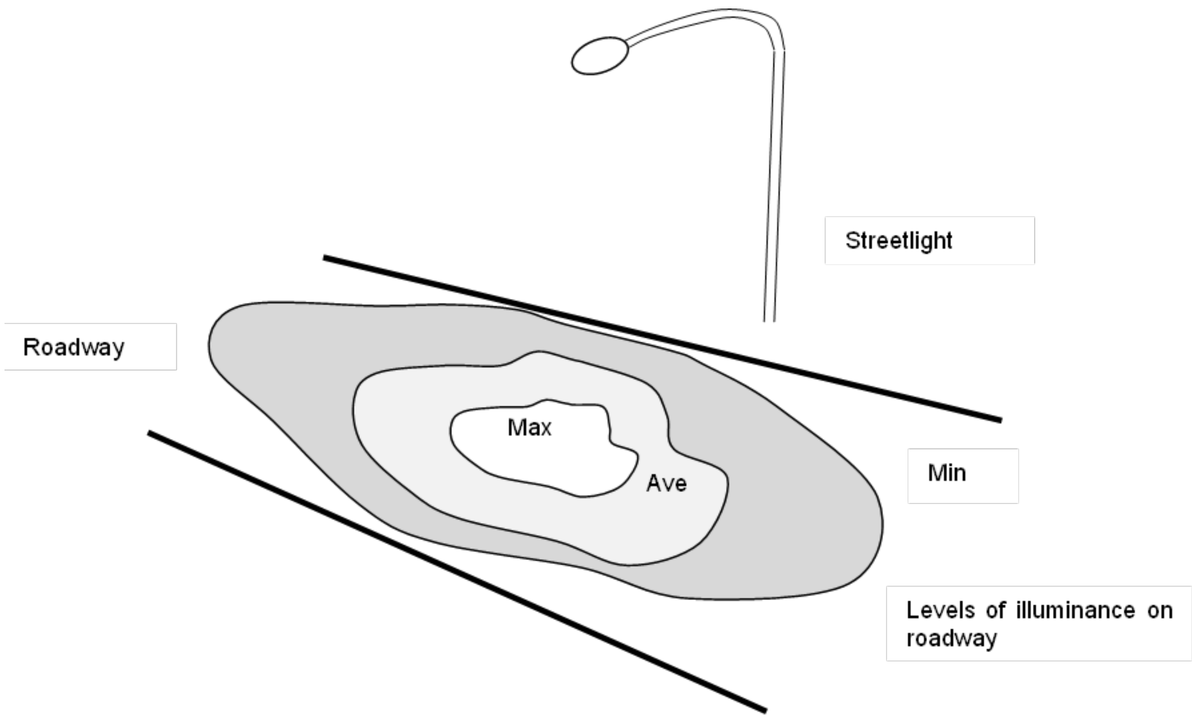
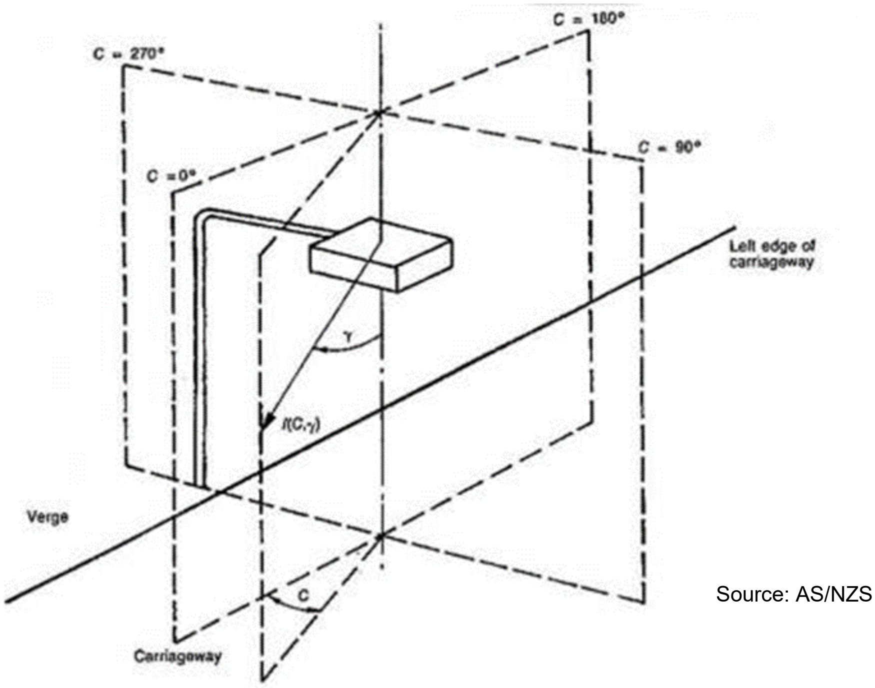


Figure 4: Typical Isolux Diagram Indicating Levels of Illuminance

4.3.5 Luminaire Characteristics

The light intensity distribution characteristics of an individual luminaire are given as an intensity table otherwise known as an 'I-Table' in '.cie' format produced for every angle and position.

To produce an I-Table in '.cie' format, light intensity values are measured at specified angles about the horizontal, known as C angles, and specified angles up from 'vertical down', known as Gamma (γ) angles.



Source: AS/NZS1158:1.3

Figure 5: Light Distribution Parameters (C and γ angles)

Manufacturers will provide data relative to the light distribution intensity for a specific lamp/luminaire combination in this format.

Each lamp/luminaire combination has a unique I-table.

4.3.6I-Tables

Figure 6 shows the I-table specific to the Sylvania S100 semi cut-off Roadster streetlight indicating the candelas for a number of C and γ angle combinations.

98262 - ROADSTER S100C

y angle degrees	Luminous intensity (I), cd/1000 lamp lumens — C angle, degrees																									
	270	**285**	**300**	**310**	**315**	**320**	**325**	**330**	**335**	**340**	**345**	**350**	**355**	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**60**	**75**	**90**
0.0	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159	159
10.0	189	170	149	140	135	132	132	132	131	131	132	134	135	136	138	139	140	141	141	142	142	143	144	144	145	145	149
20.0	191	152	120	114	112	112	114	115	118	121	125	129	132	135	137	139	140	141	140	140	139	138	138	139	139	141	142
30.0	174	147	139	130	130	128	126	124	124	122	124	125	126	128	132	138	145	156	164	161	153	153	152	152	143	135	141
35.0	153	150	151	150	149	149	155	160	160	159	153	148	140	135	130	129	131	137	149	160	171	180	174	172	171	146	143
40.0	131	134	140	152	157	170	187	191	194	200	202	196	186	167	152	139	135	142	148	158	168	183	187	185	184	166	158
45.0	118	121	124	133	141	148	163	177	185	190	199	210	218	216	211	201	184	162	142	149	171	189	199	205	207	193	169
47.5	113	115	121	130	133	147	160	177	187	200	206	208	216	221	216	205	193	178	163	169	183	207	217	221	215	191	164
50.0	107	108	115	126	127	134	150	164	182	195	196	205	216	220	224	229	224	209	202	204	190	197	212	220	215	194	154
52.5	100	102	112	124	125	145	157	178	194	198	208	215	216	218	221	226	230	228	218	204	196	197	204	201	200	165	139
55.0	93	96	104	120	120	127	146	168	185	192	205	211	225	229	230	232	228	228	224	209	203	188	183	182	177	150	124
57.5	86	93	109	117	124	139	158	186	199	197	213	223	226	227	228	223	218	216	215	201	187	172	163	153	144	130	107
60.0	78	84	97	110	119	126	144	160	175	183	210	225	230	235	236	235	237	236	217	197	179	174	159	143	121	114	88
62.5	68	76	90	104	111	120	144	170	201	220	234	244	249	249	248	247	243	236	211	186	167	152	132	121	103	94	71
65.0	58	69	82	99	104	110	129	163	192	214	246	270	284	292	291	285	271	249	233	206	178	161	134	112	89	78	59
67.5	46	60	78	97	105	118	142	171	196	229	268	306	336	355	359	341	305	262	216	185	169	146	120	100	84	63	49
70.0	36	52	69	88	96	104	124	144	175	212	250	300	362	401	417	409	375	315	247	208	166	141	122	104	82	55	39
72.5	26	39	66	84	92	101	117	141	171	199	244	314	377	435	465	456	393	305	227	184	157	131	100	90	74	48	33
75.0	19	28	58	77	84	90	103	119	139	159	203	266	337	414	459	453	390	311	223	180	150	129	104	90	72	42	31
77.5	15	15	41	72	79	91	103	123	137	160	195	240	285	358	417	422	363	270	198	152	130	113	92	84	70	36	23
80.0	11	11	14	34	38	41	37	33	37	49	68	91	131	207	261	255	240	205	154	145	137	110	86	79	62	29	19
82.5	8	8	9	15	16	13	13	16	20	23	31	42	61	87	132	149	113	97	68	56	47	41	41	47	44	21	14
85.0	5	5	6	7	8	8	9	10	12	13	14	18	23	24	29	46	70	46	42	33	24	18	16	16	16	12	11
87.5	5	5	5	6	6	7	8	10	12	12	12	13	13	13	14	17	28	30	24	20	14	9	7	7	7	7	7
90.0	4	4	5	5	5	5	6	7	10	12	11	10	11	11	11	12	12	15	18	16	12	9	7	6	6	5	5
92.5	5	5	4	5	4	5	6	9	10	9	8	10	11	12	12	13	12	12	11	10	7	6	5	5	4	3	3
95.0	4	4	4	4	4	4	5	6	9	9	8	7	9	10	10	11	11	10	10	9	9	7	7	6	5	2	2
97.5	4	5	5	5	5	5	6	9	10	8	7	8	8	8	8	8	7	6	6	6	5	5	5	5	4	3	3
100.0	4	5	5	5	4	5	5	6	8	7	7	7	7	7	7	7	7	6	5	5	4	4	4	4	4	3	4
102.5	4	5	5	4	4	5	5	7	6	6	6	6	6	7	7	6	5	5	4	4	3	3	3	3	3	3	3
105.0	4	4	5	4	4	5	5	6	6	5	5	6	6	6	6	6	6	5	5	4	4	3	3	3	3	3	3
120.0	2	2	2	3	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	2	2	2	2	3	3
135.0	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
150.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
165.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 6: Typical I-Table for a S100 Roadster Luminaire

Isolux diagrams can then be developed from these I-tables to represent the horizontal distribution of a streetlight at a specified mounting height and upcast angle.

4.3.7 Isolux Diagrams

Figure 7 shows the isolux diagram generated from the I-Table shown in Figure 6 for this S100 Roadster streetlight when mounted at 9.0m above ground and with a 5° upcast.

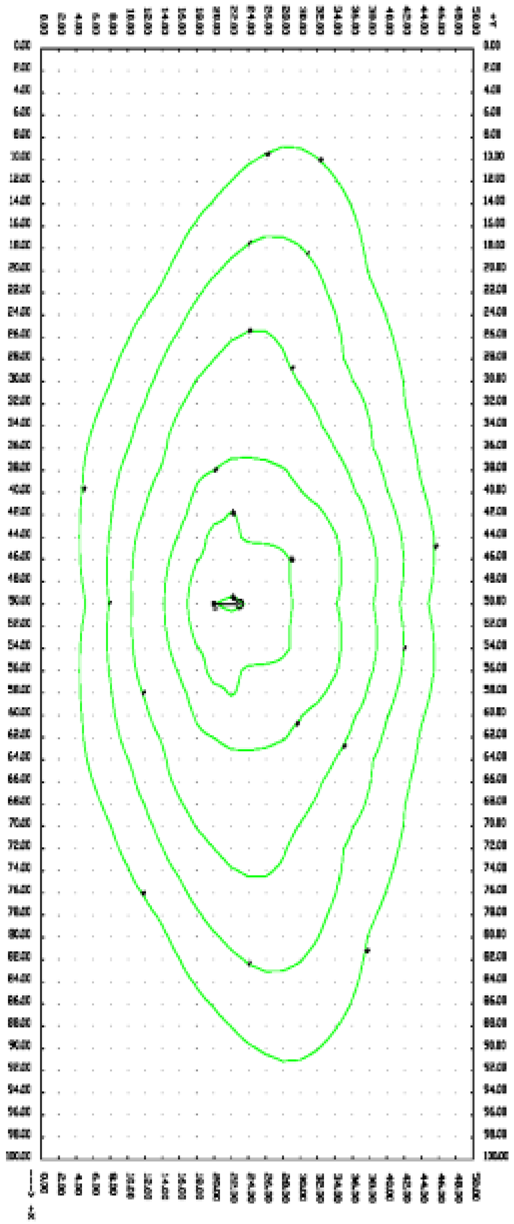


Figure 7: Typical Isolux Diagram for a S100 Roadster Luminaire

In order to achieve compliance with the various light technical parameters, analysis of roadway luminance (using I-table data as illustrated in Figure 6) and analysis of roadway illuminance (as illustrated by Figure 7) is necessary.

The spacing, relative positioning and orientation of adjoining streetlights is determined by integrating the two concepts described above.

4.3.8 Inverse Square Law

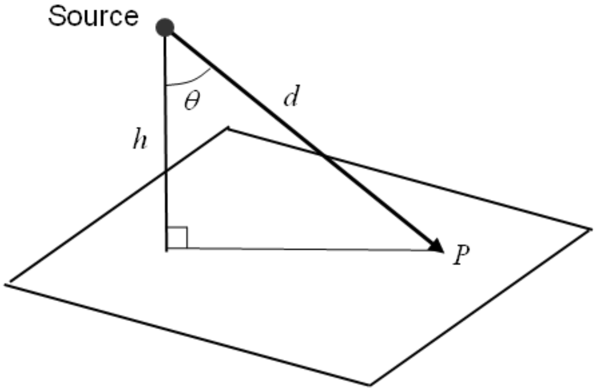


Figure 8: Illumination of a Plane

For calculating illumination at a point *P* on a plane surface in Figure 8:

$E = \frac{I}{d^2}$ for a point directly below the light source

$E = \frac{I_\theta}{d^2} cos\theta$ for a point at some angle θ elsewhere on the plane

or $E = \frac{I_\theta}{h^2} cos^3\theta$

where:

E = Illuminance in lx

d = the distance from the source to the point (m)

θ = the angle of the light from the normal

I_θ = the intensity of the source in the direction θ (cd) as per the I-table

h = the perpendicular distance from the source to the plane (m)

Notice that an inverse square law is evident here. Thus, if the mounting height of a luminaire were doubled, the illumination levels would fall to one quarter of their original value.

4.3.9 Colour Rendering

The various lamp types used by the DNSPs display different performance levels including colour rendering. This relates to the capacity of light to enhance the spectral colours of an area being lit. The broad spectrum of white light sources provides improved colour over the narrower spectrum light sources.

Table 3: Colour Rendering for the Various Lamp Types

Lamp Type	Source Appearance	Colour Rendering
Fluorescent	Cool white	Excellent
High Pressure Sodium	Orange yellow	Fair
LED	Cool white / Warm White	Excellent
Mercury Vapour	Blue/white	Good

Metal Halide	White	Excellent

The intended application of the light source can assist with determining the type of lamp used e.g. high-pressure sodium is adequate for carriageway lighting and continue to be used because of its efficiency in terms of power consumption. However, in areas where prestige and security are paramount e.g. shopping precincts, metal halide or compact fluorescent may be more appropriate.

4.3.10 Luminance / Illuminance Design

Luminance is the measure of surface brightness and is used primarily for the design of straight sections of major carriageways.

Illuminance is the measure of luminous flux falling on a surface and is used in the design of intersections, conflict points.

Figure 9 shows a section of a typical lighting design with the application of luminance and illuminance designs highlighted.

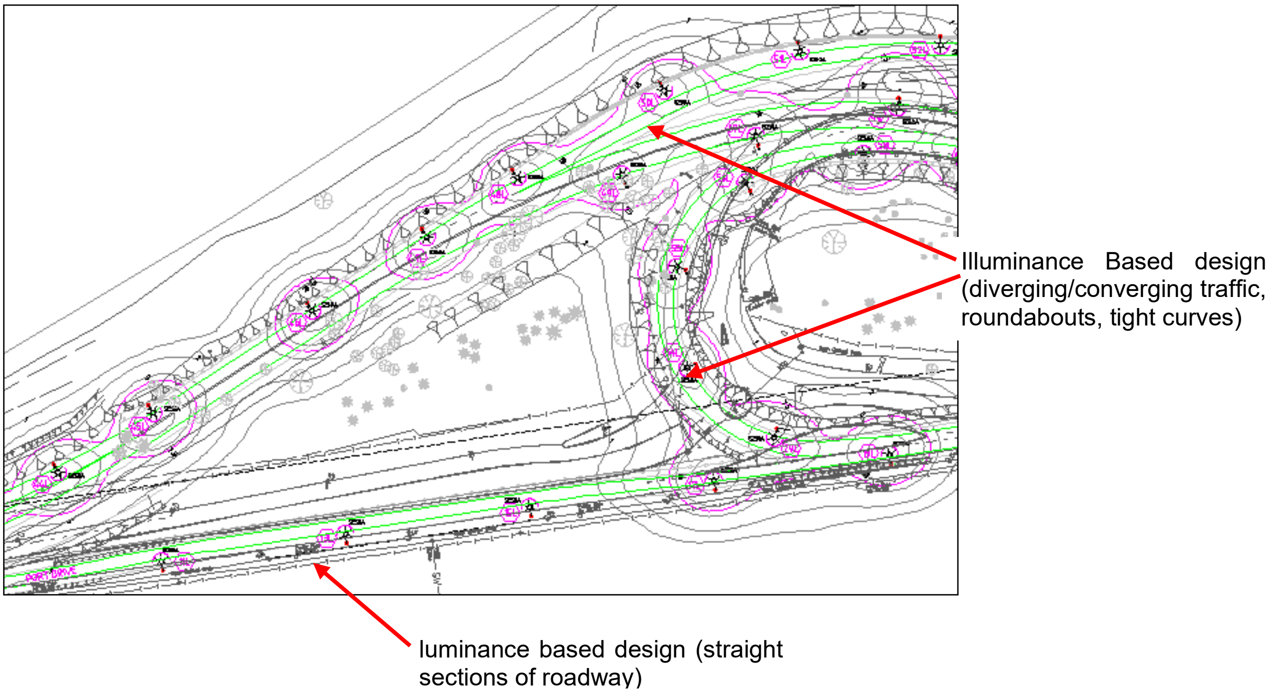


Figure 9: Typical Luminance and Illuminance Lighting design

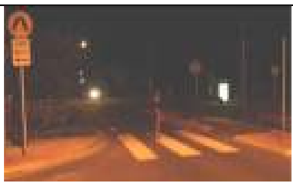
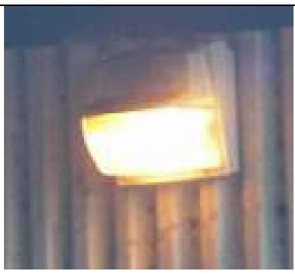
4.4 Lighting Standards and Categories

4.4.1 Categories of Public Lighting Design

AS/NZS 1158 series contain the detailed design processes for a range of lighting design applications.

The four key design categories are shown in Table 4.

Table 4: *AS/NZS1158* Public Lighting Categories

Category	Typical Example	Applications
		Non *AS/NZS1158* Private roadways, existing rural roadways
V		*AS/NZS1158 Part 1.1* Used for high traffic volume roadways where the requirement of motorists is dominant. Includes provision for motorways, arterial and sub arterial and main roads, speed zoning, on/off ramps, interacting carriageways, underbridges and areas accompanied by high pedestrian volumes. As a secondary consideration, the lighting assists pedestrians walking along the verges of the road.
P		*AS/NZS1158 Part 3.1* Used for low volume traffic roadways and other outdoor public spaces where the requirement of pedestrians is dominant. It is applicable to pedestrian pathways, cycleway, external car parks, outdoor shopping precincts, malls, town squares, transport interchanges, subways, footbridges, ramps and stairways where lighting for pedestrians is the main consideration. As a secondary consideration, the lighting assists drivers of vehicles to identify kerbs, intersections and other key features across the whole of the roadway.
PX		*AS/NZS1158 Part 4* Used for Zebra crossings unless otherwise specified by the Public Body. Floodlighting is to provide illumination in the vertical plane so that the person is contrasted against the background. Within Category PX, there are three subcategories.
Underpass		AS/NZS 1158 Part 5 Used for both traffic and pedestrian underpasses, tunnels where the lighting is fixed directly to walls.

4.4.2 Subcategories of Category V and P Public Lighting

Figure 2.1 of AS/NZS 1158.3.1 shows typical applications for the various categories and subcategories of lighting.

Whilst there are five category V lighting standards identified in the AS/ZNS 1158 series, only two are utilised by the Queensland DNSPs. They are identified in Table 5.

Table 5: Subcategories of Category V Lighting utilised by Queensland DNSPs

Sub Section	Typical Example	Application
V3		Applied for highways and major arterial roads that carry high through traffic volume with no access for traffic between interchanges
V5		For sub arterial or principle roads that predominantly carry moderate to low speed through traffic from one region to another

There are 19 subcategories for Category P identified in the AS/ZNS 1158 series; nine are utilised by the Queensland DNSPs. They are identified in Table 6.

Table 6: Subcategories of Category P Lighting utilised by Queensland DNSPs

Sub Section	Typical Example	Application
PR3 - 4		Local collection roads used for accessing abutting properties and common areas, pedestrian path and cycle ways.
PR6		Local roads used for accessing abutting properties and common areas
PA1 - 3		Outdoor shopping precincts, malls, open arcades, town squares, civic centres , transport terminals and interchanges
PE2		Stairs and ramps
PC1-3		Public car park spaces, aisles, circulation roadways. There are three sub categories for this category.
PCD		Designated parking spaces specifically intended for people with disabilities

4.4.3 Pedestrian Underpasses

Lighting at the approach and through the underpass must be such that the pedestrian can see clearly into the underpass during the day and night. This will provide good visual identification of any hazards through the underpass.

4.4.4 Pedestrian Crossings

The principal objectives in the lighting of pedestrian (zebra) crossings are as follows:

- Provide advanced warning to motorists of the presence of the crossing, associated signs and markings
- Provide enhanced pedestrian visibility by direct illumination of the pedestrian contrasted against the background.

The lighting scheme will involve the use of both vertical and horizontal illuminance over the designated area.

The three subcategories of Category PX lighting identified in *AS/ZNS 1158* series are given in Table 7.

Table 7: Subcategories of Category PX Lighting

Sub Category	Description
PX1	Local or arterial roads with speeds equal to or greater than posted speed of 60kph
PX2	Local or arterial roads with speeds equal to or less than posted speed of 50kph
PX3	Local roads

4.4.5 Technical Parameters relevant to each Lighting Category

Table 8 shows the key lighting technical parameters, their symbols, units relevant to a lighting category.

Table 8: Lighting Technical Parameters

Term	Symbol	Category
Luminance	$\bar{L}$ (cd/m^2)	V
Illuminance	Eh (lx)	V, P, PX
	Ev (lx)	V, P, PX
Uniformity	UO	V
	U_L	V
	U_{E1}	V
	U_{E2}	P

The design light technical parameters are specified in the *AS/NZS1158* series to ensure adequate levels of lighting within the roadway for a specified maintenance cycle.

4.4.6 Typical Luminaires used for Different Categories

Historically different luminaire types where used depending on the category of lighting. Table 9 show the historical typical luminaires used by application.

These technologies are being phased out or no longer available and have been replaced by LED luminaires. LED luminaires are suitable for all applications.

Table 9: Historical Luminaire Application

Luminaire	Application
Mercury Vapour	Category P (previously used on URD estates, cycleway etc)
Compact Fluorescent Lamps	Category P (primarily URD estates, cycleway etc)
Linear Fluorescent Lamps	Category P (primarily industrial areas)
High Pressure Sodium	Category V and PX
Metal Halide	Special pedestrian precincts, car parks, CCTV covered areas, CBD areas, areas of high prestige and areas having civic displays. It is not intended to use these lamps for pedestrian crossings.

4.5 Ownership, Responsibilities, and Rates

Lighting is provided under a number of DNSP funding arrangement schemes which allow for the installation of standard and nonstandard lighting. The funding arrangements vary allowing for differences in ownership and payment structures of the lighting.

The Standard Conditions Provision for Public Lighting Services contains the details relating to the ownership, responsibilities and rates. Table 10 shows the basic requirements and responsibilities in relation to the three funding categories available.

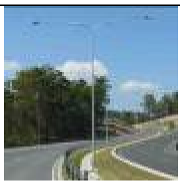
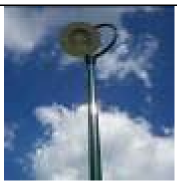
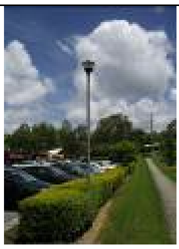
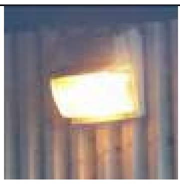
Table 10: Basic Requirements and Responsibilities for Public Lighting Schemes

Rate	Maintenance Responsibility	Initial Cost	Hardware	Typical Use
1	DNSP	Up front by DNSP. Recovered over time	Standard only	Older existing streetlights
2	DNSP	Up front by developer	Standard only	• New estates • Some DTMR
3	Public Body	Up front by developer	Standard or non-standard Cabling to *AS/NZS3000*	• DTMR where maintenance access is difficult • Decorative special • Tollways

4.6 Lighting Styles

4.6.1 Standard, Decorative, Post Top, High Mast, Bulkhead

Table 11: Lighting styles available

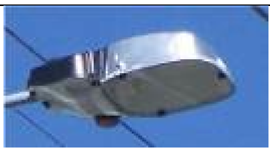
Light	Typical Example	Application
Standard		This is the most common streetlight column. It may support single, or multiple outreaches and luminaires. Generally steel columns and outreaches (Ergon Energy used concrete in certain circumstances).
Decorative		There is a variety of decorative lighting arrangements available for use in underground estates and roadways. These are more stylish column and luminaire combinations and are used to improve the prestige of an area. They are generally used for category P lighting arrangements. However, they have some category V lighting applications.
Post Top		(Obsolete) Post top lighting were used to provide general lighting for an area e.g. car parks, cycle or walk ways. They are used for category P lighting only. They can present problems with glare.
High Mast		The high mast column is taller than the standard streetlighting column and can have a number of luminaires attached to a headframe. They are used for Category V and P applications. They are utilised for centre roundabouts, car parks and complex intersections where central light dispersal can be achieved.
Bulkhead		Used in vehicular and pedestrian underpasses and tunnels where it is not possible to install conventional lighting arrangements but is convenient to attach the luminaires directly to the walls.

4.6.2 Luminaires

Luminaires used for streetlights are designed to disperse the light along the length of the carriageway rather than into adjacent properties, achieving a typical dispersion pattern as illustrated in Figure 4. The luminaries have sophisticated optics (reflectors and refractors) to achieve this.

Table 12 shows the two types of luminaires indicating their application.

Table 12: Typical Luminaire Types

Type	Typical Example	Application
Semi Cut Off (SCO)		Were the most commonly (for HID Technology) used for road lighting. For LED technology used for Flag Lighting.
Aeroscreen (cut off)		Aeroscreen luminaires are most commonly used for road lighting. in areas where spill light is to be reduced to a minimum because of legislative requirements e.g. restrictions with spill light in the vicinity of airports, to reduce intrusive lighting (residential properties abutting major roads), to reduce glare where the background is normally dark e.g. bridges, flyovers, overpasses, railway crossings to comply with certain Public Body requirements.

4.6.3 Lamps

Lamps have largely been replaced by LED luminaires with integrated LED chip.

Table 13 shows the historical range of the common lamps used by the DNSPs in Queensland. No new installations utilising these lamps will be accepted, some lamp types are retained for maintenance activities.

Table 13: Historical Lamps used by Queensland DNSPs

Lamp Type	Common Ratings	Comments
High Pressure Sodium	70, 100, 150,250, 400	Most cost-effective light source due to high efficiency, high lumen maintenance, long life
Metal Halide	70, 100, 150, 250, 400	Not favoured on overall economic grounds but used in precinct and pedestrian lighting with quartz lamps being replaced by ceramic arc.
Compact Fluorescent Lamps	32	Used on minor roads in residential areas
Linear Fluorescent Lamps	2 x 14, 2 x 24	Used on minor roads in industrial areas
Mercury Vapour	50, 80	Used on minor roads in residential estates.
Low Pressure Sodium	35, 55, 90	Used in coastal areas where other lamps could confuse marine animals.

4.6.4 Minor and Major Road Hardware

Spigots are utilised to ensure the variety of luminaires, outreaches and columns can be assembled to suit the design. Different spigot sizes tend to be used for minor road lights than for major road lights. It is important to ensure that the columns, outreaches/brackets and luminaires are compatible. This ensures the acquisition of the correct materials for construction.

Major and minor road luminaires can be fitted to the alternative columns using adaptors.

Figure 11 shows the range of spigot sizes available for major and minor road lighting.

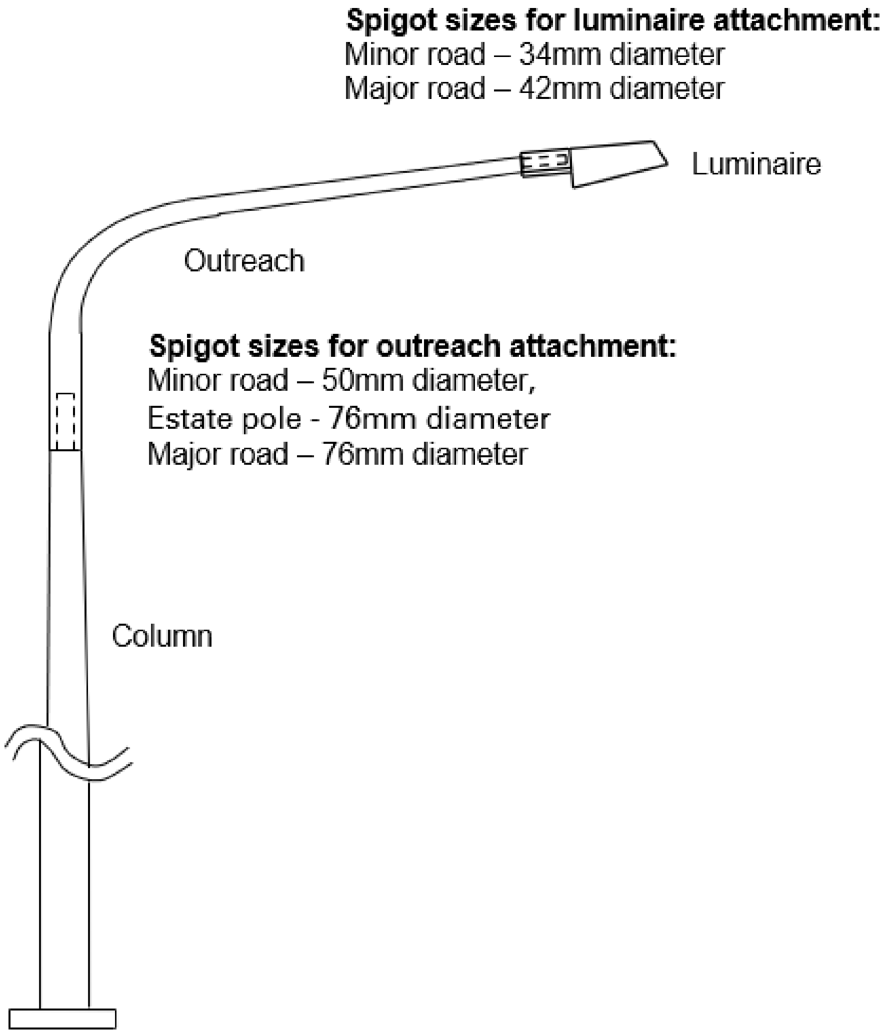


Figure 11: Range of Spigot Sizes for Major and Minor Road Lighting

4.7 Lighting Arrangements

Figure 12 shows the typical lighting arrangements used by DNSPs in Queensland.

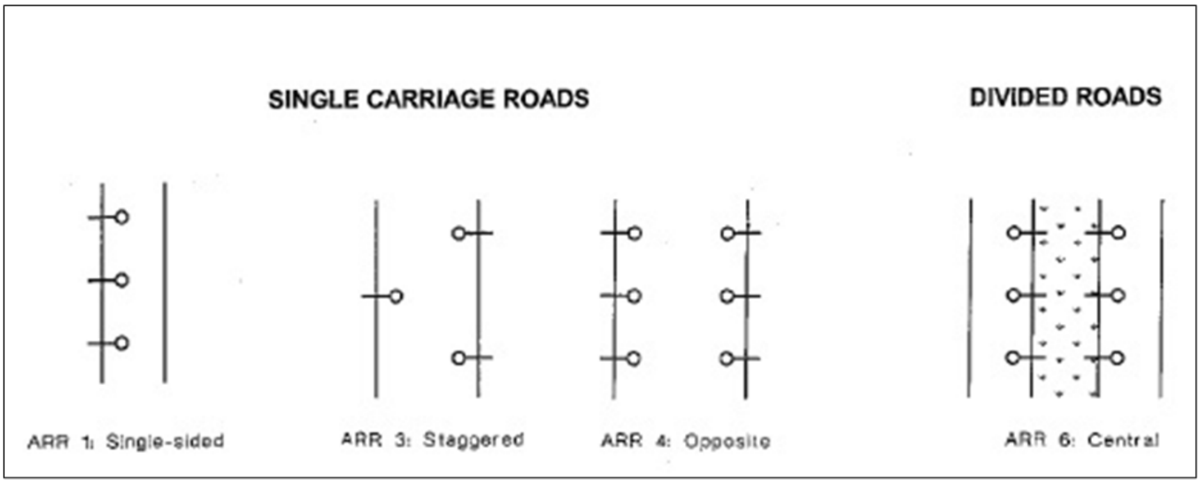


Figure 12: Typical Arrangements used for Public Lighting

When considering the arrangement to be used, the following can be used as a guide:

- For minor roads and narrow major roads, arrangements 1 and 3 are commonly used.
- For wide major roads, arrangement 4 would be commonly used.
- For roads where there is a centre median strip or centre barrier, arrangement 6 would be commonly used.

5 Standard Hardware

5.1 Luminaires

There are a range of luminaires used by the DNSPs in Queensland. Details can be found in The Public Lighting Construction Manual and the Standard Conditions for Public Lighting Services.

5.1.1 Preferred and Minimum Mounting Heights

As a general rule, the brighter the luminaire, the higher it should be mounted. If it is mounted too low, there will be an intensely bright patch immediately below, but poor dispersion of the light further afield. Conversely, if the luminaire is mounted too high, the light will disperse too widely and the effectiveness will be lost.

Note that if the column is setback on a sloping bank adjacent to the carriageway, due allowance needs to be made for the altered mounting height.

Table 14: Preferred and Minimum Mounting Height for Standard Luminaires

Luminaire Wattage	Type of Road	Preferred mounting Height (m)	Minimum Mounting Height (M)
L14, L14A, L14A 3K	Minor	7.5	5.0
L24A, L24A 3K	Minor	7.5	5.5
L25A 2K	Minor	7.5	5.5

L40A	Major	9.0	7.5
L37A	Major	9.0	7.5
L60A	Major	10.5	9.0
L67A	Major	10.5	9.0
L113A	Major	10.5	9.0
L138A	Major	12.0	10.0
L204A	Major	15.0	12.0
L220A	Major	15.0	12.0
L38 3K	Major	9.0	7.5
L61A 3K	Major	10.5	9.0
L70A 3K	Major	10.5	9.0
L113A 3K	Major	10.5	9.0
L143A 3K	Major	15.0	12.0
L210A 3K	Major	15.0	12.0

L = LED

Table 15: Typical Mounting Height for Historic Standard Luminaires

Luminaire Type/Wattage	Type of Road	Energex		Ergon Energy	
		Preferred Mounting Height (m)	Minimum Mounting Height (m)	Preferred Mounting Height (m)	Minimum Mounting Height (m)
CFL32	Minor	7.5	5.5	7.5	5.5
2 x LF14	Minor	7.5	5.5	7.5	5.5
2 x LF24	Minor	7.5	5.5	7.5	5.5
M50	Minor	6.5	5.0	7.5	5.5
M80	Minor	6.5	5.5	7.5	5.5
S70	Minor	7.5	5.5	7.5	5.5
S100	Major	9.0	7.5	9.0	7.5
S150	Major	10.5	9.0	10.5	9.0
S250	Major	12.0	10.0	10.5	10.5
S400	Major	15.0	12.0	12.0/15.0	12.0

CFL = Compact Fluorescent | LF = Linear Fluorescent | S = High Pressure Sodium | M = Mercury Vapour

Table 16: Typical Mounting Height for Decorative Luminaires

Luminaire Wattage	Lighting Style	Type of Pole	Nominal Mounting Height[1] (m)
L14, L18	Nostalgia Type 1	Nostalgia	5.1
L14, L18	Nostalgia Type 2	Nostalgia	5.1

L = LED

Table 17: Typical Mounting Height for Historic Decorative Luminaires

Luminaire Type/Wattage	Lighting Style	Type of Pole	Nominal Mounting Height (to Photometric Centre of Fixture)	
			Energex (m)	Ergon Energy (m)
CFL32, M50, M80 S70	Nostalgia Type 1	Nostalgia	5.1	5.1
CFL32, M50, M80, S70	Nostalgia Type 2	Nostalgia	5.1	5.1
M50, M80, S70	Post Top	Estate	4.8	-
M50, M80, S70	Post Top	Standard	5.8	-

CFL - Compact Fluorescent M – Mercury Vapour S – High Pressure Sodium

[1] To Photometric Centre of luminaire

5.1.2 Available Types including Photometric Files

Table 18: Photometric References for Existing Contract Luminaires

Type/Wattage	Manufacturer / Product	Design Lumens	I-Table No
Standard Minor Road luminaires			
L14	Sylvania Schréder StreetLED3	1,825	StreetLED3 13.7W 4K - 200375BPH
L14A	Sylvania Schréder StreetLED3	1,819	StreetLED3 13.7W 4K Aero - 200376BPH
L14A 3K	Sylvania Schréder StreetLED3 3K	1,815	StreetLED3 13.7W 3K Aero - 201052PH
L24A HO	Sylvania Schréder StreetLED3	3,448	StreetLED3 24W 4K Aero P2DG211029060-10
L24A HO 3K	Sylvania Schréder StreetLED3 3K	3,337	StreetLED3 24W 3K Aero P2DG211029061-10
L25 2K	Sylvania Schréder StreetLED3 2K	2,396	StreetLED3 25W 2.2K Aero 191206PH
Decorative Minor Road Luminaires			
L14 (Nostalgia Type 1 & Type 2)	Sylvania Schréder AVENUE GEN2	1,969	AVENUE II 4K 14W V2 210729PH
L14 3K (Nostalgia Type 1 & Type 2)	Sylvania Schréder AVENUE GEN2 3K	1,962	AVENUE II 3K 14W V2 210732PH
L18 (Nostalgia Type 1 & Type 2)	Sylvania Schréder AVENUE GEN2	2,523	AVENUE II 4K 18W V2 210730PH
L18 3K (Nostalgia Type 1 & Type 2)	Sylvania Schréder AVENUE GEN2 3K	2,522	AVENUE II 3K 18W V2 210731PH
Refer to Public Lighting Construction Manual for available range of colours			
Standard Major Road Luminaires			
L40A	Connected Light Solutions Evolve Leopard	5,987	CLS Leopard IES file 25-8-21
L37A	Philips RoadFlair	6,053	BRP392 LED60NW 37W 220-240V DWV
L60A	Philips RoadFlair	9,680	BRP392 LED96NW 60W 220-240V DWV
L67A	Philips RoadFlair	10,838	BRP392 LED108NW 67W 220-240V DWV
L113A	Philips RoadFlair	16,179	BRP392 LED161NW 113W 220-240V DWV
L138A	Philips RoadFlair	20,417	BRP393 LED204NW 138W 220-240V DWV
L204A	Philips RoadFlair	28,867	BRP393 LED288NW 204W 220-240V DWV
L220A	Philips RoadFlair	32,400	BRP394 LED324NW 220W 220-240V DWV
L38A 3K	Philips RoadFlair 3K	6,058	BRP392 LED60WW 38W 220-240V DWV

Type/Wattage	Manufacturer / Product	Design Lumens	I-Table No
L61A 3K	Philips RoadFlair 3K	9,636	BRP392 LED96WW 61W 220-240V DWV
L70A 3K	Philips RoadFlair 3K	10,850	BRP392 LED108WW 70W 220-240V DWV
L113A 3K	Philips RoadFlair 3K	16,179	BRP392 LED161WW 113W 220-240V DWV
L143A 3K	Philips RoadFlair 3K	20,450	BRP393 LED204WW 143W 220-240V DWV
L210A 3K	Philips RoadFlair 3K	28,895	BRP393 LED288WW 210W 220-240V DWV
L100H	Sylvania Schréder / RoadLED	12,600	RoadLED HM 100W 4K AERO 180722PH
L175H	Sylvania Schréder / RoadLED	21,400	RoadLED HM 175W 4K AERO 180723PH
L300H	Sylvania Schréder / RoadLED	35,300	RoadLED HM 300W 4K AERO 180721PH
Standard Pedestrian Crossing Floodlighting Luminaires			
L100	Philips Tango G4	13,400	BVP431 LED134 NW 220~240V 100W AMB GM
L200	Philips Tango G4	27,206	BVP432 LED271 NW 220~240V 200W AMB GM
L200 3K	Philips Tango G4 3K	25,200	BVP432 LED252 WW 220-240V 200W AMB GM

A – Aeroscreen H – HighMast HO – High Output L - LED

Table 19: Photometric References for Obsolescent Luminaires

Type / Wattage	Manufacture	Design Lumens	I-Table No.
Standard Minor Road Luminaires			
M50D*	Sylvania Urban	1,800	95642.cie
M50D*	Sylvania Suburban	1,800	204004A.cie
M50D^	Sylvania Urban	1,800	201076.cie
M50DA	Sylvania Urban Aero	1,800	95638.cie
M80D*	Sylvania Urban	3,650	95626.cie
M80D*	Sylvania Suburban	3,700	203276.cie
M80D^	Sylvania Urban	3,700	201045.cie
M80DA	Sylvania Urban Aero	3,700	95635.cie
S70D*	Sylvania Urban	5,600	95627.cie
M50*	Bega	1,800	BE1083.ies
CFL32D	Sylvania Suburban ECO*	2400	206243.cie
CFL32D	Sylvania Urban Aero ECO	2400	207270.cie

Type / Wattage	Manufacture	Design Lumens	I-Table No.
2xLF14*	Pierlite Greenstreet GS214	2 x 1200	GS214T5.cie
2xLF24	Pierlite Greenstreet GS224	2 x 1750	GS224T5.cie
S70D	Sylvania Suburban	5,600	203352.cie
S70DA	Sylvania Urban Aero	5,600	95633.cie
H35*	Sylvania Suburban		211096.cie
H35A*	Sylvania Urban		201307A.cie
H70	Sylvania Suburban	7,700	213180.cie
H70A	Sylvania Urban	7,700	201307A.cie
Decorative Minor Road Luminaires			
M50D (PT)*	Sylvania B2001	1,800	96224.cie
M80D (PT)*	Sylvania B2001	3,650	96232.cie
M50D (Nostalgia type 1)	Sylvania B2223 Nostalgia M50D	1,800	95677.cie
M50D (Nostalgia type 2)	Sylvania B2223 Avenue M50D	1,800	95677.cie
M80D (Nostalgia type 1)	Sylvania B2223 Nostalgia M80D	3,700	95650.cie
M80D (Nostalgia type 2)	Sylvania B2223 Avenue M80D	3,700	95650.cie
M50D Bourke Hill (B/G)*	Sylvania Bourke Hill M50D	1,800	8969.cie
M80D Bourke Hill (B/G)*	Sylvania Bourke Hill M80D	3,650	71642B.cie
S70D Bourke Hill (B/G)*	Sylvania Bourke Hill S70D	5,600	71642.cie
CFL32D (Nostalgia type 1)	Sylvania B2223 Nostalgia CFL32D	2400	209078.cie
CFL32D (Nostalgia type 2)	Sylvania B2223 Avenue CFL32D	2400	209078.cie
S70D (Nostalgia type 1)	Sylvania B2223 Nostalgia S70D	5,600	95675.cie
S70D (Nostalgia type 2)	Sylvania B2223 Avenue S70D	5,600	95675.cie
Standard & High Mast Major Road Luminaires			
S100C	Sylvania Roadster S100C	10,000	98262.cie
S150C	Sylvania Roadster S150C	14,500	98207.cie
S250C	Sylvania Roadster S250C	27,500	98100.cie
S400C	Sylvania Roadster S400C	48,000	98382.cie
S100CA	Sylvania Roadster S100CA	10,000	98385.cie
S150CA	Sylvania Roadster S150CA	14,500	98321.cie
S250CA	Sylvania Roadster S250CA	27,500	98318.cie
S400CA	Sylvania Roadster S400CA	48,000	98379.cie
H100C	Sylvania Roadster H100C	10,000	21377.cie
H150C	Sylvania Roadster H150C	14,700	213178.cie

Type / Wattage	Manufacture	Design Lumens	I-Table No.
H250C	Sylvania Roadster H250C	TBA	213179.cie
H400C	Sylvania Roadster H400C	TBA	TBA
H100CA	Sylvania Roadster H100CA	10,000	213325.cie
H150CA	Sylvania Roadster H150CA	14,700	213326.cie
H250CA	Sylvania Roadster H250CA	TBA	213327.cie
H400CA	Sylvania Roadster H400CA	TBA	201023.cie
S150CH*	Sylvania HI MAST*	14,500	L173.cie#
S250CH*	Sylvania HI MAST*	27,500	L172.cie#
S400CH*	Sylvania HI MAST*	48,000	L66.cie#
Standard Pedestrian Crossing Floodlighting Luminaires			
S250WL	Phillips HNF901 Puma wide beam + louvre	27,500	INR9023.iesna
S250NL	Phillips HNF901 Puma narrow beam + louvre	27,500	INR9011.iesna
S400WL	Phillips HNF901 Puma wide beam + louvre	48,000	INR9019.iesna
S400NL	Phillips HNF901 Puma narrow beam + louvre	48,000	INR9007.iesna
Standard Bulkhead Luminaires			
CFL32	Bega	2400	TBA - Energex
S70*	Bega	5,600	BE1084.ies
S150*	Tomkat	14,500	33264.ies

D – Diffuse PT – Post top B/G – Blue/grey * - Used by Energex only ^ - used by Ergon only

5.1.3 Wattage / Current – Starting and Running Current

Table 20: Starting and Running Currents – Existing Contract

Luminaire	Inrush Current (amps)	Running Current (amps)	Power factor
Minor Road - Standard Range			
L14	40.4	0.06	> 0.9
L24	40.4	0.1	> 0.9
L25	40.4	0.06	> 0.9
Minor Road – Nostalgia			
L14	40	0.058	0.94
L18	40	0.077	0.93
Minor Road - Post Top			
L17	40	0.08	0.86
L28	40	0.119	0.93
Major Road - Standard Range			
L37	46	0.16	> 0.95
L38			
L40	74.4	0.1771	0.95
L60	46	0.25	> 0.95
L61	46	0.26	> 0.95
L67	46	0.28	> 0.95
L70	46	0.29	> 0.95
L113	53	0.47	> 0.95
L138	53	0.58	> 0.95
L143	53	0.6	> 0.95
L204	106	0.85	> 0.95
L210	106	0.88	> 0.95
L220	106	0.92	> 0.95
Major Road – High Mast			
L100	41	0.42	≥ 0.9
L175	45	0.76	≥ 0.9
L300	49.6	1.39	≥ 0.9

L – LED

Table 21: Starting and Running Currents – Obsolescent Luminaires

Luminaire	Starting Current (amps)	Running Current (amps)	Power factor
CF32	0.15	0.15	>0.95
M50	0.35	0.27	0.9
F1x18	0.4	0.37	0.3
F2 x 14	0.15	0.15	>0.95
F2 x 18	0.52	0.41	0.48
F4 x 18	1.1	0.74	0.5
F2 x 24	0.24	0.24	>0.95
F2 x 36	1.26	0.83	0.44
F3 x 36	1.9	1.29	0.44
F4 x 36	2.5	1.73	0.44
H35	0.2	0.2	>0.95
H70	0.48	0.38	>0.95
H100	0.67	0.51	0.9
H150	0.97	0.75	0.9
H250	1.57	1.23	0.9
H400	2.48	1.94	0.9
M50(old)	0.76	0.61	0.43
M80	0.57	0.41	0.9
M80(old)	1.11	0.8	0.47
M125	1.66	1.15	0.5
M250	3.15	2.13	0.53
M400	6.0	3.25	0.53
M700	9.0	5.4	0.57
S50	0.86	0.76	0.34
S70	0.48	0.38	0.9
S70 (old)	1.4	0.93	0.36
S100	0.68	0.52	0.9
S100 (old)	1.5	1.2	0.4
S150	0.97	0.75	0.9
S150 (old)	2.21	1.8	0.39
S250	1.57	1.23	0.9
S250 (old)	3.8	3.0	0.38
S400	2.48	1.94	0.9
S400 (old)	5.9	4.6	0.4

CF - Compact Fluorescent F - Fluorescent Light H – Metal Halide M - Mercury vapour S – High pressure sodium

5.2 Columns

5.2.1 Summary of Available Types

Table 22 and Table 23 show the range of available columns for minor and major roads. Further details can be found in The Public Lighting Construction Manual and the Standard Conditions for Public Lighting Services.

Table 22: Streetlight Columns (Minor Roads)

Type	Description	Pole Type	Colour	Outreach Arm Combinations	Luminaire
BPM	5.5m steel (3 bolt base plate – 187 PCD)# (4 bolt base plate – 350 PCD)	Minor Road BPM	Galvanised	1.5m single & double outreach arms Post top adaptor^	Nostalgia may be fitted to poles with 50 x 300mm spigot by using an adaptor* (applies to 5.5m pole only)
	6.5m steel (3 bolt base plate – 187 PCD)# (4 bolt base plate – 350 PCD)			Integral 0.5m bracket*	Standard Minor road normal L14 (non-preferred) Standard road Aeroscreen L14A & L24A HO
	4.5m Estate steel (350 PCD)		Green	Single or twin*	Decorative luminaires L14 & L18
	4.5m Estate steel (– 350 PCD)		Blue/Grey		
	4.5m Estate steel (350 PCD)		Navy		
	4.5m Estate steel (350 PCD)		Black		
	5m steel (350 PCD)	Minor road* mid-hinged (right) w/-hinged base plate	Galvanised	Integral outreach	L14A & L24A HO
	5m steel (350 PCD)		Green		
	5m steel (350 PCD)		Black		
	5m steel (350 PCD)		Blue/Grey		
	5m steel (350 PCD)	Minor road* mid-hinged (left) w/-hinged base plate	Galvanised	Integral outreach	L14A & L24A HO

BPM – Base Plate Mounted SBM – Slip Base Mounted PCD – Pitch Circle Diameter

Right hinged poles are standard and hinge in the direction of the traffic flow. Left hinging poles are a special nonstock item.

* - Energex only

- Three bolt base plate columns are obsolete – maintenance spares only.

^ - Pole spigot adaptors (for galvanised, green and black poles) can be used to convert 50mm diameter pole spigot to 75mm diameter, so as to accept Nostalgia fixtures.

Table 23: Streetlight Columns (Major Roads)

Type	Description	Pole Type	Colour	Outreach Arm Combinations	Luminaire
BPM	7m steel (350 PCD)	Rigid	Galvanised	1.5m single & double 3m single & double 1.5m extension arm	Standard road lighting luminaires for normal, Aeroscreen applications including: S100, S150, S250, S400, H100, H150, H250, H400
	8.5m steel (350 PCD)				
	10m steel (350 PCD)				
	13m steel (500 PCD)				
SBM	7m steel (350 PCD)	Slip base			
	8.5m steel (350 PCD)				
	10m steel (350 PCD)				
	13m steel (500 PCD)				
SBM	Slip base adaptor for up to 10m pole - for M24 bolts (350 PCD)	Slip base			
	Slip base adaptor for 13m pole - for M24 bolts (500 PCD)				
BIG & BPM	Spider head frame 3 way & 4 way	Rigid^		1.5m & 3m	Standard road lighting luminaires
BPM	10m steel (350 PCD)	Rigid or mid hinged*		High mast headframe 1 way, 2 way, 3 way, 4 way	L100H, L175H & L300H
	13m steel (500 PCD)				

BPM – Base Plate Mounted SBM – Slip Base Mounted PCD – Pitch Circle Diameter

* Energex only (intended for high mast applications only) ^ Ergon Energy only

5.2.2 Standard and Decorative

Standard columns are used for all categories of lighting. They may be manufactured from metal, concrete or even composite fibre materials. They are generally straight sided with continuously tapering shape towards the top. The cross section may be circular or polygonal.

Decorative columns are designed to provide a more aesthetic presentation for areas where prestige is a key consideration. They are generally utilised in category P areas e.g. residential estates, precincts where the developer requires a more attractive scheme. The columns (and outreaches) are usually made from metal and may have a distinctive non-linear shape.

5.2.3 Fixed Base/Slip Base

Fixed base infers BPM poles where the pole is securely fixed at the base flange of the pole to the rag bolt foundation.

Slip base infers SBM poles where the base plate of the pole is attached to an adaptor plate (via shear washer) which in turn is securely fastened to the rag bolt footing. The pole can easily break away from the adaptor at the top shear plane under low down lateral vehicle impact within close proximity of the shear washer.

5.2.4 Columns behind Barriers

Metal barricades can be installed on major roadways to provide protection for motorists and pedestrians from errant vehicles that may leave the carriageway e.g. cross median strips and centre lines or mount kerbs.

Public lighting columns may be placed behind these barricades further reducing safety hazards to motorists. In these situations, BPM pole footing can be utilised where SBM footings may ordinarily have been required. Generally columns are to be located at least 1m behind any barricade.

5.2.5 Hinged Poles

Hinged poles are utilised where the normal maintenance vehicles cannot access the site to perform standard maintenance activities e.g. lamp changes. The poor access may be due to the presence of barricades, sloping ground, narrow laneways or pedestrian pathways and safety issues relating to access from busy high-speed roadways etc.

5.2.6 Joint Use Columns

In consideration of safety and economy, it may be appropriate to use joint-use columns e.g. public lighting and traffic management.

Used at intersections to reduce the number of columns.

In these situations, separate panels for electrical supply will be required (two sources of supply). However, there will be a common MEN earth for both installations.

5.2.7 Footings

Freestanding public lighting columns are supported using specific foundations and footings.

The pole footings are selected based on the physical characteristics and constraints of the location, Public Body policy and the usage of the roadway by vehicular and pedestrian traffic.

Table 24 shows the two types of footings used for public lighting poles.

Table 24: Pole Footing Types and Applications

Pole Footings	Typical Example	Application
BPM (Base Plate Mounted)		These employ a rag bolt assembly set in concrete, to which the base plate of the column is attached. Less prone to corrosion. Easily replaced if damaged. Used in areas where there is a minimal risk of vehicle impact or in areas where there is a high pedestrian activity. Electricity supply from pillar, pit or overhead service.

Pole Footings	Typical Example	Application
SBM (Slip Base Mounted)		Pole bolted to rag bolt assembly via a slip base adaptor. Used in more hazardous locations e.g. higher speed arterial roads, unprotected median strips. Designed to shear off on vehicular impact while at the same time disconnecting the electrical supply using a plug and socket arrangement. Electricity supply from local underground pit and junction box.

5.2.8 Foundations

The foundations are designed to resist the resultant overturning force of 1kN (applied by wind loads, attached cable tensions etc) taking into account the bearing pressures that will be resisted by the average soil conditions.

The Public Lighting Construction Manual shows the range of Base Plate Mounting and Slip Base Mounting arrangements and their reinforced concrete foundations that may be poured in-situ or pre-cast foundation structures.

For minor streetlighting, a foundation depth of 1.2m is required for single outreach streetlights and 1.5m for double outreach streetlights.

For major streetlighting, a foundation depth of 2.4m is required for all lighting constructions.

These foundations are suitable for normal soil conditions that will resist the overturning moments under full wind load and other loading conditions.

Special foundations requiring special engineering designs may be required for:

- poor soil conditions e.g. swampy and poorly drained soils
- areas where the depth is restricted due to the presence of other services etc

5.3 Outreaches

5.3.1 Summary of Available Types

Table 25 shows the range of available outreach arms. Further details can be found in The Public Lighting Construction Manual and the Standard Conditions for Public Lighting Services.

Table 25: Outreach Arms

Outreach Arm Description	**Colour**	**Pole Combinations**
Minor Road Lighting		
0.5m single steel outreach – special lane way (0.5m uplift)	Galvanised	Minor road BPM 5.5m poles
1.5m single steel outreach (2.0m uplift)	Galvanised	
1.5m double steel outreach (2.0m uplift)	Galvanised	
0.15m single steel outreach Nostalgia (0.6m uplift)	Black	Minor road 4.5m estate poles
0.15m single steel outreach Nostalgia (0.6m uplift)	Green	
0.15m single steel outreach Nostalgia (0.6m uplift)	Blue/grey	
0.15m single steel outreach Nostalgia (0.6m uplift)	Navy	
0.5m single steel outreach Avenue (0.6m uplift)	Black	
0.5m single steel outreach Avenue (0.6m uplift)	Green	
0.5m single steel outreach Avenue (0.6m uplift)	Blue/grey	
0.5m single steel outreach Avenue (0.6m uplift)	Navy	
0.5m double steel outreach Nostalgia/Avenue (0.6m uplift)	Black	
0.5m double steel outreach Nostalgia/Avenue (0.6m uplift)	Green	
0.5m double steel outreach Nostalgia/Avenue (0.6m uplift)	Blue/grey	
0.5m double steel outreach Nostalgia/Avenue (0.6m uplift)	Navy	
Major Road Lighting		
1.5m single steel outreach (2.0m uplift)	Galvanised	Major road 7m, 8.5m, 10m, 13m BPM and SBM galvanised steel 8.5m, 10.25m, 11.9m, 15.2m BIG concrete (Ergon Energy only)
1.5m double steel outreach (2.0m uplift)	Galvanised	
3.0m single steel outreach (2.0m uplift)	Galvanised	
3.0m double steel outreach (2.0m uplift)	Galvanised	
1.5m steel extension	Galvanised	
0.5m High Mast 1 way, 2-way, 3-way, 4 way (2.0m uplift)	Galvanised	10m, 13m (Energex only)
1.5m three way and four-way spider head frame (2.0m uplift)	Galvanised	7m, 8.5m, 10m BPM galvanised steel, 8.5m, 10.25m, 11.9m BIG concrete (Ergon Energy only)
3.0m three way and four-way spider head frame (2.0m uplift)	Galvanised	
Steel adaptor converter major road pole spigot to minor road	Galvanised	

5.3.2 Effect of Upcast Angle

Tilting the head of the luminaire has the effect of casting more light out in front of the installation. For Queensland DNSPs, the upcast angle is 0° above horizontal. No upcast angle is available for Nostalgia, Avenue, Bourke Hill, high mast, bulk head and category PX installations.

5.3.3 Single and Double Outreach, High Mast

Single outreach installations are typically used for constructions located along the outer edges of a carriageway.

Dual outreaches are typically used for constructions located along the centre median of a dual carriageway.

High mast installations are typically used for roundabout centre island, interchanges.

5.3.4 Underbridge Bracket

The bracket for underbridge luminaires have a unique construction because of the unusual method required for attachment. Typically, they are surface mounted either offset from directly over the carriageway or recessed between the bridge girders to protect from vehicle impact.

5.4 Wood Pole Brackets

5.4.1 Summary of Available Types

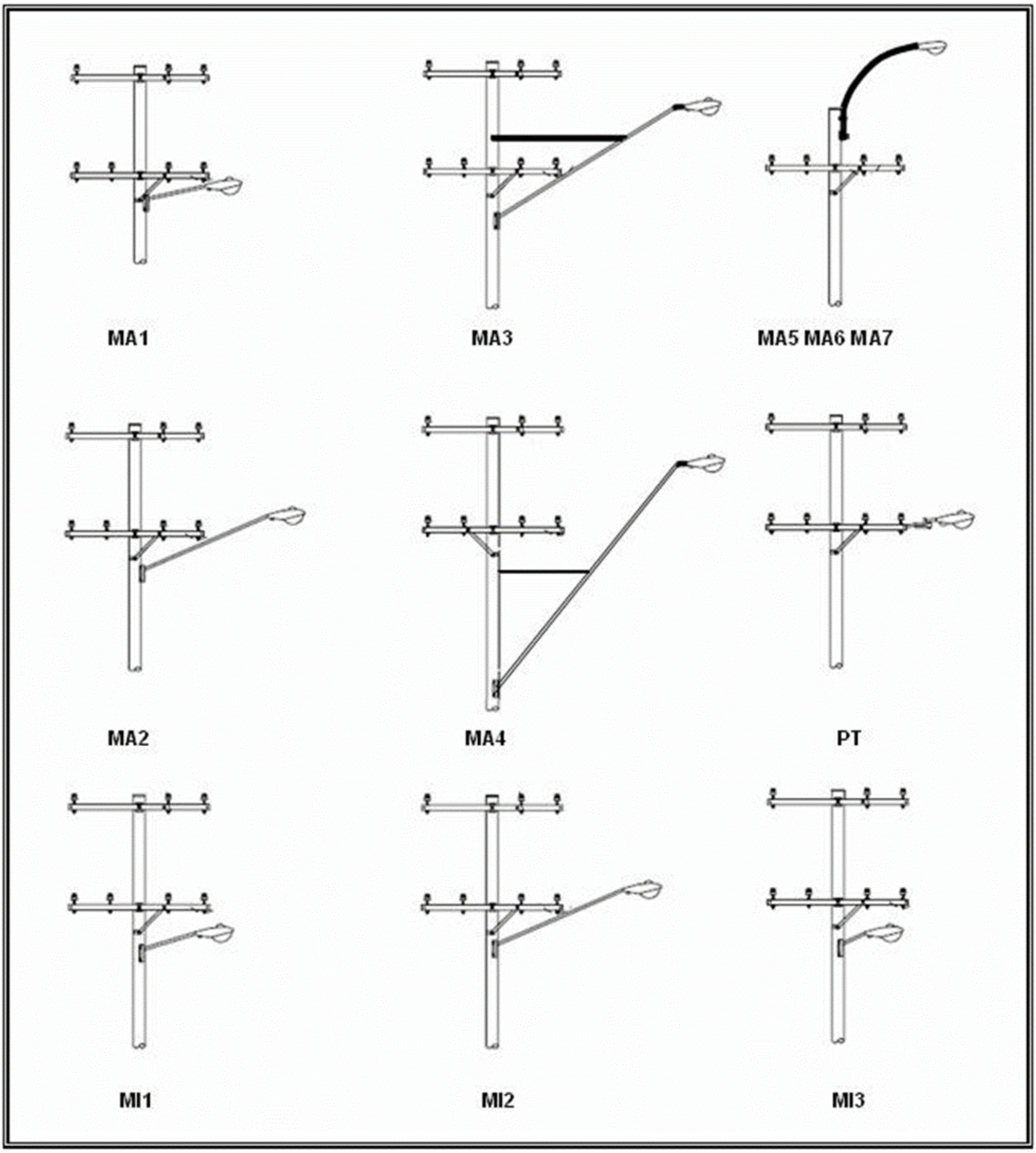


Figure 13: Range of Wood Pole Brackets

To ensure that the lighting attachment fulfils all of the requirements, the designer may need to use graph paper or scaled transparent overlays to determine the possible positions for the bracket on the pole. By moving the bracket location, the optimum position (satisfying the mounting height) can be determined with due consideration to electrical clearances of the bracket, luminaire and stays from live conductors.

This may require several iterations and will need to be undertaken for each pole where a lighting attachment is required.

Figure 14 shows the specific dimensions that must be considered when determining the attachment location on wood poles.

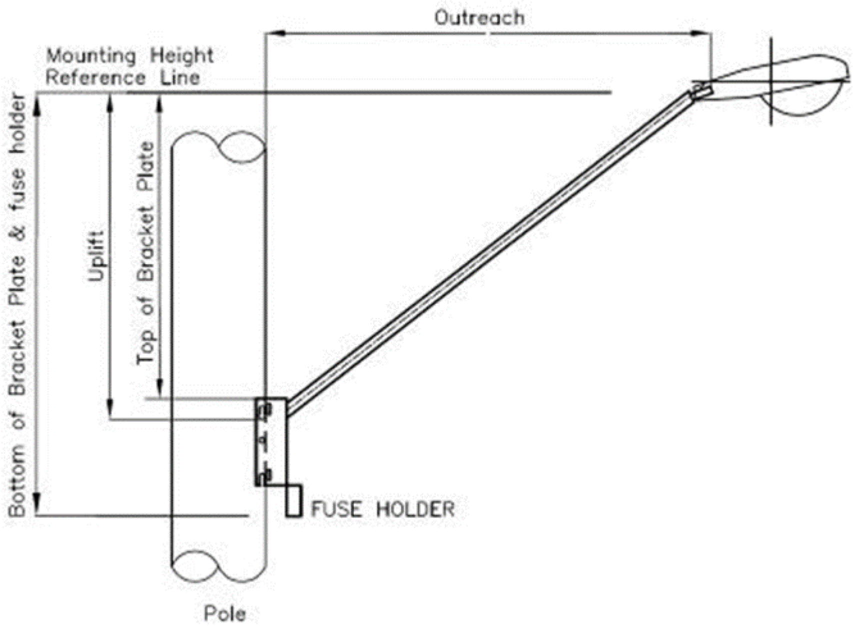


Figure 14: Pole Mounting Dimensions

Table 26 shows the recommended bracket base plate attachment dimensions (in relation to the luminaire mounting height) for the range of available brackets.

Table 26: Attachment Dimensions for Wood Pole Brackets

Bracket ID	**Application**	**Outreach (mm)**	**Uplift (mm)**	**Top of Bracket Plate (mm)**	**Bottom of plate and Fuse Holder (mm)**
MA2	Major Road	3000	1000	775	1375
MA3	Major Road	4500	2500	2345	2750
MA4	Major Road	3000	4000	3845	4245
MA5	Major Road	1500	2000	2250	2800
MA6	Major Road	3000	2000	2250	2800
MA7	Major Road	4500	2000	2250	2800
MI1	Minor Road	1200	105	-10	310
MI2	Minor Road	3000	1000	775	1375
MI3	Minor Road	500	43	5	335
PT	Minor Road Major Road	300	300	-	-

5.4.2 Stays

The MA3 and MA4 arrangements have stays that attach to the pole and provide support for the longer outreach brackets. The pole-end attachment can be attached ±500mm for MA4 and ±300mm for MA3 along the pole above or below the horizontal (the preferred attachment arrangement). This provides some flexibility for the pole attachment allowing for the diversity of distribution electricity hardware and cables/conductors that can be attached to wood poles.

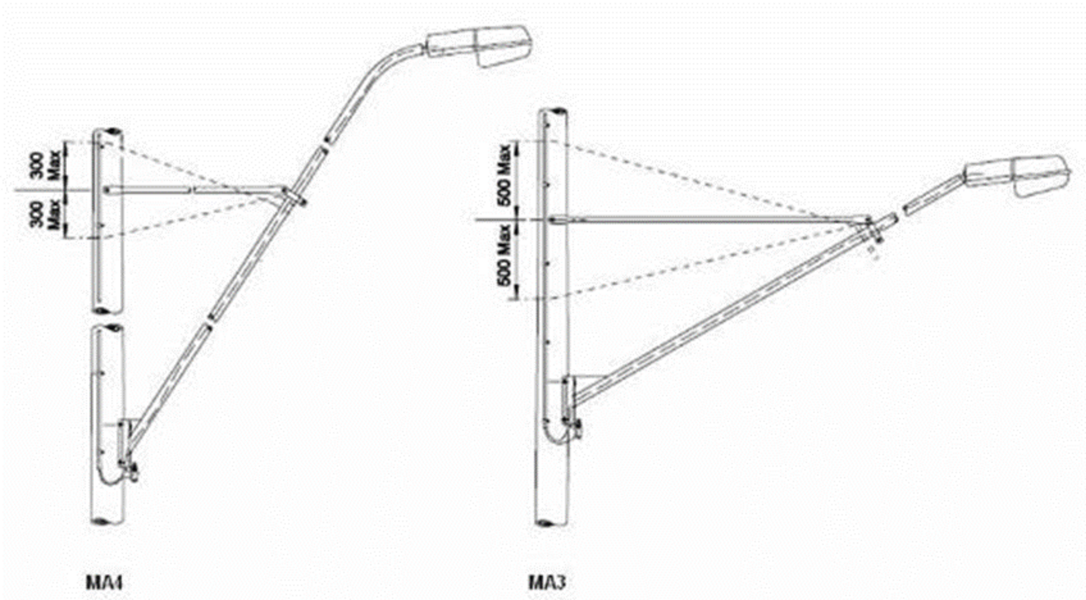


Figure 15: General Arrangement for MA3 and MA4 Wood Pole Bracket Stay

5.4.3 Maintaining Clearance from Mains

Where streetlights are to be attached to existing wood poles, adequate clearances must be maintained between the supporting metal brackets/ luminaires and HV/ LV mains attached to the same pole. Table 27 shows the required DNSP installed minimum clearances from the live overhead mains to any part of the bracket or luminaire.

Table 27: Clearances to Streetlight Brackets

DNSP	Clearance to LV Mains (mm)	Clearance to 11kV, 22kV and 33kV Mains (mm)	Clearance to 66kV Mains (mm)	Clearances to 110/132kV Mains (mm)
Ergon Energy	100	1200	1800	2400
Energex	100	1200	-	2400

Note:

1. The table applies to installations from the date of publication of this manual.
2. The clearances may be varied based on the results of a formal risk assessment.

The above clearances are adopted by Ergon Energy and Energex as part of their safe working practices and applied to installation of brackets with the mains energised.

It is possible that the bracket is to be attached to an interspan wood or metal pole. The clearance from the live overhead mains for these structures can be found in the Ergon Energy and Energex Overhead Design Manuals and Queensland Public Lighting Construction Manual.

If the clearance to the LV and/or HV mains cannot be achieved, other design solutions may be necessary e.g. repositioning the streetlight onto another pole.

6 Design Process

6.1 Triggers for Design

Because of the variety of public lighting options available, the request for design (and installation) can derive from a number of sources as follows:

- Public Body
- Developer associated with estate design, road works
- Infrastructure alliance company e.g. interfacing with toll roads, motorways

In all cases, the requesting body must provide a written application to the DNSP that may include a design brief.

6.2 Design Process Overview

Input	Activity	Output
• Design brief including intended funding arrangements • Site roadway drawings • Standard Conditions for Public Lighting Services	Consolidate the stakeholder requirements and intended funding arrangements and incorporate into the design brief	Confirmed design instructions e.g. lighting category, luminaire type/style, mounting height, nominated funding arrangements, acceptance of Electricity Distributor Standard Conditions
	Conduct site inspection to review geographical, road structure, obstructions, future maintenance issues etc and prepare base plan or map	All site-specific information recorded. Fully detailed drawing showing all relevant road features including road curves, medians, conflict points as well as distribution assets etc
• I-tables • Site data	Generate trial lighting layouts, analyse luminance/illuminance for selected hardware configuration criteria	Analysis data including isolux and/or E_h/E_v diagrams, spacing tables, curve spacing adjustments
• Luminaire mounting height • Outreach lengths • Luminaire and lamp • Tilt angle	Prepare and document final lighting layout	Detailed plan lighting layout including schedules, notes pole pegging positions etc
• Point of Supply • Location of other services • Site Layout	Develop electrical reticulation and augmentation design	Cable & fuse/MCB sizes, control method, underground/overhead cable route including conduits, pits, junction boxes, volt drop calculations, fault loop impedance analysis
	Finalise work plan	Approved works plan

Figure 16: Public Lighting Design Process

6.3 The Design Brief

Before any design work can commence, the designer must review the data and instructions provided by the requesting stakeholders e.g. Road Controlling Authority.

It is imperative that the scope of the design and the design requirements are discussed and agreed with the requesting body and that the requirements of the Electricity Distributor's Standard Conditions for Public Lighting Services and funding arrangements are incorporated.

6.3.1 Funding Arrangement and Other Charges

The funding arrangements will assist the designer in determining who is to be consulted in respect to budget allocated to the job. This could affect the design considerations e.g. use of underground or overhead supply, steel or wood poles.

The funding body may be DNSPs, Local Government Authorities (LGA), Department of Transport and Main Roads (DTMR), Qld Motorways Corporation or combination of these.

In accordance with the Standard Conditions for Public Lighting Services, the funding body is responsible for the initial design, supply and installation of a public lighting scheme.

In the situation where the Public Body has funded ownership and wishes to vest ownership of the installation in the distributor on completion of the installation for ongoing maintenance and operation, the designer is required to specify the DNSPs' standards and materials in the lighting scheme. Such an arrangement would constitute a Rate 2 installation.

Network charges will depend on choice of lamps, numbers of lights etc. Details of the network charges are contained in the DNSP Network Pricing Schedule.

The agreed lighting design must reflect requirements of these industry documents.

6.3.2 Base Plans and Other Data

The scaled base plans and other provided data must be inspected to ensure that the layout details have been provided including:

- the extent (scope) of the lighting design
- road sections if there are embankments
- form and dimensions of the carriageway layout
- form and location of intersections, median strips and islands
- form and location of traffic management devices e.g. rumble strips, speed bumps, splitter islands, Local Area Traffic Management Devices (LATMDs)
- underground and overhead power lines and cables, storm water drains and other underground services
- locations of site features including bus shelters, property boundaries, vegetation, points of concentration of pedestrian movement etc

6.3.3 Lighting Category

The lighting category must be nominated. AS/NZS1158 series identifies the categories of streetlights and associated design standards required. The design must comply with the requirements of the *AS/NZS1158* series unless otherwise instructed by the Public Body.

6.3.4 Style of Lighting

The style of lighting will affect the column spacing and layout. Selecting the luminaire can be affected by the following:

- lighting type e.g. standard, decorative

- lamp type e.g. metal halide, high pressure sodium, compact fluorescent, linear fluorescent
- luminaire manufacturer e.g. lamp performance varies for various manufacturers
- lamp wattage e.g. S100
- mounting height and arrangements e.g. outreach, mounting height
- style of luminaire e.g. normal (SCO), aeroscreen, decorative

These can be consolidated and incorporated into the design brief.

6.3.5 Public Body Preferences

The Public Body have developed specific lighting system preferences for their areas based on budgetary, societal and other considerations. Any departure from the *AS/NZS1158* series and any variations to standard alignment will need to be clarified with the Public Body. These will affect the design in relation to the:

- setbacks from the kerb for lighting columns
- setback from the walking & cycling paths for lighting columns
- types of lighting columns acceptable e.g. slip base mounted
- type and wattage of luminaires e.g. Aeroscreen, sodium vapour
- arrangement of the lighting columns in the street e.g. staggered

6.3.6 Other Considerations

There are many other design brief issues that must also be considered including the following:

- Responsibility for maintenance e.g. DNSP, Public Body.
- Road widths and alignments e.g. allowable alignments for underground cables, unusual setbacks for lighting columns.
- Identification of prospective future infrastructure and/or development that may conflict with the lighting design e.g. transmission line crossings, staged roadway upgrade
- Clearance to overhead mains to allow for vehicle impact on SBM lighting columns.
- The control systems for the streetlights e.g. individual or group PE cell, audio frequency signal, time clock
- Aesthetics e.g. the presentation of the design is important to the amenity and prestige of the local community
- Safety and environmental e.g. conforms to legislative requirements and industry standards
- Specific stakeholder requirements e.g. DTMR prefer the use of specific types of pits
- Initial costs e.g. are there costing limitations for the design?
- Physical access to lights for installation and maintenance

- Joint use assets (traffic lights and streetlights on same pole) for the purpose of rationalisation of street furniture
- Clearances of streetlighting structures from DNSP overhead mains including easements for OH transmission
- Maintenance factor of luminaires

6.4 Site Inspection and Base Plan

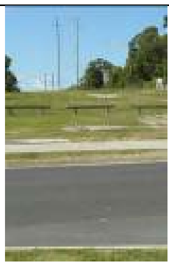
6.4.1 Physical Site Feature

The site visit will identify or confirm the site features that may possibly impede the precise achievement of the luminaire spacing.

They may also impede the installation of streetlights and underground or overhead electricity supply to the new installations.

Table 28 shows typical physical site features that could impede the positioning of lighting infrastructure and electricity supply.

Table 28: Typical Physical Site Features

Physical Site Feature	Typical Example	Physical Site Feature	Typical Example
Stormwater, drainage conduits and collection devices, bridges & culverts, entry/exit driveways and other street furniture		Road geometry e.g. kerbs,	
Driveways impinging on possible pole location		Vegetation interference	
Other utility infrastructure (gas, water, telecommunications)		Layout constraints e.g. driveways, pram ramps, bus shelters, shop awnings	
Transmission and distribution (UG & OH) infrastructure e.g. pole locations		Environmental and landscapes e.g. heritage listed trees, permanent survey marks, cultural heritage	

6.4.2 Non-Physical Site Features

Non-physical site features that could prevent or limit lighting infrastructure installation include the following:

- Spill light and glare in proximity of residences
- Site access e.g. traffic running lanes, roundabouts, laneways
- Earthing issues e.g. on bridges
- Site specific technical limitations e.g. cannot use SBM poles near schools
- Future maintenance restrictions e.g. access for lamp replacement

The designer may need to incorporate Aeroscreen luminaires, hinged poles, special foundations and other corrective measures to overcome these limitations.

If the public lighting infrastructure layout cannot be located to avoid the site feature, the designer may need to negotiate the removal, relocation of the conflicting infrastructure or obtain special approvals with the relevant authority for public light positioning.

6.4.3 Identify the Attributes of the Site

A review of the civil roadwork drawings and/or site survey will identify the attributes of the site.

Table 29: Site Specific Physical Attributes for Lighting Categories

Attribute	Cat V	Cat P	Cat PX
Roadway layout and direction of traffic flows	√		
Posted traffic speed	√		
Carriageway widths	√		√
Existing pole setback distances	√	√	
Existing longitudinal pole positions	√	√	
Existing typical pole constructions/mounting heights	√	√	√
Existing/new pole alignments (including median strip for Cat V)	√	√	
Curvature of roadway in conjunction with topographical data	√		
Aerial crossing clearance	√	√	√
Location of lot side boundaries	√	√	√
Road reserve width		√	
Location of laneways entering onto road reserves		√	
Areas of high pedestrian activities e.g. schools, hospitals, shopping precincts		√	√
Potential for spill lighting and glare complaints		√	√
Site distance to crossing			√

6.4.4 Safety Considerations

The safety aspects include the installation and future maintenance processes for work crews and the impact of the installation on the motorists and pedestrians.

The safety issues that must be identified within the site include:

- the volume and speed of vehicles using the carriageway
- the access for construction and maintenance vehicles
- the risks of vehicle impact with lighting poles

Specific safety features are considered as part of the design. Examples of these include the following:

- Safe access for the installation of lighting and underground cables and lighting control mechanisms
- Avoiding the positioning of lights in locations that lead to false indications for motorists
- Restricted use of SBM columns in areas of high pedestrian traffic
- Lighting in areas of high pedestrian traffic
- The use of zoned setbacks for lighting poles to reduce the possibility of vehicle impact
- The use of slip-based poles in specified areas to mitigate the effects of vehicle impact
- The use of hinged poles to facilitate maintenance of luminaires and lamps

Risk assessments may be required for site-specific conditions where high impact safety implications exist e.g. steep embankments, restricted access for work vehicles. Solutions including the installation of barricades and service bays, relocation of assets may be necessary.

6.4.5 Basic Design Elements

The site should be inspected to determine the site geometry and features that will affect the locating of the streetlighting infrastructure and electricity supply.

Examples of these include the following:

- Soil type – this will affect the style and type of pole foundation used
- Pole positioning opportunities for the spacing of luminaires
- Lighting materials – suitability of standard lighting hardware for the site
- Electricity supply points of supply – the most appropriate overhead/underground LV supply point and access details
- Control mechanism and cable routes – the means of switching the installation and route for the supply cables

7 General Design Approach for Various Situations

7.1 Identify Light Technical Parameters

The first step is to determine the type and method of analysis that will be required based on the requirements of the Standards for particular road elements.

Table 30 shows the type and method of lighting analysis to be used for the design.

Table 30: Identifying the Type and Method of Lighting Analysis

Lighting Standard	AS/NZS Reference	Analysis
Cat P	*1158:3.1*	E_h values and E_v values
Cat V	*1158:1.1 and 1.3*	E_h values and $\bar{L}$ values
Cat PX	*1158:4*	E_v values and Cat V approach lighting as appropriate

7.2 Establish Roadway Elements

The next step is to identify the separate sections of the roadway (elements) that require public lighting. Table 31 shows the technical parameters that are required for the individual roadway elements that will be incorporated into the design.

Table 31: Roadway Elements and Technical Parameters

Attribute	**Cat V**				**Cat P**			**Cat PX**
	GC	**($\bar{L}$)**	**S_c**	**E_h**	**GC**	**E_h**	**E_v**	**Ev**
Straight sections of roadway:								
At uniform grade		√				√		√
At a crest	√				√			
Divided carriageway		√				√		√
Grade separation between carriageway		√				√		
Number of lanes per carriageway		√						
Provision of kerbside parking and/or bikeways		√		√				
Intersections:								
At grade		√				√		
Isolated intersection				√		√		
On/off ramps		√		√				
Access roads				√		√		
Roundabouts				√		√		
Interchange		√		√				
Curves in carriageway (radius of curves)		√	√					
L.A.T.M.D.				√		√		
Pedestrian refuges				√		√		√
Other features e.g. bus set down bays, external car parks, pedestrian pathways, and cycleway, connecting elements (steps and subways)				√		√	√	

Legend:

E_h	Horizontal illumination level in lux
E_v	Vertical illumination level in lux
GC	Special Considerations e.g. glare, line of sight, Civil Aviation Authority, rail crossings
$\bar{L}$	Average luminous intensity in cd/m^2 in the section
LATMD	Local Area Traffic Management Device (small roundabouts, chicanes, etc)
S_c	Average luminous intensity in cd/m^2 as determined by the curve spacing ratio

7.3 Establish Layout and Standard Equipment Requirements

By using appropriate software, the lighting technical performance can be determined. The aim is to achieve optimum use of public lighting infrastructure whilst complying with the lighting standard specified in the design brief.

The installation should be designed to adequately light the whole of the used portion of the road, whether or not it is sealed across the full width.

For a variety of arrangements and lamp/luminaire combinations, the designer must analyse individual roadway elements to achieve compliance to specified light technical parameters. The analysis is an iterative process. As a result of the analysis, an optimum design can be developed.

Table 32: Typical Arrangements used for DNSP's in Queensland

Design Category	Arrangement	Carriageway Width W_k	Mounting Height	Typical Luminaire
V3	1	Up to 12m	10.5 – 12m	L60A or L138A
V3	3	12m to 16m	10.5 – 12m	L60A or L138A
V3	4	16m to 20m	10.5 – 12m	L60A or L138A
V3	6	Up to 16m	12 – 15m	L138A or L204A
V5	1	Up to 12m	9 – 10.5m	L40A or L60A
V5	3	12m to 16m	9 – 10.5m	L40A or L60A
V5	4	16m to 18m	9 – 10.5m	L40A or L60A
V5	6	Up to 14m	10.5m	L60A
P5	1 or 3	¼ road reserve width	5.1*/6.5-7.5m	L14A
P4	1 or 3	¼ road reserve width	5.1*/7.5m	L14A or L24A HO
P3	1 or 3	¼ road reserve width	7.5m	L24A HO

* For luminaires mounted on estate poles

For each possible arrangement, the designer can use appropriate software to determine the optimum spacing and hardware requirements for the public lighting scheme. Computer based design aids may be used to assess potential compliance of a trial design. These include:

- spacing tables,
- performance tables,
- isolux diagrams and
- diagrams showing light levels at grid points over the design area

Manufacturers will provide photometric data for their lamps/luminaires.

The design requires the application of the technical parameters for the individual roadway elements. The design process contained in the following sections relates primarily to the carriageway or roadway lighting.

In general terms, the order for undertaking the design process, will be to focus on the conflicts (curves, crests, intersections) then infill straight sections.

7.4 Straight Sections

Determine the maximum spacing given a lighting configuration.

Table 33 shows the data and process required for the Category V and P public lighting.

Table 33: Process for determining Luminaire Spacing for Straight Sections

Category	Objective	Required Data	Process
V	Determine the maximum luminaire spacing for a variety of arrangements and hardware configurations.	Reflectance for most roadways set at R3# in the absence of direction from the client Observer position has been fixed Upcast set at 5º I-table from manufacturer for lamp and luminaire Lamp luminous flux Mounting height Carriageway overhang Arrangement	Conduct a number of evaluations to determine the most efficient design satisfying the requirements of Table 2.2 of *AS/NZS 1158.1.1*
P	Determine the maximum luminaire spacing for a variety of arrangements and hardware for road and pathway applications.	Upcast set at 5º I table from manufacturer for lamp and luminaire Lamp luminous flux Mounting height Nominal ¼ road reserve Arrangement	Conduct a number of evaluations to determine the most efficient design satisfying the requirements of Table 2.6, 2,7, 2.8, 2.9 of *AS/NZS 1158.3.1*

- R3 road surface consists of asphaltic concrete with harsh texture and is used as a default value for Queensland roadway luminaire calculations

7.5 Corners, Crests and Curves

For curved sections of road, the maximum allowable luminaire spacing may be reduced on based on the curve radius. Considerations for the pole positioning on curves include:

- Curve radius (mean radius of curve to the centre line of the roadway)
- Poles located on the inside, outside of the curve or both
- Pole separation for the adjacent straight sections

Using the data listed above, the pole spacing ratio can be determined as per the requirements of *AS/NZS1158.1.1.*

Supplementary lighting may be required depending on the roadway width and the arrangement and the roadway width.

- For crests or humps in the roadway, the following requirements shall apply:
- One or more luminaires shall be located as close as practicable to the apex of the crest or hump

The first luminaire on either side of the apex of the crest or hump shall be no further from the apex than 70% of the spacing otherwise required for the straight section.

In certain circumstances e.g. crest in steep roadway sections, it may be necessary to consider the use of Aeroscreen luminaires to reduce the glare for approaching vehicles.

7.6 Intersections

Intersections can include 'T' junctions, multi road intersections and roundabouts. The intersections can also be channelised (including pedestrian refuges, chicanes, chevrons, speed humps) and non-channelised.

Table 34: Lighting Design Requirements for Category P Intersections

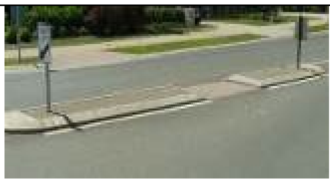
Description	Typical Streetscape	Design requirements
Non-channelised		One only luminaire of the higher category of the two intersecting roads shall be required within 10m from the projected property boundary of the intersecting roadway
Channelised (raised islands including speed humps, roundabouts but excluding chicanes, pedestrian refuges)		One or more luminaires shall be required at the intersection in order to provide 3.5 lux-maintained illumination over and three metres leading up to all raised island conflicts within the intersection. At least one luminaire shall be located within 10m from the projected property boundary of one of the intersecting roadways as per the 'non-channelised' section described above.
Channelised (pedestrian refuges)		One or more luminaires shall be required adjacent to the refuge in order to provide 3.5 lux-maintained illumination over the raised island(s).
Channelised (chicanes)		A luminaire shall be provided within 25% of maximum allowable category P spacing to each approach threshold to the chicane. Normal pole spacing is not to be exceeded but shall be applied either across or along the length of the chicane.

Table 35: Lighting Design Requirements for Category V Intersections

Description	Typical Streetscape	Design requirements
Category V Road intersecting with Category P road (non-channelised)		Luminance ($\bar{L}$) based design across the category V road plus the category P road to have a minor road luminaire located not greater than 50% of maximum category P spacing from the projected property boundary of the intersecting category V roadway.
Category V road intersecting with Category P road (channelised)		Luminance ($\bar{L}$) based design across the category V road plus illuminance (E_h) based design to be carried out over whole of intersection and associated traffic islands and line marking and including extended areas of merging and diverging traffic movements.
Category V road intersecting with Category V road (non-channelised)		One only luminaire of the higher category of the two intersecting roads shall be required within 10m from the projected kerb line of the intersecting roadway.
Category V road intersecting with Category V road (channelised)		Luminance ($\bar{L}$) based design across both category V roads plus illuminance (E_h) based design to be carried out over whole of intersection and associated traffic islands and line marking and including extended areas of merging and diverging traffic movements.
Category V Carriageway (roundabouts)		Illuminance based design shall be required for roundabout lighting designs. The size of the roundabout will determine the lighting layout. For smaller roundabouts (typically up to 30m diameter), lighting at the approach splitter islands and/or within the centre island, shall be provided. For roundabouts in excess of 30m diameter, lighting about the outer edge of the centre island will be required (instead of high mast lighting) in addition to the approach lighting at the splitter islands coming into the roundabout.

7.7 Pedestrian Crossings

Light technical parameters as specified in *AS/NZS1158*.4 apply. Light spill and glare should be minimised.

The adverse effects can impact on the surrounding environment as follows:

- Veiling luminance to pedestrians and motorists traversing the installation
- Night sky viewing conditions
- Spill light and glare into adjacent premises

Table 36 shows the range of floodlights used for the subcategories of pedestrian crossing lighting.

Table 36: Typical Louvred Floodlight used in Category PX Lighting

Category	Floodlight Type	Application
PX3		Category P roadways where reduced vertical illuminance and greater glare control is required.
PX1, PX2	L100 Asymmetric Medium Beam	Smaller dimension road crossings with minimal setback from leading edge of crossing, typically 3 – 7m.
PX1, PX2		Smaller dimension road crossings with average setback from leading edge of crossing, typically 7 – 12m.
PX1, PX2	L200 Asymmetric Medium Beam	Larger dimension road crossings with minimal setback from leading edge of crossing, typically 3 – 7m.
PX1, PX2		Larger dimension road crossings with minimal setback from leading edge of crossing, typically 7 – 12m.

A typical Category PX lighting arrangement is shown in Figure 17.

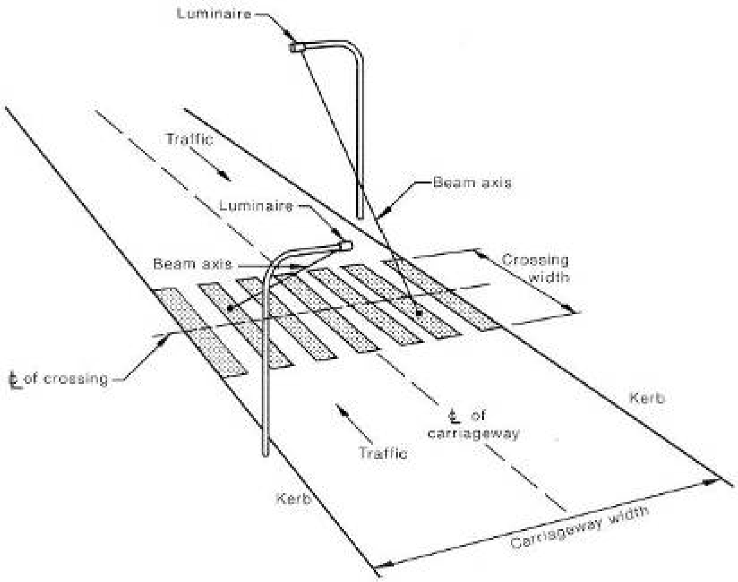


Figure 2: Typical Category PX Lighting Arrangement

Source: *AS/NZS1158:4.0*

Where there is two-way traffic approaching from opposite directions, each side of the road must be analysed separately. The designer must select and configure available standard materials to the requirements of the design. This may require several iterations of the construction positioning before the optimum design can be achieved. It will be based on the materials, setbacks, aiming, outreach and its orientation, and floodlight mounting height.

A standard louvered, aimable floodlight shall be used in accordance with *AS/NZS1158.4* unless specified otherwise in the design brief. The designer must conduct a series of software analyses to determine the optimum design minimising spill and glare.

Table 37 shows the data and process required for the category PX public lighting.

Table 37: Determining Optimum Arrangement for Category PX Lighting

Category	Objective	Data	Process
PX	Determine the optimum layout geometry and aiming point onto each side of pedestrian crossings (the use of louvres to control spill light and glare is required)	I-table from manufacturer for lamp and luminaire Lamp luminous flux Positioning of floodlight e.g. setback, mounting height, overhang Aiming point onto the road surface	Iteration and verification to satisfy Table 3.2 of *AS 4282 .4*

It is important to ensure that the aiming angle is adjusted to achieve a minimum Point Vertical Maintained Illuminance (EPV) of 32 lux for category PX1 and PX2 and 16 lux for category PX3 at each of the 18 points of the relevant crossing zone as defined in *AS/NZS1158.4.* This is necessary when establishing the relationship between the luminaire mounting height and set-back of the luminaire from the leading edge of the crossing.

Using appropriate software, the light technical parameters can be calculated. They must conform to those contained in Table 3.2 in *AS/NZS1158.4*.

The luminaires should be positioned avoiding shadows cast over the area to be illuminated from vegetation, service cables and conventional streetlight installations.

Categories PX1 and PX2 are to be provided with approach lighting in accordance with clause 3.2.5 and Table 3.3 in *AS/NZS1158.4*

8 Luminaire Positioning and Other Design Issues

8.1 Preferred Locations

Positioning of lighting columns is extremely important in order to avoid and minimise damage from/to errant vehicles (risk of collision) or long vehicles (risk of side-swiping).

General considerations:

- Road safety (for workers and public)
- Environment
- Obstructions e.g. physical and non-physical site features
- Access for installation and future maintenance
- Specific Public Body requirements
- Obscuring or distracting from the visibility of street signs including such influences as background glare
- Aesthetic appearance of the installation particularly in the vicinity of attractive community areas e.g. civic centres

Alignment considerations:

- Positioning poles on property boundaries
- Clearance from turn in/out to driveways
- Alignment with parking bay separation lines (in external car parks)

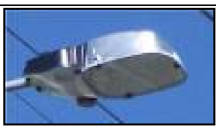
When merging the roadway element designs, consider the following:

- For category P, start with intersecting road reserves and secondary roadway elements e.g. speed humps before progressing to backfill the sections of uninterrupted straight sections of roadway.
- For category V, start with intersecting carriageways including roundabouts and interchanges, curves, crests, and other conflict points to be highlighted before progressing to backfill
- Considerations when merging straight sections, crests, curves and intersections:

- For tee intersections, the first luminaire in the joining road should be located at a distance not exceeding 50% of the maximum spacing from the junction limits.
- The curve spacing ratio and roadway width will determine the luminaire separation for luminaires located on curves
- For curved sections of the road, a straight line joining successive luminaires should lie within the road reserve.
- A luminaire should be located in close proximity to a traffic management device—no more than one quarter of the maximum spacing away.

There are many more rules contained in the *AS/NZS1158* series.

Table 38: Typical Position Limiting Factors for Luminaire

Positioning Limit Factor	**Typical Example**	**Possible Solution**
Physical and non-physical site features including driveways, vegetation, overhead and underground utility infrastructure, pram ramps, barricades		Locate lights clear of obstructions. Clearances will depend on statutory clearances, adequate physical separation or as required by the Public Body.
Conflict points including roadway narrowing		Highlight by adjacent streetlight installations
Streetlight maintenance program e.g. safe EWP access to lights		• Use of hinged high mast poles • Installation of barricades • Provision of maintenance bays • Road access to high mast lights
Environmental e.g. Spill light and glare		• Use of Aeroscreen luminaires • Luminaire orientation with respect to the roadway
Locations that lead to false indications to motorists		Locate luminaires to avoid misleading visual guidance to the passage ahead.

Positioning Limit Factor	Typical Example	Possible Solution
Locations that can create hazards to motorists e.g. poles located on roundabouts, about intersections or on the outside of curves where they can be easily impacted by errant vehicles		• Locate luminaires clear of possible conflict areas • Install guard rail or steel/concrete barriers • Consider joint use of poles with other utilities • Specified setbacks from the kerb or running lane • Use of building walls, verandas etc • Locate poles on the inside of curves
SBM poles striking overhead mains after vehicle has impacted them		A pole shall not be located closer than: • 1.2 times the mounting height on the approach side of cross roads mains • 0.6 times the mounting height on the departure side of cross roads mains • 0.6 times the mounting height where the mains run parallel to the carriageway
Slip-base-mounted poles must not be used in areas of high pedestrian volume e.g. schools, shopping centres, bus stops		Utilise BPM structures in these locations.
Public Body requirements		As an example, some Public Bodies require minimum setbacks from vehicle carriageways, cycle way and footpath trees.

In accordance with Section 3.1.2 of *AS/NZS1158.1.1*, for uninterrupted straight sections where limitations and obstructions exist, the spacing of individual spans may exceed the design spacing by no more than 10% provided that such non-complying spacing does not occur in more than one span and does not reoccur for the next three consecutive spans.

8.2 Setbacks and Zones

Authorities in control of roadways often restrict the use of rigid columns to minor, low-speed-limit roads or locations behind guard rails or within median barriers. *AS1158.1.2*, Appendix B defines various pole setback zones adjacent to the carriageway.

Table 39 shows the setback zones.

Table 39: SetBack Zones

Zone	Application
1	Total Exclusion Zone: For kerbed roads - normally up to 0.7m beyond kerb, but extending to 1.0m at intersections or sharp bends For un-kerbed roads with speed limit≤70km/h – not less than 1.0m beyond the edge of the carriageway but not more than 3.0m from the outer edge of the traffic lane(s). For un-kerbed roads with speed limit >70km/h – not less than 1.0m beyond the edge of the carriageway but not more than 6.0m from the outer edge of the traffic lane(s).
2	Slip-base or impact absorbing pole zone: 3.0m wide for roads up to 70km/h speed limit and 6.0m for posted speed limit >70km/h
3	Unrestricted pole zone

8.3 Clearance to Driveways

The required horizontal clearance from the public lighting pole to from turn in/out to driveways is 1.0 m. This clearance is important in order to avoid and minimise damage from/to errant vehicles (risk of collision) or long vehicles (risk of side-swiping). Additional clearance may be required for commercial and industrial driveways where larger vehicles are expected.

The clearance is applied from face of the pole to the wings of the driveway, refer Queensland Public Lighting Construction Manual, for pictorial representation.

8.4 Clearances to Overhead Mains

The required vertical and horizontal clearances from the public lighting pole, bracket and luminaire to overhead conductors is specified in the Queensland Public Lighting Construction Manual. These clearances allow for conductor blow out and sag under maximum conductor temperature conditions.

8.5 Proximity to Airport

The Principles for a National Airports Safeguarding Framework acknowledges the importance of airports to national, state / territory and local economics, transport networks and social capital. Two aspects of streetlighting will impact on the safe operations of airports and aviation facilities. They are:

- Intrusion into operational airspace
- Lighting causing pilots to be either distracted or mistake such lighting as being aeronautical ground lights from the airport.

In the first instance designers should refer to the relevant Local Government Planning Scheme for development requirements in the proximity of Airport and Aviation Facilities. The below is provided as general guidance.

It is important to note, the fact that a certain type of structure or light already exists in an area is not an indication that additional installations can be added.

8.5.1 Intrusion into Operational Airspace

The height of structure or streetlight column must not affect the operational efficiency of an airport or create a hazard to the safe navigation or aircraft using the airport. The height restrictions for structures and other activities are defined by the Obstacle Limitation Surfaces (OLS) chart. Generally, the OLS will extent 15 km from the airport.

8.5.2 Lighting Zones

General guidance for designers of Public Lighting schemes where lights are to be installed within a 6 km radius[1] of a known aerodrome, are most likely to be subject to the provisions of Regulation 94 of Civil Aviation Regulations 1988. This area is divided into four lighting control zones: A, B, C and D. These zones reflect the degree of interference ground lights can cause a pilot. The drawing shown in Appendix 1, shows the primary 6 km buffer and nominates the lighting control zone areas.

Even though a proposed installation is designed to comply with the zone intensities shown in Appendix 1, designers are advised to consult the Local Government Planning Scheme and CASA as there may be overriding factors that require more restrictive controls to avoid conflict.

8.5.3 Defence Aviation Areas Regulations

Declared Defence Aviation Areas (DAA) cover an area situated within 15 km radius of an airport. DAA declarations are provided at the Australian Government Defence website:

https://www.defence.gov.au/about/locations-property/defence-aviation-areas-regulation

The DAA declarations define the heights at which proposed structures need to be referred to Defence for approval.

8.6 Maintenance Access Requirements

Future lighting maintenance will be required for all lighting infrastructure including lamps, columns, supply cabling, pillars and pits. Maintenance staff will require safe access both for themselves and their vehicles and equipment. The positioning of the lighting infrastructure must facilitate the safe working environment.

The following are typical issues that must be considered:

- Road speeds
- Blind access (obstructions creating visual impairment for drivers of oncoming vehicles)
- Barricades (may prevent access or may provide safe work environment)
- Inaccessible (vehicle access impossible due to terrain or obstructions)
- Height of luminaires (access to high mast luminaires may be difficult for some vehicles)

[1] The 6 km buffer radius is applied for the centre point of each runway.

9 Reticulation Design

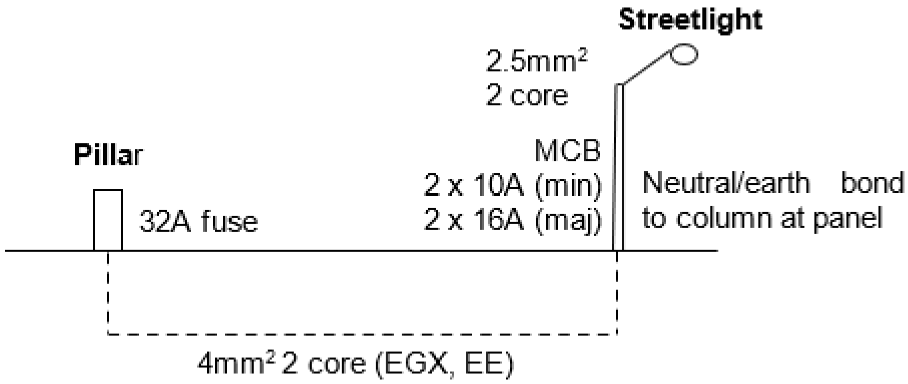
9.1 Wiring Diagrams for Rate 1 and 2 Lighting

The following diagrams show the typical cabling and protection requirements for the more common streetlight schemes.

Underground streetlight cables shall be installed as per the requirements of the relevant DNSP Underground Construction Manual.

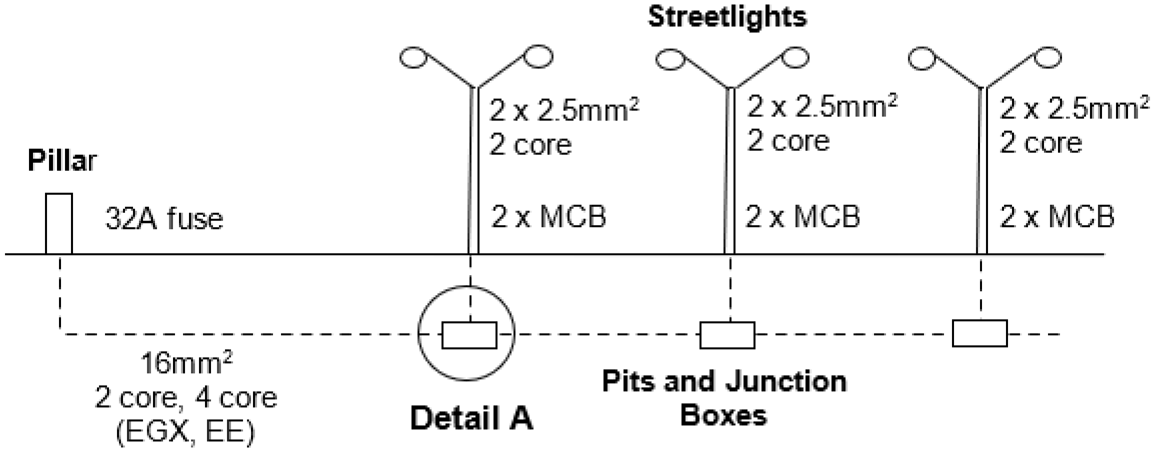
Single (or Multiple) Streetlight Scheme (Including pedestrian floodlighting)

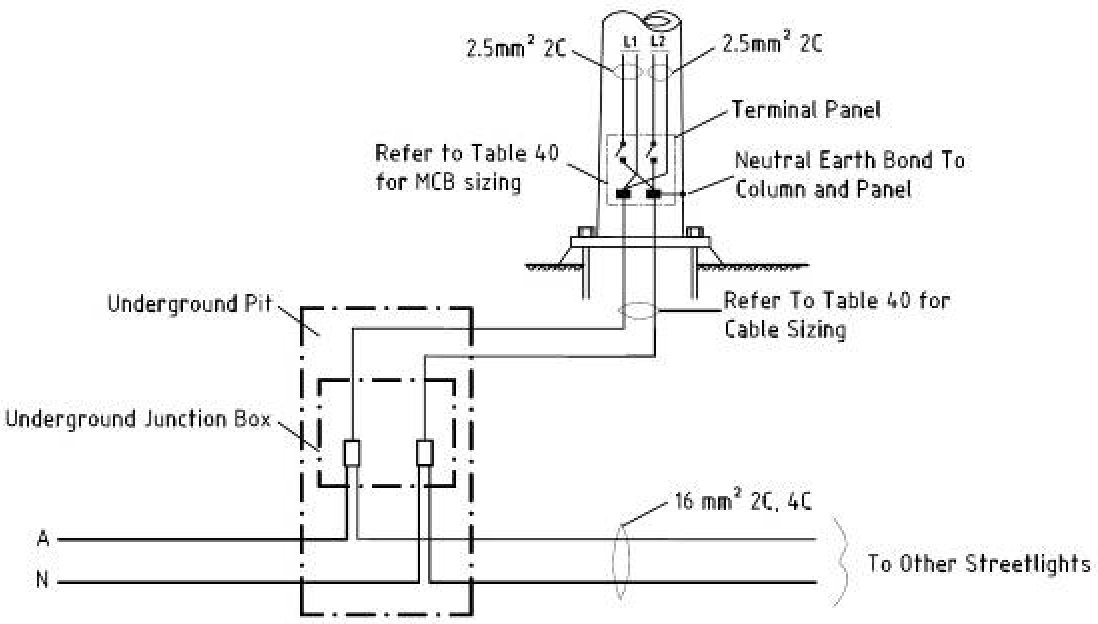
For a circuit that is unlikely to be extended, subject to voltage drop limitations and maximum fault-loop impedance criteria.



Multiple Streetlight Scheme(BPM) – Pit and Junction Box

Subject to voltage drop limitations and maximum fault-loop impedance criteria





Detail A

Table 40: Cable and Protection for BPM Scheme

DNSP	Supply (pit – pit)		Pit – Column		Column	
	Cable	Protective Device	Cable	Protective Device	Cable	Protective Device
EE	16mm^2 #	32-amp fuse	4mm^2	none	2.5mm^2	6-amp RCBO (Min)[1] 10-amp MCB (Min) 16-amp MCB (Maj)
EGX	16mm^2 #	32-amp fuse	4mm^2	none	2.5mm^2	6-amp RCBO (min)[1] 10-amp MCB (Min) 16-amp MCB (Maj)

Notes& Abbreviations:

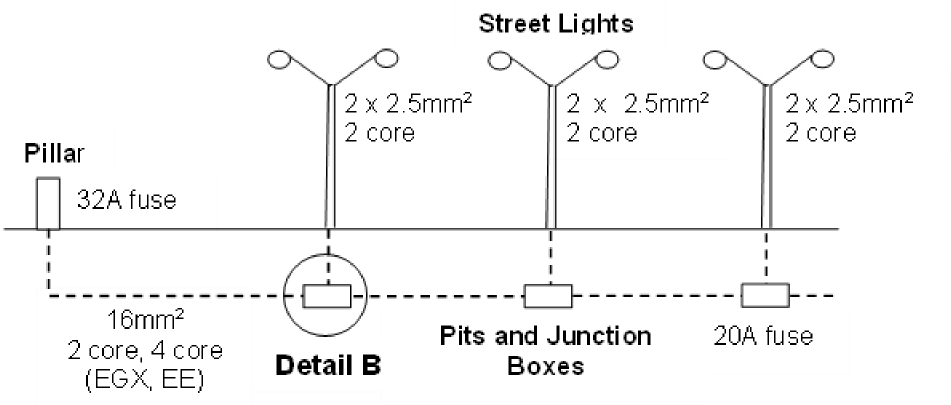
Min – Minor Road lighting scheme

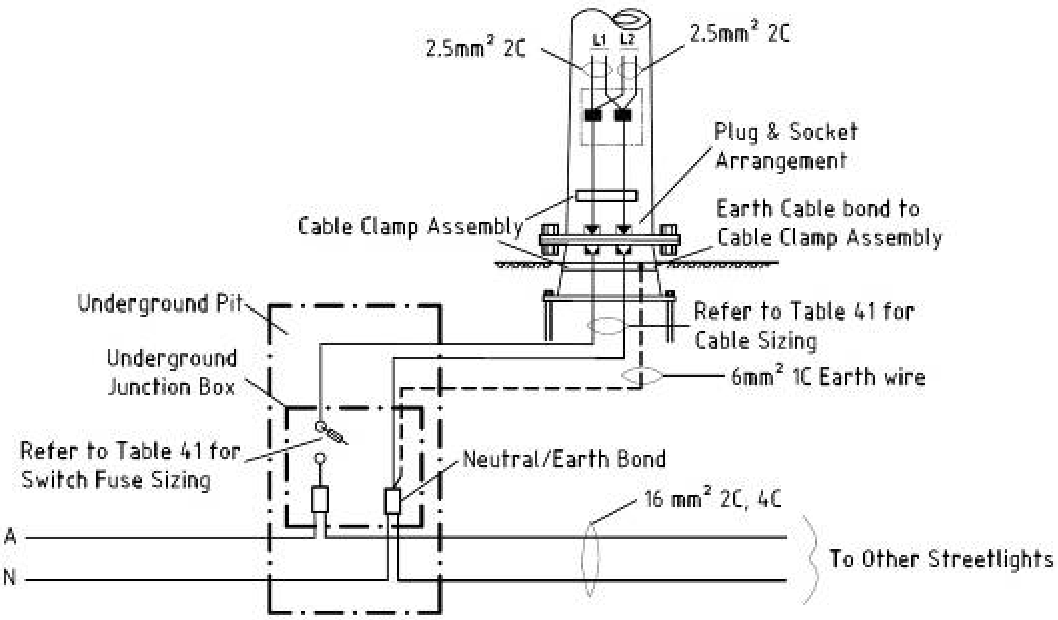
Maj – Major Road lighting scheme

- 16mm² circuit cable may be connected into the terminal panel of the last streetlight in a circuit (if junction box is not required).

[1] RCBOs required in High Risk Locations

Multiple Streetlight Scheme (SBM) – Pit and Junction Box





Detail B

Table 41: Cable and Protection for BPM Scheme

DNSP	Supply (Pit – Pit)		Pit – Plug/Socket		Plug/Socket – Terminal Panel		Terminal Panel – Luminaire	
	Cable	Protective Device	Cable	Protective Device	Cable	Protective Device	Cable	Protective Device
EE	16mm²	32A fuse	4mm²	20A fuse	4mm²	none	2.5mm²	none
EGX	16mm²	32A fuse	4mm²	20A fuse	4mm²	none	2.5mm²	none

Notes:

1. SBM poles used for major road lighting only.
2. The 6mm² single core earth cable is to be run from the neutral/earth bond in the underground junction box to the cable clamp assembly in the streetlight column foundation. The earth cable is to be bonded to the cable clamp assembly.

High Mast Installation (One MCB per luminaire)

Headframe Arrangement	Cable Riser Size
1 way headframe	2.5mm^2 2 core
2-way headframe	4mm^2 4 core
3-way headframe	4mm^2 4 core
4-way headframe	4mm^2 4 core

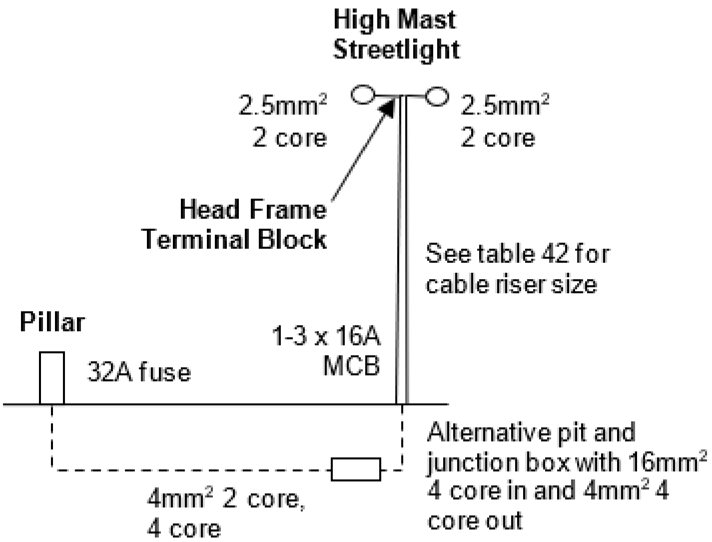
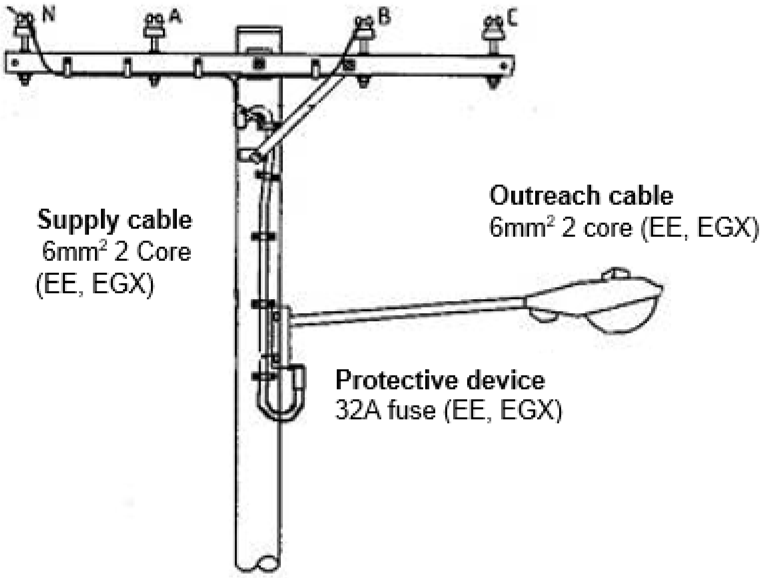


Table 42: Column Cabling Requirements

Wood Pole Installation



Notes:

1. BPM and BIG streetlight columns contain terminal panels with protective devices. SBM columns contain terminal panels without protective devices.
2. For BPM streetlighting circuits, the standard installation will include the pit and junction box arrangement.
3. Ergon Energy neutral screened underground cables are rated for insect protection (neutral screened cable to the base of the terminal panel). The neutral screened cable is used in all Ergon regions.
4. If the installation of the streetlights is extending from an existing scheme, the current carrying capacity, volt drop and earth fault loop impedance must be reviewed for the entire scheme.
5. The use of two core or four core supply cable is determined by considering the total circuit current and the volt drop for the installation.
6. Minor road, high mast and SBM streetlighting poles must be supplied from underground supply. All other lighting may be supplied from either overhead or underground mains.
7. Generally, one protective device is installed for each luminaire. In some cases e.g. double outreach minor columns, one protective device will be installed for both luminaires.
8. 25mm² underground supply cable may be used for special conditions.
9. Where joint use galvanised steel poles are installed e.g. traffic management and public lighting, separate LV supplies and terminal panels will be installed inside the column. However, a 6mm² copper MEN earth bond is to be installed from the neutral at the public lighting terminal panel to the earth stud inside the steel column.

10. In some cases, the LV mains may need to be extended to the point of supply.

9.2 Cable and Protection

Table 43 shows the cables and types of protective devices used for various applications for public lighting.

Minor Road installations in High Risk Locations, shall be fitted with a terminal panel featuring a RCBO. Minor road installations outside High Risk Locations shall be fitted with a terminal panel featuring a Circuit Breaker.

RCBO shall not be used in major road installations or for streetlights mounted on distribution poles.

Table 43: Cabling and Protective Devices for Public Lighting

Cable	OH/UG Supply	Application	Protective Device & Location
$2x6mm^2$ Cu XLPE black ABC	OH	Aerial service to streetlight-only, floodlight-only pole (EGX)	32A fuse – Distribution pole
		Circuit from OH mains to luminaire protective device mounted on wood pole bracket base (EGX, EE)	None
		Final sub circuit from luminaire protective device mounted on wood pole bracket base to luminaire (EE, EGX)	32A fuse – Wood pole bracket base
2x or $4x25mm^2$ Al XLPE black ABC	OH	Aerial service to streetlight circuit	50A fuse (EGX), 80A fuse (EE) – Distribution pole
2C $2.5mm^2$ Cu PVC/ PVC flat	UG	Final sub circuit from streetlight terminal panel inside BPM pole (EE, EGX) or BIG pole (EE) to luminaire	10A MCB (Minor Road lighting), 6A RCBO (Minor Road lighting)[1], 16A MCB (Major Road lighting) – Streetlight terminal panel
		Final sub circuit from streetlight terminal panel to luminaire for double outreach SBM pole (EE, EGX) and single outreach SBM pole (EE, EGX)	None
		Final sub circuit from streetlight terminal panel to each luminaire spider bracket (EE)	16A MCB for each circuit – Streetlight terminal panel
		Final sub circuit from streetlight terminal panel inside high mast pole to luminaire – single luminaire (EGX)	16A MCB – High mast terminal panel
		Cabling from high mast head frame terminal block to luminaires – multiple luminaires (EGX)	None
2C or 4C $4mm^2$ Cu	UG	2 core/4 core circuit from pillar to single or multiple streetlight, flood light or high mast pole (EGX)	32A fuse - Pillar

[1] RCBOs required in High Risk locations

Cable	OH/UG Supply	Application	Protective Device & Location
PVC/PVC flat		4 core final sub circuit from high mast streetlight terminal panel to headframe terminal block for a 2, 3- or 4-way arrangement. (EGX)	16A MCB for each circuit – High mast terminal panel
		Circuit from pit junction box to streetlight terminal panel inside BPM pole (EGX)	None
		Circuit from pit junction box to plug/socket arrangement in SBM pole (EGX)	20A fuse switch – Pit junction box
		Circuit from plug/socket arrangement to terminal panel inside SBM pole for single/double outreach luminaire (EGX)	None
2C $4mm^2$ Cu XPLE/HDPE neutral screened	UG	2 core/4 core circuit from pillar to single or multiple streetlights, flood light pole (EE)	32A fuse - Pillar
		Final sub circuit from pit junction box to plug/socket arrangement in SBM pole (EE)	20A fuse switch – Pit junction box
		Circuit from pit junction box to streetlight terminal panel inside BPM pole (Minor Road) (EE)	None
		Circuit from plug/socket arrangement to streetlight terminal panel inside SBM pole (EE)	None
2C, 4C $16mm^2$ Cu XLPE/PVC	UG	Circuit from pit junction box to streetlight terminal block inside BPM pole (EGX)	None
		2 core/4 core circuit from pillar to multiple BPM, SBM arrangement (EGX)	32A fuse - Pillar
2C, 4C $16mm^2$ Cu XPLE/HDPE neutral screened	UG	Circuit from pit junction box to streetlight terminal block inside BIG, BPM pole (EE)	None
		2 core/4 core circuit from pillar to multiple BPM, SBM, BIG installation (EE)	32A fuse - Pillar
4C $25mm^2$ Cu XLPE/PVC	UG	Special circuit for multiple BPM, SBM arrangements	80A fuse - Pillar

9.3 Wiring Diagrams for Rate 3 Lighting

DNSPs will provide electricity at a point of supply which will generally be at the fuse terminals at the pillar / transformer for underground supply or the service fuse of the overhead mains. The Public Body will be responsible for the supply and installation of the streetlights and the electrical reticulation (under Rate 3 conditions). The electrical installation will be installed as per the requirements of *AS/NZS3000*.

9.4 Positioning the Pits and Cables

Underground supply cables owned by the DNSP can be installed on the standard Public Body roadway alignments. In certain circumstances, e.g. wide footpaths, CBD schemes, it may be convenient to install the conduits, pits and junction boxes in line-of-sight between poles (appropriate for both BPM and SBM arrangements). The junction box and pits should be located as per the requirement of the Queensland Public Lighting Construction Manual.

9.5 Volt Drop Calculations

The public lighting electrical installation must be designed so that no lights will normally be operating outside the voltage range specified in *The Queensland Electricity Regulations*. This will be achieved within the low voltage design if the streetlighting circuit is designed in accordance with the below.

The voltage drop over the length of the service cable must not reduce the circuit voltage below 216 volts.

The voltage at the point of supply where the public lighting circuit leaves the LV mains reticulation shall be regarded as being the nominal voltage, i.e. 230 volts. This means that, in a worst-case scenario, the allowable voltage drop is 14 volts in the public lighting circuit to the last luminaire.

Figure 18 shows a typical median strip lighting layout where the effects of voltage drop should be considered.

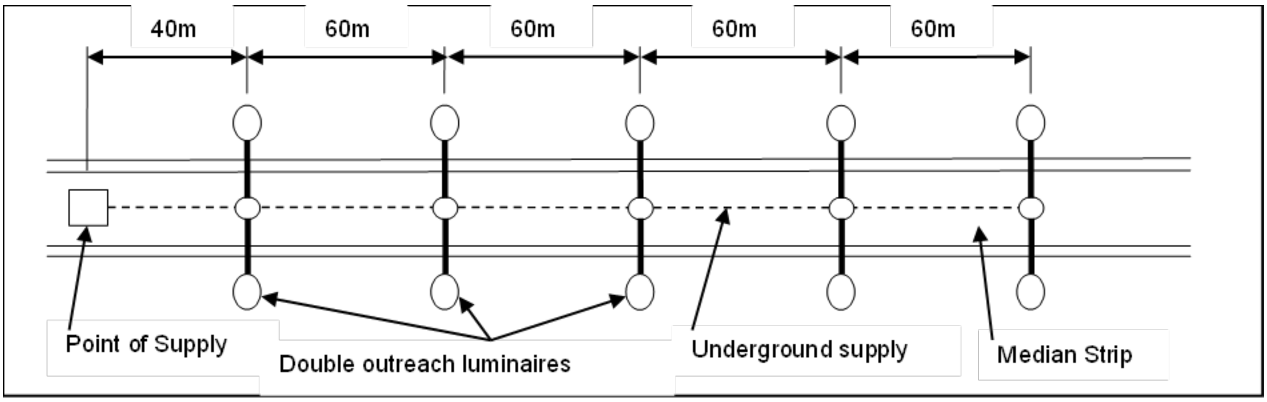


Figure 18: Typical Layout where Voltage Drop may exceed Voltage Limits

For the purpose of streetlight calculations, it is appropriate to adopt the *AS/NZS3000* method of calculating circuit loop impedance i.e. ignoring the reactance component because of its negligible value.

Methods of calculation are as follows:

- For straight circuits, may be determined by method of moments
- For circuits with one or more tee-offs, a section-by-section evaluation will be necessary
- The voltage drop is increased for single phase cables. Voltage drop occurs in both the active and neutral conductors for single phase cables.

For any single-phase circuit, the voltage drop can be determined using the following formula:

$V = I \times (2 \times L \times \rho / A)$

where:

Z = Impedance (Ω)

L = Length (m)

A = conductor cross-sectional area (mm^2)

ρ = resistivity (ohm-mm^2/metre)

Table 44: Cable Electrical Characteristics

Conductor Type and Cross-Sectional Area (mm^2)	AC Resistance^ (ohms/metre)	Current Carrying Capacity (amps)	Resistivity (ohm-mm^2/metre at 20° C)
2.5mm^2 Copper	0.00814	37	22.5×10^{-3} for Copper 36×10^{-3} for Aluminium
4mm^2 Copper	0.00506	48	
6mm^2 Copper	0.00338	60	
16mm^2 2 core Copper	0.00126	105	
16mm^2 4 core Copper	0.00126	89	
25mm^2 4 core Copper	0.000799	115	
2B6 Copper (HD)	0.00348	60	
2B25 Aluminium (HD)	0.00132	110	

Note: All cables are annealed unless shown as (HD) – hard drawn

^ Rating in underground PVC conduit operating at 45°C - Sourced from *AS/NZS3008.1.1*

The inrush / running currents for current luminaires are shown in Table 20 and starting / running currents for obsolete luminaires are shown in Table 21.

For the purposes of determining load current for calculating voltage drop the following shall apply:

a) Running current shall be used for LED luminaires in all cases

b) For all other luminaire types

1. Sum of all starting current shall be used for bulk switched scheme
2. Sum of starting current for last pole in the installation and the running current for proceeding poles

9.6 Fault Loop Impedance

The earth fault loop impedance should not exceed that recommended for the type of circuit breaker or fuse that protects the LV supply circuit.

Streetlight supply cables are protected by either fuses or circuit breakers. For circuits that form part of a MEN system, it is important that the fault loop (earthing system) impedance is not excessive otherwise the LV circuit protective device may not operate correctly when an earth fault occurs.

Public lighting circuits are protected by fuses or type C circuit breakers that are required to clear a short circuit fault to earthing system in 0.4 seconds for cables entering a steel lighting pole before connection to the termination panel within the pole. Otherwise, for a main lighting circuit from pit-to-pit with tee-offs to each pole fused within the pit, the maximum earth fault clearance time shall be 5 seconds.

Public Lighting circuit protected by RCBOs shall be treated the same as circuit protected by circuit breakers, i.e. fault loop impedance requirements shall be maintained.

Calculations shall be undertaken as per *AS/NZS3000* requirements.

Impedance for single phase streetlight cables can be calculated as follows:

$Z = 2\,L\,\rho\,/\,A$

where:

Z = fault loop impedance (ohms)

L = circuit length (metres)

A = conductor cross sectional area (mm^2)

ρ = resistivity (ohm-mm^2/metre)

AS/NZS3000 shows the maximum fault loop impedance for circuits protected under these conditions for the particular protective device.

9.7 Inrush Currents

When the AC supply is switched on, LED luminaires can cause an initial peak transient current several hundred times higher than their load current during normal operation; this is compounded by simultaneous switching of multiple LED lighting. This inrush current typically lasts less than 1 ms. The peak inrush current magnitude and inrush current pulse duration are key parameters in characterising the inrush current profile, which are important when selecting circuit protective devices to avoid unintentional operation.

The protective devices (fuse / MCB / RCBO) manufacturers use varying methods for the selection of the correct device for supply LED luminaires.

Public lighting circuits with 20 or fewer luminaires connected and protected by a HRC fuse do not require calculations of the inrush current to be performed.

For all public lighting circuits with greater than 20 luminaires connected, the inrush current profile of the connected luminaires shall be compared with the protective devices performance to ensure unintentional operation is avoided.

9.8 Control Mechanisms

All public lighting must have control mechanisms to turn them on (at times when they are required) and off (when not required). This may require connecting to an existing control mechanism.

Figure 19 shows some typical streetlighting control mechanisms.

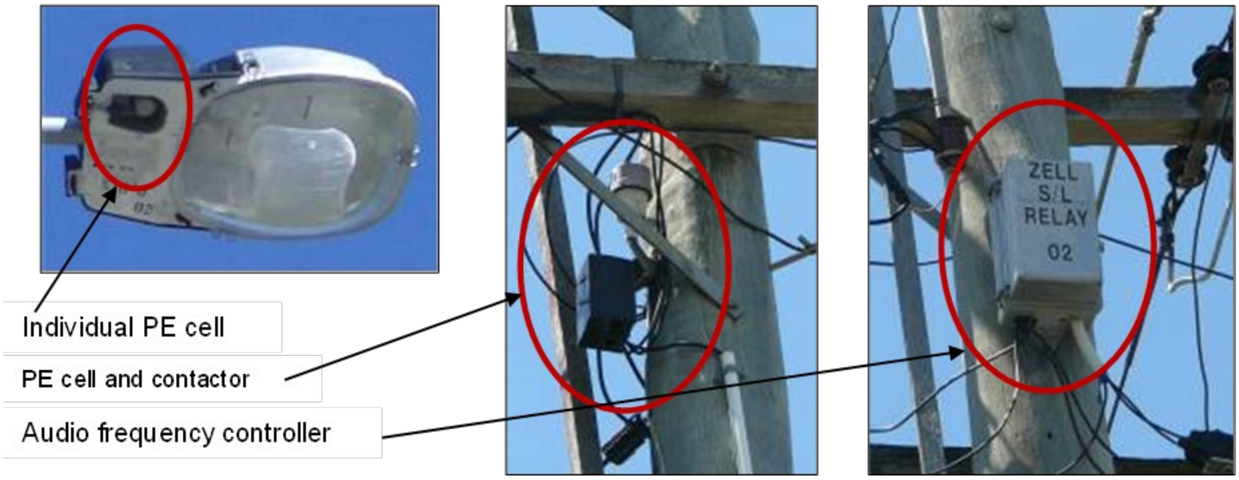


Figure 19: Typical Lighting Control Mechanisms

The majority of streetlights are controlled by PE cells installed in the individual luminaire.

Streetlight contactors are used:

- if a group of streetlights are to be installed and can be conveniently controlled from a single power source
- in CBD areas where poor natural lighting may be inadequate to control the streetlight operation
- as specified in the design brief

When connecting to the existing control mechanism, it is necessary to check that the rating of the existing contactor, control wire, protective device and even the supply transformer will not be exceeded when the new lights are connected.

9.9 Earthing

9.9.1 Rate 1 and 2 Lighting Arrangements

All metal and concrete poles shall employ MEN earthing by direct connection to the supply neutral. The copper earthing conductor shall have a cross sectional area of not less than 6mm2. The MEN point is created by bonding the neutral conductor to the pole.

For extended overhead streetlight circuits, MEN electrodes are to be installed as per the Overhead Construction Manual for LV circuits.

Streetlight columns are normally self-earthing through their base, with the neutral bonded to earth at each location. This obviates the need to run an earth wire along with the active and neutral lines.

For BPM and SBM poles, the DNSPs require a 6mm² copper earthing conductor to be run from the junction box in the supply pit (where it is bonded to the neutral terminal) to the earth connection point on the streetlight footing.

For streetlights attached to wood poles, no earth connection is to be made. Where streetlights are constructed on conductive distribution poles (e.g.: concrete and steel poles) the brackets are to be bonded to the pole. For concrete poles this shall be by an earth strap from the bracket to an earth ferrule.

Streetlight brackets erected on Sub-Transmission concrete poles shall be insulated from the pole and no earth connection is to be made.

The Public Lighting Construction Manual provides details of the earth connections for each streetlight arrangement.

9.9.2 Rate 3 Lighting Arrangement

All Rate 3 lighting arrangements must comply with the requirements of *AS/NZS3000*.

9.9.3 Remote Areas and Bridges

In situations where it is not possible for the earthing to be connected to a MEN system e.g. bridges, overpasses, underpasses with bulkhead lighting or remote areas where there is no MEN system available, then separate earthing is to be installed.

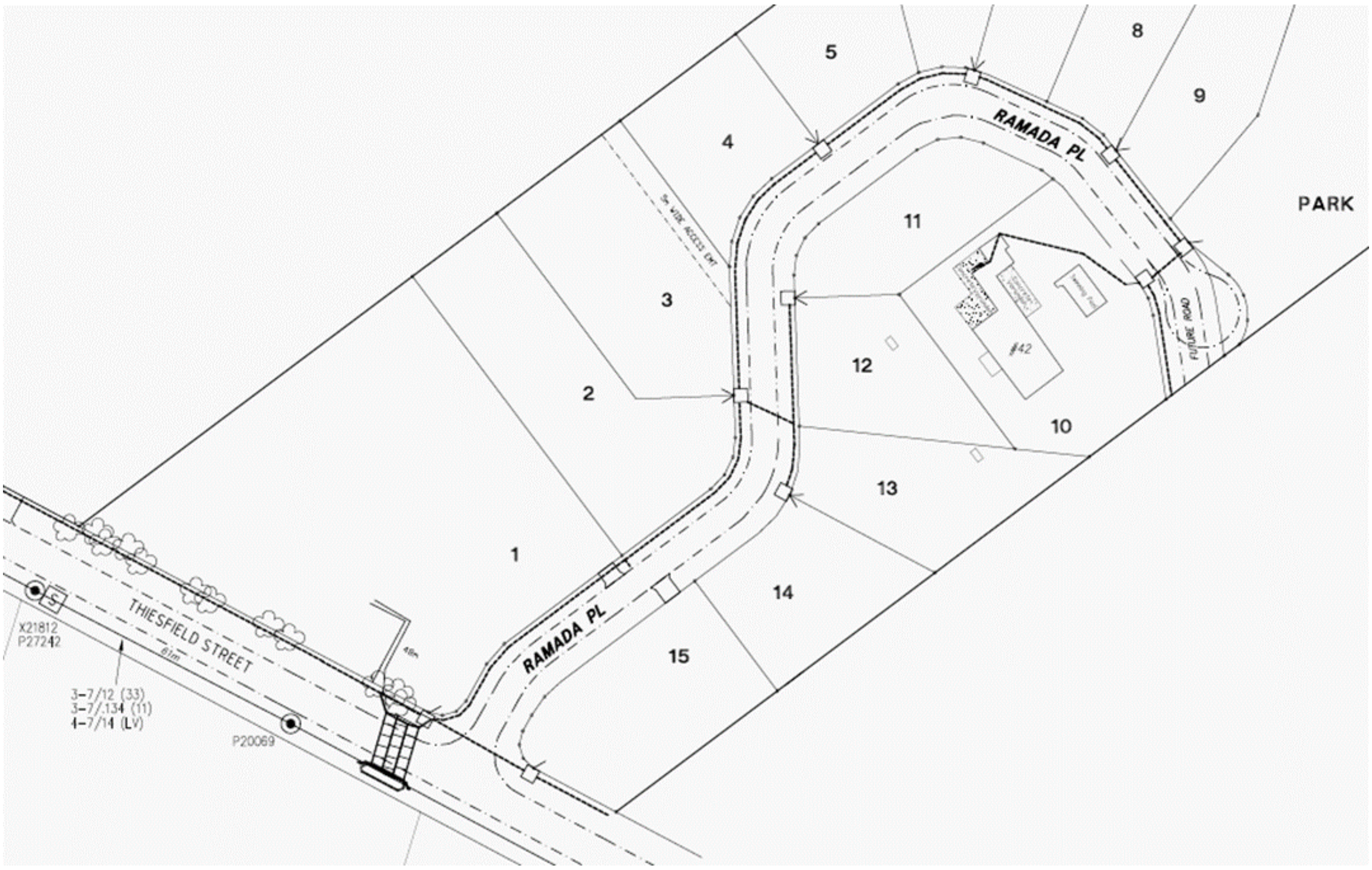
9.10 Joint Use Poles - Isolation

Where joint use steel poles are installed for traffic management (mainly traffic lights) and road lighting, there will be separate LV supplies and LV panels within the poles. To ensure that the road lighting supply may be located and isolated in the event of an emergency and in the course of maintenance work on the traffic light system it is required that the road lighting shall be supplied from a service pit containing a junction box kit including a 20 A fuse-switch combination, installed where practicable within 1.0 metre of the joint use pole/column.

10 Worked Example – Category P

Design lighting for the new subdivision shown below, noting the following requirements:

- The local authority requires category P5
- The local authority requires a staggered arrangement to be used where possible. Future streetlight positions should be shown on the opposite side of the road to the development but need not be installed at this stage.
- The developer has requested a decorative 'Nostalgia' style of light be used within the subdivision along the new road (with a mounting height of 5.1m), but on Thiesfield St a standard style (with mounting height 6.5m) should be used to remain compatible with other streetlights nearby.
- 32CFL lamps should be used.
- The cul-de-sac end is temporary—Ramada Pl will be extended into an adjacent subdivision in the near future. Any streetlights installed in this area should be consistent with the future layout.
- There are no existing streetlights nearby in Thiesfield St that we need to coordinate with.
- To facilitate scaling from the diagram below, it should be noted that Thiesfield St is 20m wide and Ramada Pl is 14m wide. The frontage of the estate is 135m.



File *209078.cie* is loaded into the lighting design software for the 32CFL Nostalgia luminaire. The flux output is 2400lm. The spacing table generated is shown below. For a 14m wide road & 5.1m high mounted Nostalgia, the maximum spacing is 54.8m.

P Category Lighting - AS/NZS 1158.3.1-2005
****

ENERGEX

I-table Filename: C:\Program Files\Perfect Lite\209078.cie

Luminaire Description: 209078 SLA B2223 Nostalgia/Avenue CFL 32
Lamp Wattage & Type: 32CFL Nost
Initial Lamp Flux: 2400 lms
Maintenance Factor: 0.7
Stores Code: 22686
Upcast Angle: 0 degrees
Arrangement: Staggered
Offset Distance: 1/4 Road Reserve
ward Waste Light Ratio: 3.3 %
Light Source: Other - Other than MV, MH, HPS or LPS
minaire Classification: Type 4

Lighting Category: P5 (Local Area Roads - Tables 2.1 & 2.6)

Illuminance Criteria: Minimum Illuminance (Eph) >= 0.07 lux
(Maintained values) Average Illuminance (Eav) >= 0.50 lux
Illuminance Uniformity (Up) <= 10.0

Calculation Grid: 20 x 11 points - Figure 3.7 of AS/NZS1158.2

Mounting Height	Maximum Spacing at different Road Reserve Widths										
	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
5.1	65.4	62.4	59.7	57.1	54.8	52.7	50.7	48.9	47.2	45.9	44.6
6.1	75.3	75.0	74.7	74.4	72.3	69.7	67.3	65.0	62.9	60.9	59.1

Value/s in above table are all in metres.
The table contains maximum spacings which, for the specified luminaire and lamp combination, provide compliance with the light technical parameters (LTPs) of Table 2.6 of AS/NZS 1158.3.1-2005.

For the standard 32CFL luminaires in Thiesfield St, at a mounting height of 6.5m and 20m wide road reserve, a maximum spacing of 71.4m is obtained as shown below.

P Category Lighting - AS/NZS 1158.3.1-2005

****

ENERGEX

I-table Filename: C:\Program Files\Perfect Lite\206243.CIE

Luminaire Description: 206243 SLA Suburban Eco CFL 32W SCO
Lamp Wattage & Type: 32W CFL
Initial Lamp Flux: 2400 lms
Maintenance Factor: 0.7
Stores Code: 21224
Upcast Angle: 5 degrees
Arrangement: Staggered
Offset Distance: 1/4 Road Reserve
ward Waste Light Ratio: 2.6 %
Light Source: Other - Other than MV, MH, HPS or LPS
minaire Classification: Type 4

Lighting Category: P5 (Local Area Roads - Tables 2.1 & 2.6)

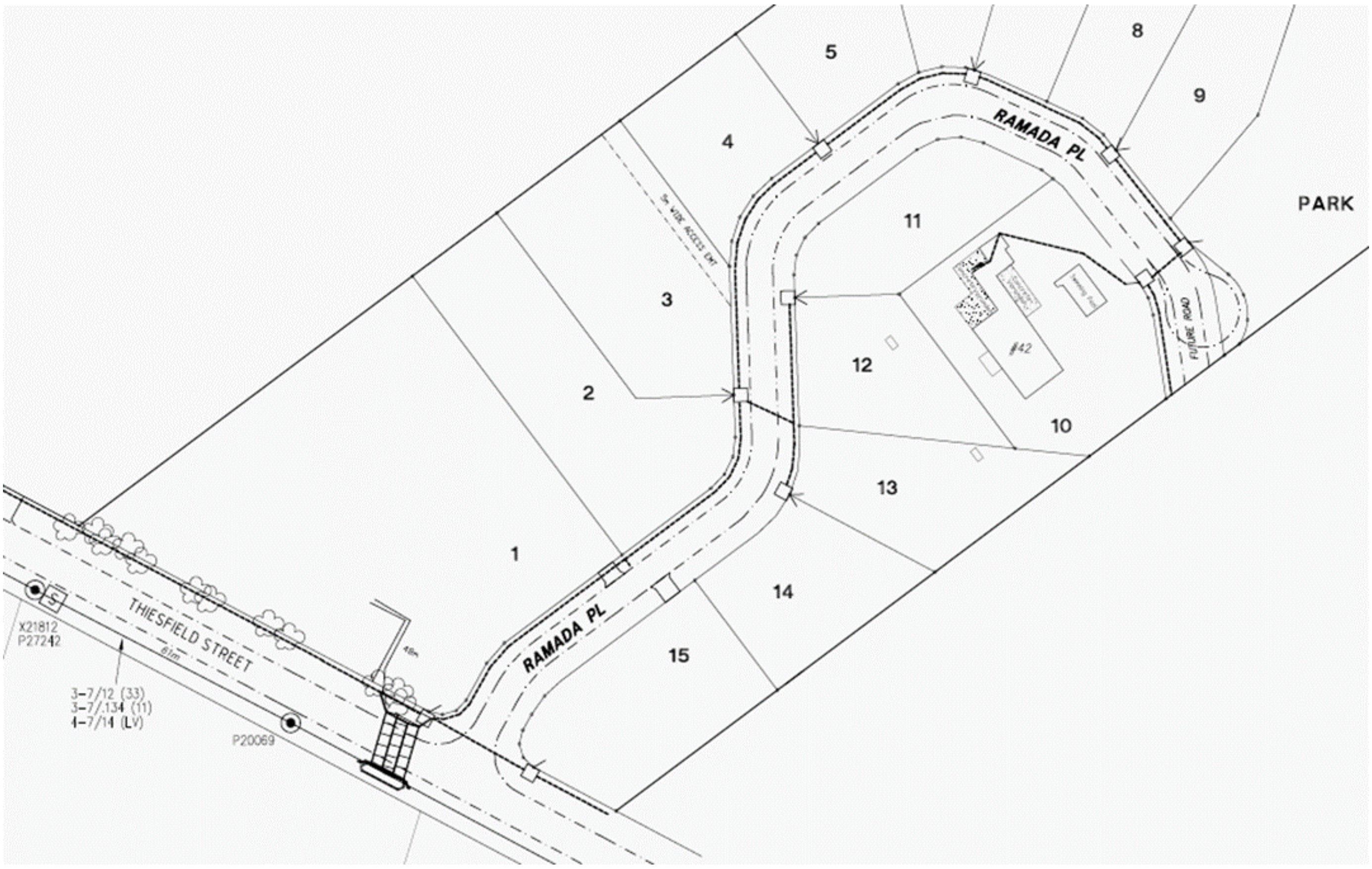
Illuminance Criteria: Minimum Illuminance (Eph) >= 0.07 lux
(Maintained values) Average Illuminance (Eav) >= 0.50 lux
Illuminance Uniformity (Up) <= 10.0

Calculation Grid: 20 x 11 points - Figure 3.7 of AS/NZS1158.2

Mounting Height	**Maximum Spacing at different Road Reserve Widths**					
	15.0	16.0	17.0	18.0	19.0	20.0
6.5	73.1	72.8	72.6	72.3	71.9	71.4
7.5	79.2	78.9	78.7	78.4	78.0	77.7

Value/s in above table are all in metres.
The table contains maximum spacings which, for the specified luminaire and lamp combination, provide compliance with the light technical parameters (LTPs) of Table 2.6 of AS/NZS 1158.3.1-2005.

With all lighting design, identifying areas of conflict is a good place to begin our design. To comply with code, the following areas of conflict must meet the specifications of category P lighting. These have been highlighted below.



A diagram illustrating such areas of conflict and their constraints can be found in *AS/NZS1158.3.1.*

For this example we will start at the temporary cul-de-sac at the end of Ramada Pl. Considering the future road works proposed on the cul-de-sac, the streetlight is placed on a known surveyed point clear of future works, in a position close to existing electrical infrastructure and to provide the best coverage.

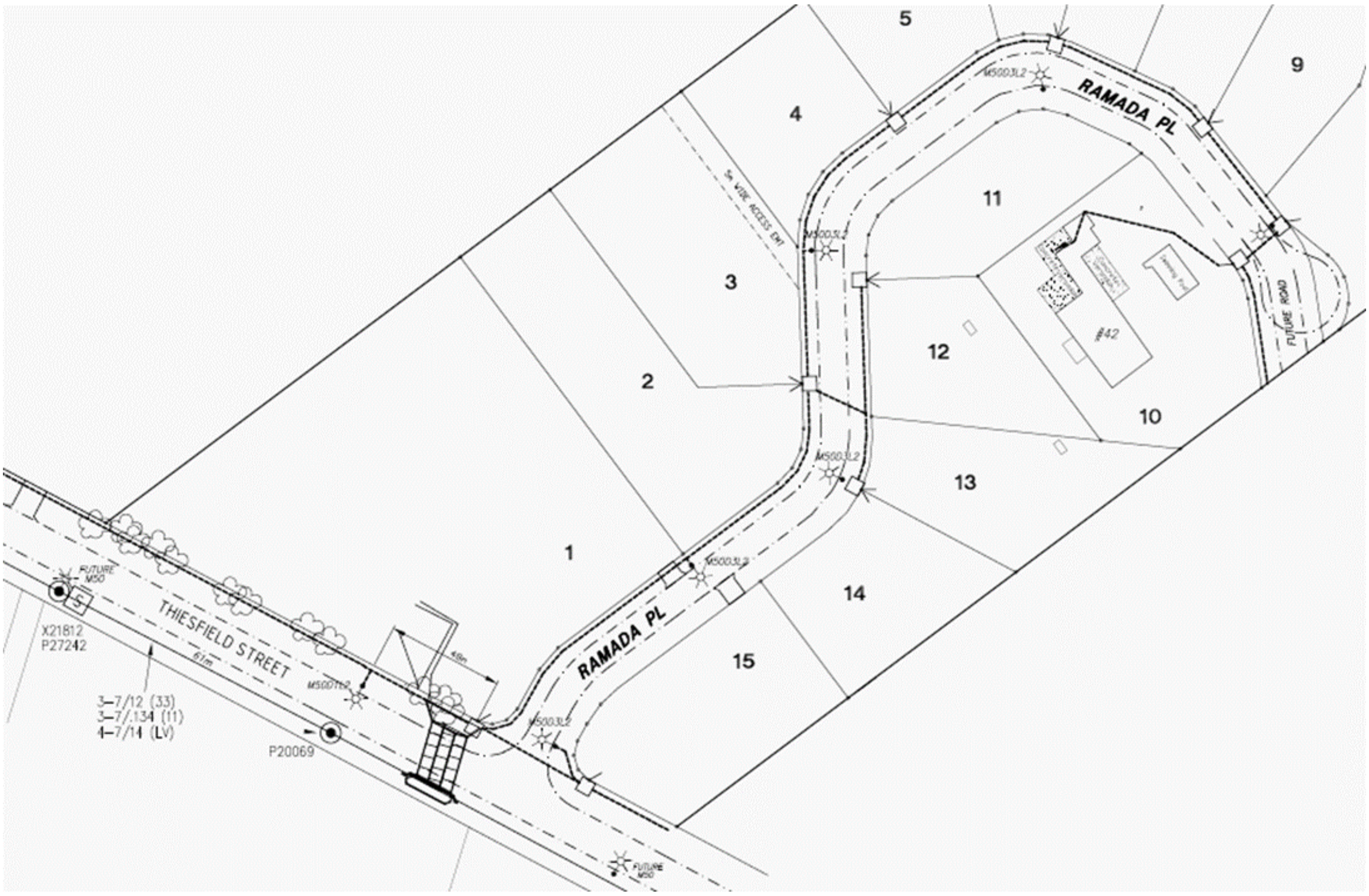
In accordance with category P lighting standards, a light must be placed at the end of a cul-de-sac but due to the temporary nature of this cul-de-sac and the location of this light falling within the future road works, this will not be considered in the design.

The next area of conflict we will consider is the intersection of Thiesfield Street and Ramada Place. To comply with code, a light must be within 10m of the intersection. In general, it is good practice to place a light right at the start of a new road leading into a subdivision. In line with this a light is positioned at the intersection not far from an existing pillar.

The final area of conflict to design for is the curved sections of Ramada Place. To design an acceptable layout for this, the code specifies that spacing between each luminaire must not exceed those required for a straight section. From our generated spacing table this is not to exceed 54.8 m. It also requires that a light be placed within a radial distance of 10 m from the centre of each road bend and in an effort to minimise glare into properties, a straight line drawn from each successive luminaire must not cross a property boundary. Lights are positioned taking into account pillar locations as illustrated below.

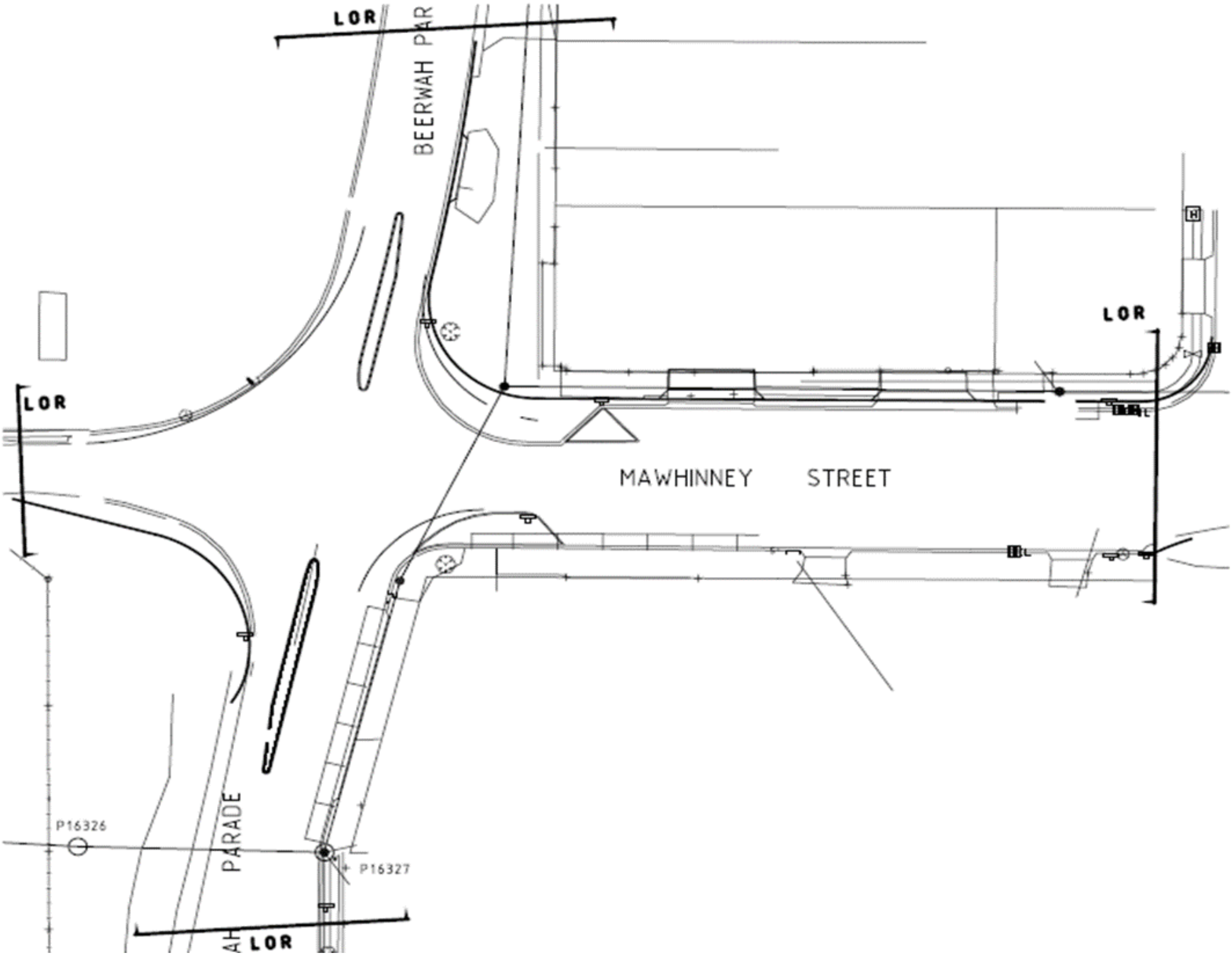
The remaining area to be designed for is the subdivision's Thiesfield St frontage. Keeping in mind that lights proposed on the opposite side of the street can be shown as future streetlights to be installed at a later date by council or other property developers, we can start by placing a future light on the existing pole X2182/P27242. Using our spacing graph calculations, we can place a light 71.4 m away on the opposite side of the road in a staggered arrangement. The final light can be shown a similar 71.4 m away as a future light on Thiesfield Street.

The final arrangement is shown below.



11 Worked Example – Category V

Design lighting compliant with Category V5 for the major road shown below. Attempt to use the poles supporting existing overhead mains where possible. To enable scaling, Mawhinney St is 30 m wide. A 60 km speed limit applies throughout. The 'LOR' lines indicate the limit of the design recommendation area.



As a rule of thumb, the standard luminaire used for a V5 Category design is an S150 (High Pressure Sodium 150W) mounted at 10.5m. The standard outreach used with this luminaire is 3.0m.

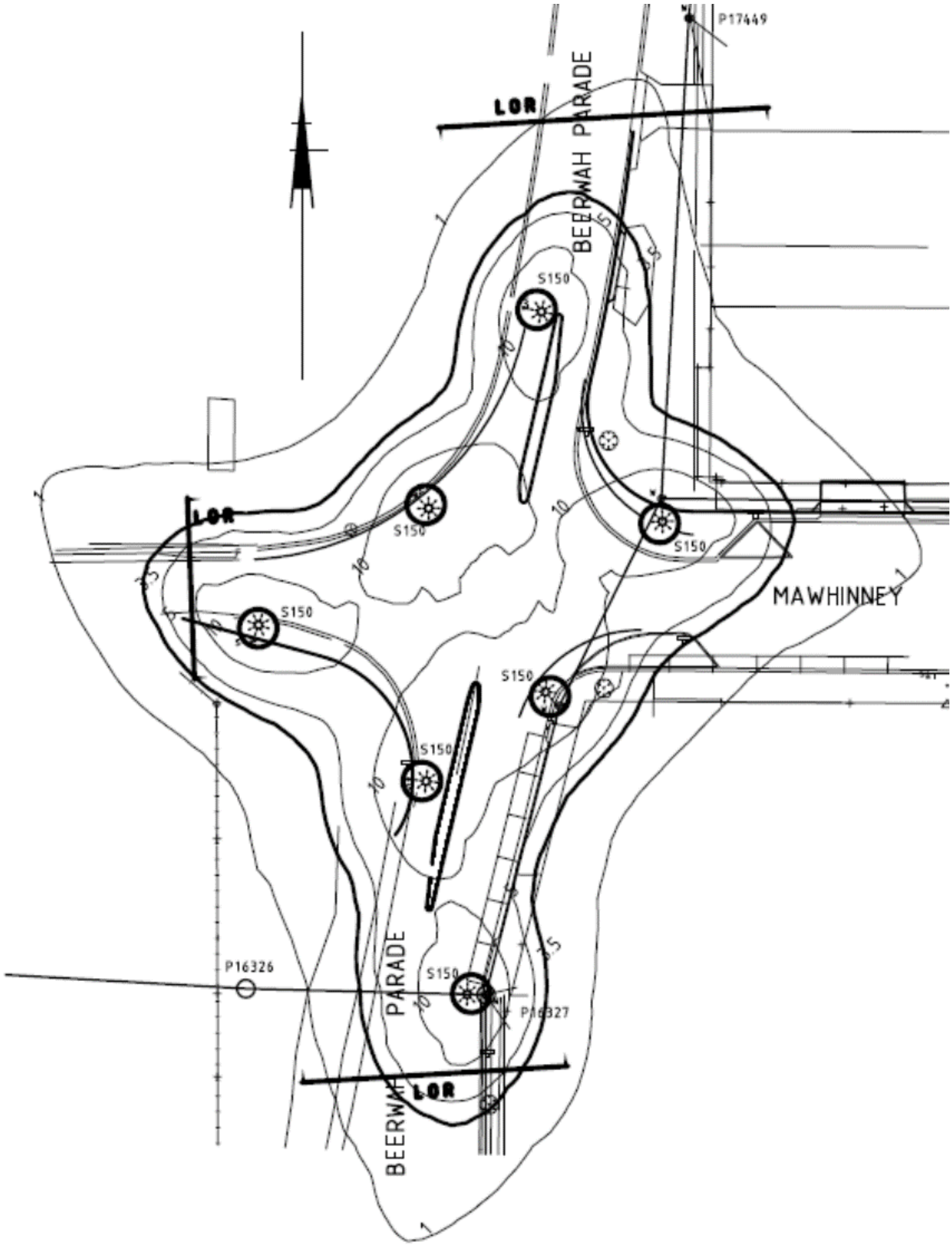
Using a top-down approach, start by designing areas that will fall under the illuminance section of the standard first, followed by areas that will fall under luminance.

Starting with the intersection of Beerwah Parade & Mawhinney Street, highlight areas of conflict as illustrated above. Conflict areas are situated where a median, splitter or any other Local Area Traffic Management (LATM) device is used or where the carriageway width has changed. These areas of conflict are to include the area immediately surrounding these positions for a radial distance of 10m.

Lights that are placed at intersections are placed a further distance behind the kerb than on straight sections. For this design, lights will be placed 1.0m behind the kerb line at intersections and conflict areas and 0.8m on straight sections. Place lights in positions that will illuminate the highlighted conflict areas making use where possible of existing infrastructure.

Isolux contours can be produced using computer software and photometric data supplied by the luminaire manufacturer. For this design, a Sylvania Roadster S150C luminaire emitting an initial value of 14,500 lumens will be used.

As a requirement of *AS/NZS1158:1:1,* this value will be altered to more accurately model the affects of pollution, luminaire wear and lamp failure by multiplying the initial lumens value by a maintenance factor of 0.7 (10,150 lm). The luminaire will also be vertically oriented at an upcast angle of 5°. The corresponding photometric file for this specific luminaire is 98207.cie.



Using the aforementioned constraints, lights are positioned at the intersection and contours generated using the luminaire data as shown above. Inspection of the contours shows that the entire intersection meets the standard of category V5 providing a minimum of 3.5 lux maintained. If the coverage were inadequate or overly generous, various layouts would need to be attempted until an optimum arrangement was obtained.

After any workable concept design has been realised, it is necessary to investigate whether any existing poles used are suitable for fitting the luminaires and associated hardware and that the mounting height can be achieved without clearance issues.

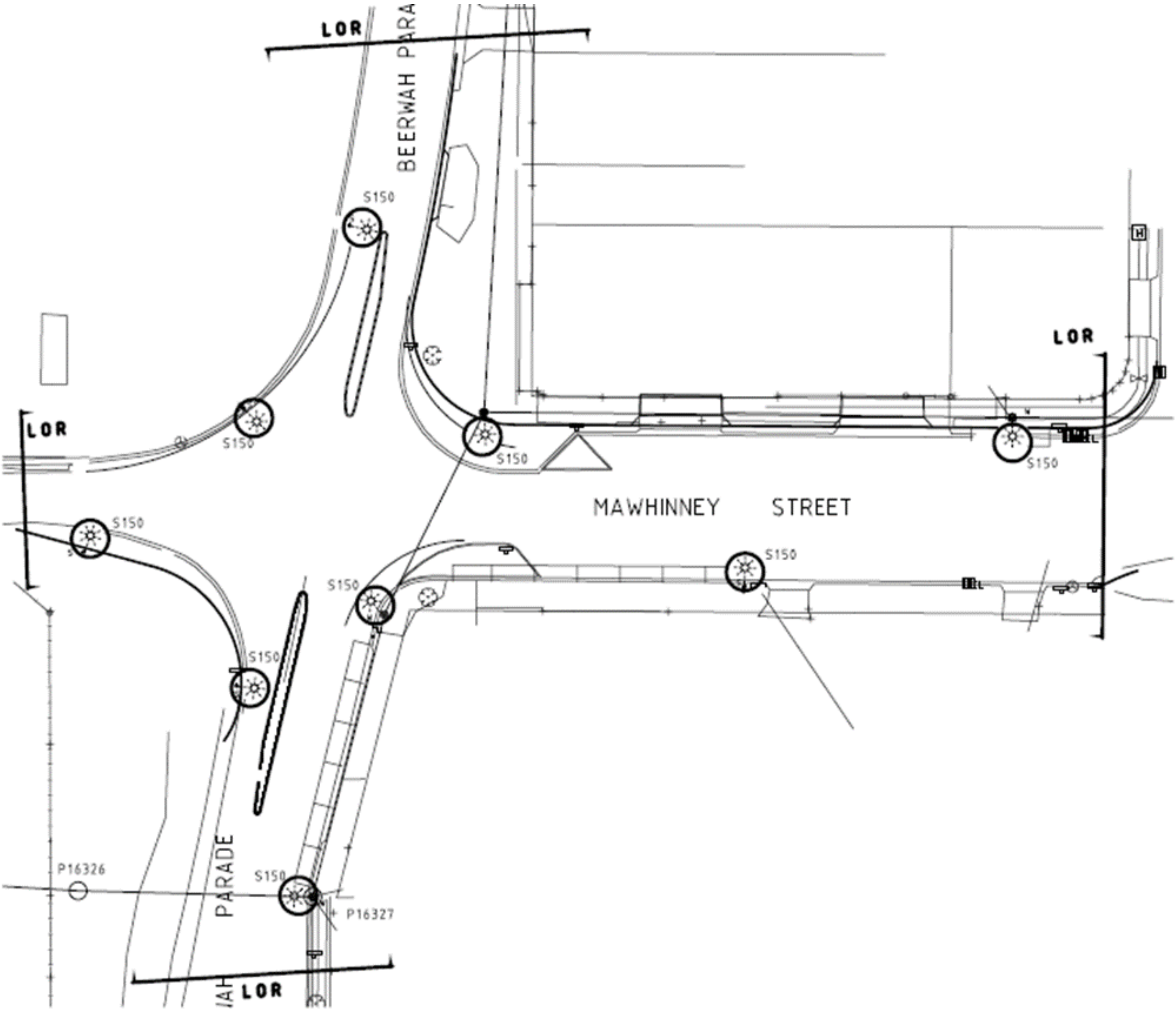
The remainder of the design area consists of a short length of straight roadway (Mawhinney St). The geometry of this area will allow us to design using luminance. The kerb-to-kerb width is 20m. The streetlight columns are to be setback a distance of 0.8m from the kerb.

The overhang calculated in this example is equal to the outreach length (3.0m) plus half of the length of the luminaire (0.3m) less the pole setback of 0.8m, i.e. 2.5m in total. Entering this data into a computer program yields the following result:

```
         Job name: Mawhinney St


         Luminaire I-table: C:\PLE\98207.CIE
         Luminaire Description: 98207 ROADSTER S150C
         Lamp Wattage & Type: S150
         Stores Code:                      Luminous Flux: 14.5 Klms
         Upcast Angle: 5 Degrees           Arrangement: 3 Single-Stagger
         Mounting Height: 10.5 m           Carriageway Width: 20 m
         Maintenance Factor: 0.7
         Overhang 1st Row: 2.5 m           Overhang 2nd Row: 2.5 m
         Outreach Size: 3                  Outreach Size: 3
         Road Surface: CIE R3
         Traffic Flow: Two Way  ---->
                                <----
         Lighting Category: V5

Spacing Traffic   Lbar     Uo      Ul    UWLR   TI    Esl    Esr   Comply
  (m)   Direct- (>=0.35) (>=0.33) (>=0.5) (=<3) (=<20) (>=50) (>=50) with
        ion  or (>=0.38) (>=0.31)    "      "     "      "      "    V5
===========================================================================
 30.00  Normal     .69    0.32    0.69   1.69  16.98  77.78  77.78  YES
 31.00  Normal     .67    0.32    0.63   1.69  17.17  77.14  77.85  YES
 32.00  Normal     .65    0.31    0.61   1.69  17.23  76.98  77.74  YES
 33.00  Normal     .62    0.31    0.58   1.69  17.45  77.82  77.82  YES
 34.00  Normal     .61    0.31    0.57   1.69  17.66  78.06  78.06  YES
 35.00  Normal     .59    0.30    0.55   1.69  17.83  77.78  77.78  NO
 36.00  Normal     .57    0.30    0.47   1.69  18.01  77.12  78.09  NO
 37.00  Normal     .56    0.29    0.45   1.69  18.06  76.99  77.74  NO
 38.00  Normal     .54    0.28    0.44   1.69  18.29  77.86  77.87  NO
 39.00  Normal     .53    0.27    0.43   1.69  18.47  78.02  78.02  NO
 40.00  Normal     .52    0.27    0.42   1.69  18.36  77.78  77.78  NO
===========================================================================
NOTE: Where 'Normal' &/or 'Oncoming' lines are shown, compliance
      with the nominated Category, at a particular spacing, is
      only applicable when there is a 'Yes' on each line
      i.e. ANY 'No' indicates failure at that spacing.

--------------------------------------------------------------------------
PleVcat - Vers 5.02 (Built: 19/3/10)         Run: 18/ 5/2010 at 16:23:15
```

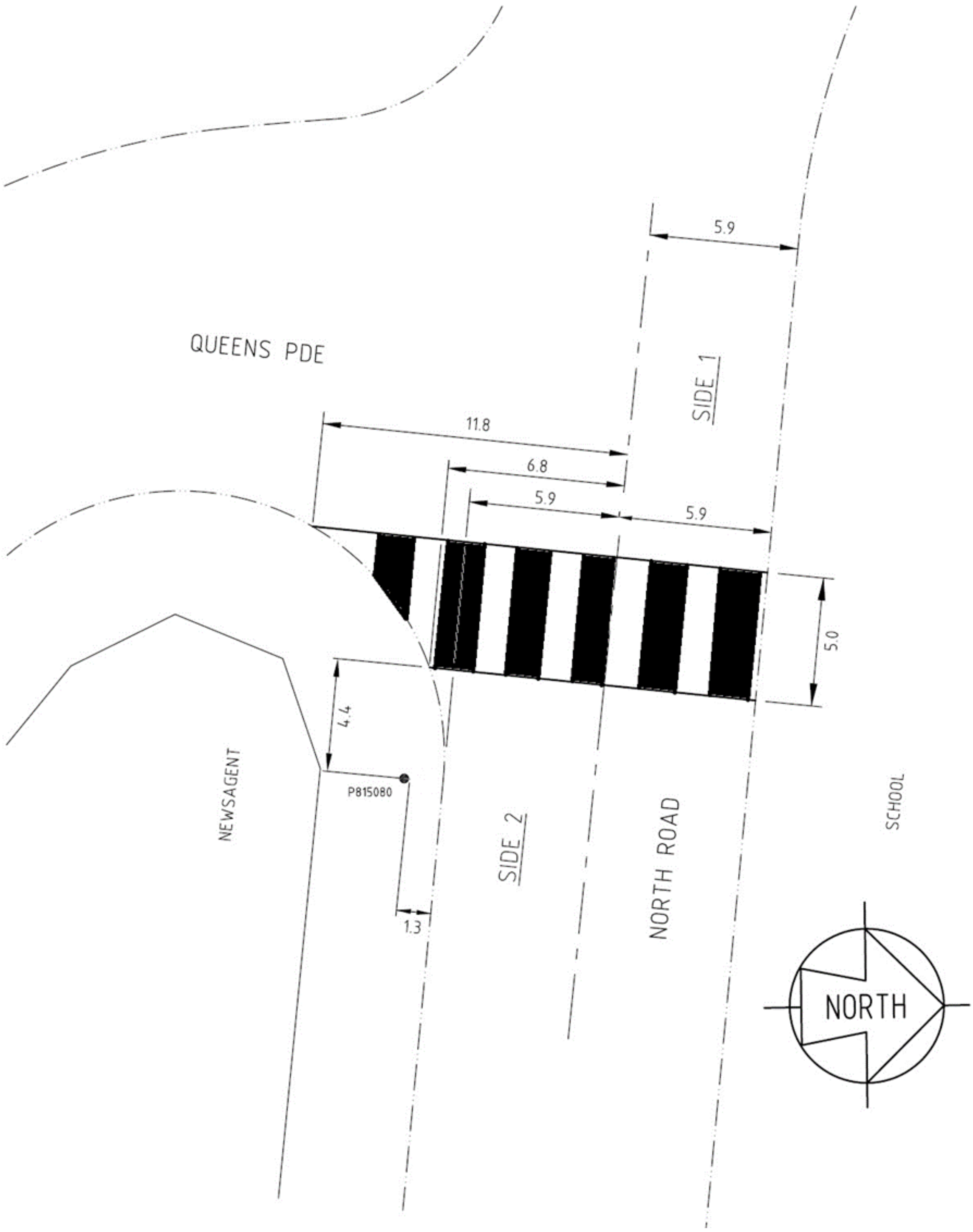
Making use of existing infrastructure, a light is placed at the eastern end of Mawhinney St. Using our spacing results, another light is placed clear from the driveway on the southern side of the street as shown. The spacing distances measured parallel along the carriage way are 31m and 34m respectively - all within our spacing requirements.

The final lighting design is illustrated below.



12 Worked Example – Category PX

Design pedestrian crossing floodlighting for zebra crossings shown on the roadway below. There is an existing power pole, P815080, located on the eastern footpath of North Road that could be utilised for the installation.



Start with the western side of the crossing (side 1). This requires the installation of a new pole - in this case a 7.0m BPM steel pole on the northern side of the road. This is to be utilised as a dual use pole i.e. streetlight and pedestrian light. The floodlight spigot height is to be 7.5m. It is to be underslung to give a mounting height of 7.1m. The outreach arm is 3m. The pole is to be positioned 5m back from the leading edge of the crossing. A S250 wide-beam floodlight (with louvre) is selected.

Using the appropriate software, establish the best aiming point considering the glare and illuminance. The optimal design is shown below using initial values.

```
                                        Carriageway                     Carriageway
------ Glare Results ------                edge                         centre line
 70 =3893 cd   80 =887 cd                  |----- 3     -----+                |
 72 =3295 cd   82 =643 cd       Ht=1.5m   |59 lx         67 lx              |55 lx
 74 =2547 cd   84 =422 cd       Ht=0.0m   |67 lx         73 lx              |58 lx
 76 =1792 cd   86 =312 cd       -+-       | ## ## ## ## ## ## ##            |
 78 =1246 cd   88 =299 cd        |        | ## ## ## ## ## ## ##            |
---------------------------      5        |109 lx## ## #129 lx ## ##        |94 lx
  +--------------------+         | -+-    |79 lx ## ## #92 lx ## ##         |75 lx
  | Illuminance: PASS  |         | 4      | ## ## ## ## Aim Point#          |
  |       Glare: PASS  |        -+--+-    | ## ## ## ##. ## ## ##           |
  | Total Design: PASS |         |        |109 lx         145 lx            |101 lx
  +--------------------+         5        |59 lx          72 lx             |56 lx
                                 |        |                                 |
  Luminaire code no.: 1181      -+-                  ###
                                                        Floodlight
   Luminaire height: 7.1              +---- 2.3   ---+               (Diagram NOT
                                                                      to Scale)
  Lamp flux (Klmns): 28               +------------ 5.9   -----------+

Job name: NORTH ST BRIGHTON-SIDE 1 /EAST BOUND

6/ 5/2010 09:20:35                                                     Version 4.89

                     ---- VERTICAL ILLUMINANCE SUMMARY ----

                     At ground level    1.5 m above ground

                        A1 = 59 lx          B1 =109 lx
                        A2 = 72 lx          B2 =145 lx
                        A3 = 56 lx          B3 =101 lx
                        A4 = 79 lx          B4 =109 lx
                        A5 = 92 lx          B5 =129 lx
                        A6 = 75 lx          B6 = 94 lx
                        A7 = 67 lx          B7 = 59 lx
                        A8 = 73 lx          B8 = 67 lx
                        A9 = 58 lx          B9 = 55 lx
```

Now prepare the eastern side crossing design (side 2). P815080 is located 4.4m back from the leading edge of the crossing and 1.3m behind the kerb. To utilise this pole, it will be necessary to install a 4.5m bracket inclined 45º backwards from the crossing to improve the downward angle. The floodlight will then be positioned 7.6m back from the leading edge of the crossing. A S400 narrow beam (with louvre) floodlight is selected. It is to be mounted at 9.1m (9.5 spigot height). There is a 1.9m overhang from the face of the kerb.

Using the appropriate software, establish the best aiming point considering the glare and illuminance.

```
                                     Carriageway              Carriageway
------ Glare Results ------             edge                  centre line
 70 =5586 cd   80 =575 cd              |----- 1.5   -----+      |
 72 =3125 cd   82 =534 cd      Ht=1.5m |129 lx        144 lx    |124 lx
 74 =1408 cd   84 =425 cd      Ht=0.0m |214 lx        237 lx    |166 lx
 76 =316 cd    86 =339 cd      -+-     | ##  ##  ##  ##  ##  ##  ##  |
 78 =496 cd    88 =278 cd       |      | ##  ##  ##  ##  ##  ##  ##  |
---------------------------     5      |329 lx## ##  #368 lx ## ## |211 lx
  +--------------------+        | -+-  |256 lx## ##  #254 lx ## ## |133 lx
  |  Illuminance: PASS |        | 3    | ##  ##  ##  ##  Aim Point# |
  |        Glare: PASS |       -+--+-  | ##  ##  ##  ##. ##  ##  ## |
  | Total Design: PASS |        |      |286 lx        264 lx    |131 lx
  +--------------------+        7.6    |136 lx        115 lx    |58 lx
                                |      |                        |
  Luminaire code no.: 1183     -+-                ###
                                                   Floodlight
   Luminaire height: 9.1             +---- 2.8   ---+          (Diagram NOT
                                                                to Scale)
   Lamp flux (Klmns): 48             +------------ 6.8   -----------+

 Job name: NORTH ST BRIGHTON-SIDE 2/WEST BOUND/FRONT

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                    ---- VERTICAL ILLUMINANCE SUMMARY ----

                    At ground level    1.5 m above ground

                       A1 =136 lx         B1 =286 lx
                       A2 =115 lx         B2 =264 lx
                       A3 = 58 lx         B3 =131 lx
                       A4 =256 lx         B4 =329 lx
                       A5 =254 lx         B5 =368 lx
                       A6 =133 lx         B6 =211 lx
                       A7 =214 lx         B7 =129 lx
                       A8 =237 lx         B8 =144 lx
                       A9 =166 lx         B9 =124 lx
```
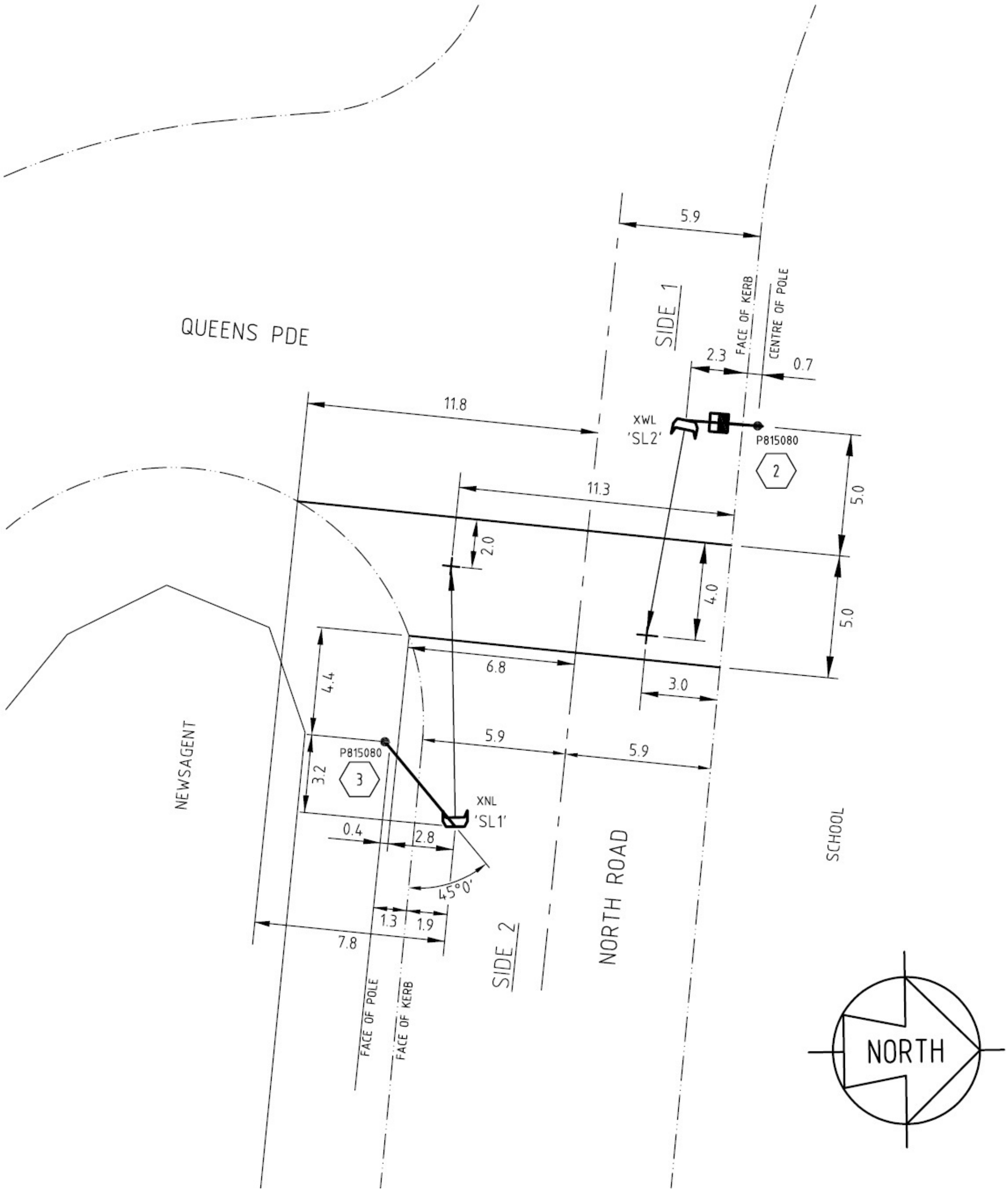
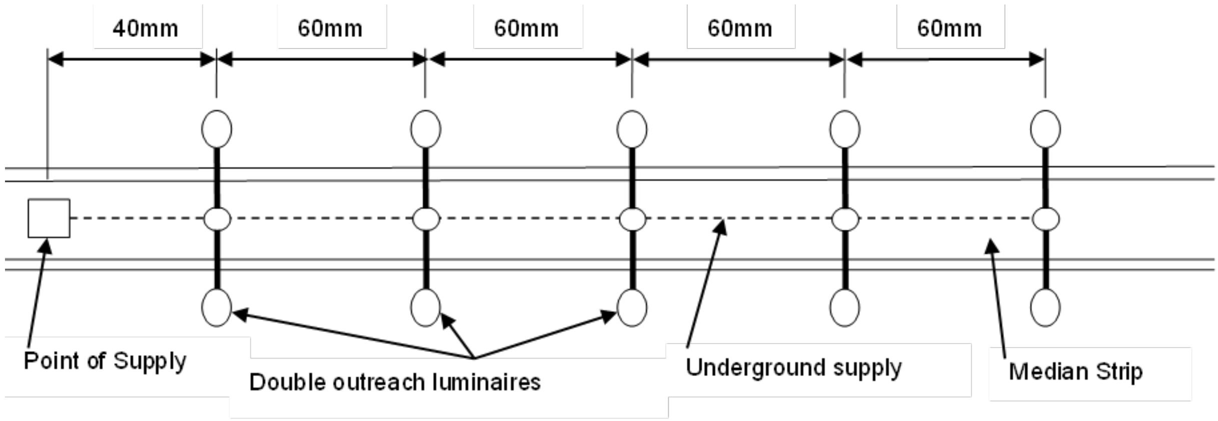

The final design is shown below.



QUEENS PDE
SIDE 1
FACE OF KERB
CENTRE OF POLE
5.9
2.3
0.7
11.8
XWL
'SL2'
P815080
2
11.3
5.0
2.0
4.0
5.0
4.4
6.8
3.0
5.9
5.9
NEWSAGENT
P815080
3
3.2
XNL
'SL1'
0.4
2.8
45°0'
1.3
1.9
7.8
SIDE 2
NORTH ROAD
SCHOOL
FACE OF POLE
FACE OF KERB
NORTH

13 Worked Example – Electrical Reticulation



Consider the case of the circuit shown above. It shows five double outreach streetlights spaced at 60m intervals with the supply pillar located 40m from the first streetlight. The luminaires are L138. The circuit is 2C 16mm² Cu XLPE/PVC protected by a 32 amp fuse in the pillar. Determine the adequacy of the circuit cable, the voltage drop to the last streetlight, Inrush current and the fault loop impedance for the circuit protective device.

From Table 20, the running current of a L138 is 0.58 amps.

For five double outreach lighting columns, the total starting current for a bulk switched circuit would be:

$$0.58 * 5 * 2 = 5.8\ amps$$

13.1 Determine the circuit cable size

All lights in the scheme are BPM; hence the minimum circuit cable size is 16mm². From Table 44, it can be seen that 2 core 16mm² Cu XLPE/PVC cable has a current carrying capacity of 105 Amps. The 16mm² cable has adequate current carrying capacity to supply the streetlights on the circuit.

13.2 Determine the voltage drop

If all the lights in the scheme are LED, only the running current needs to be considered for the purposes of determining voltage drop, refer Section 9.5.

The voltage moment method can be used here. The distance to the load centroid is:

$$40 + (60 * 2) = 160\ m$$

From Table 44 , the resistance of the 16 mm² Cu cable is 0.00126 Ω/m. For single phase, the resistance is doubled allowing for the current flow in both the active and neutral conductor. Hence, the resistance for these calculations will be:

$$2 * 0.00126 = 0.00252\ \Omega/\mathrm{m}$$

Voltage drop is then:

$$5.8 * 160 * 0.00252 = 2.34\ V$$

The maximum allowable voltage drop is 14 volts which is derived from the nominal voltage at the point of supply being 230 V less the minimum allowed voltage of 216 V. The total voltage drop is

2.34 V which is less than the allowable voltage drop of 19 volts. Hence the voltage drop for the circuit is within limits.

13.3 Determine Inrush Current

As all the lights in the scheme are LED, consideration must be given to ensure the inrush current does not cause inadvertent tripping of the 32 amp fuse at the Point of Supply. From Section 9.7, as there are fewer than 20 luminaires in the circuit no additional calculation is required.

13.4 Determine the fault loop impedance.

From *AS/NZS3000*, the maximum fault loop impedance allowable for the 32 amp fuse for 0.4 second clearance time is 1.28Ω.

Assuming that the distribution network accounts for 20% of this, the maximum allowable impedance would be

$$0.80 * 1.28 = 1.024\ \Omega$$

The total circuit length is

$$40 + (4 * 60) = 280\ m$$

For a 2 core 16mm² Cu XLPE/PVC cable, the impedance is:

$$\frac{2 * 280 * 0.0225}{16} = 0.79\ \Omega$$

This is less than the limit of 1.024 Ω and therefore acceptable.

Calculation of fault loop impedances for 2 core 4 mm² Cu PVC/PVC and 2 core 16mm² Cu XLPE/PVC cables, calculated in accordance with the method described in AS/NZS 3000, reveal that the **maximum reach of these cables**, as described in the following table, and used as main streetlight circuits emanating from LV mains and controlled by a 32 Amp fuse may be utilised in reticulation design without further calculations, subject to voltage drop limitations.

Table 45: Maximum Reach of Typical Service Cables Not Entering Steel Pole

Main Public Lighting Cables not Entering Steel Lighting Pole	Loop Impedance of Cable (reference Table 42 of this Design manual) Ohms/100 m	Maximum Loop Impedance of Cable (being 80 % of Zs from Table 8.1 of AS/NZS 3000:2007 for 32 Amp fuse 5.0 sec. disconnection time) Ohms	Max. Reach For fault clearing time of 5.0 seconds with 32 Amp fuse metres
2c 4 mm² Cu PVC/PVC	1.012	1.752	173
2c & 4c16mm² Cu XLPE/PVC	0.252	1.752	695

Table 46: Maximum Reach of Typical Service Cables Entering Steel Pole

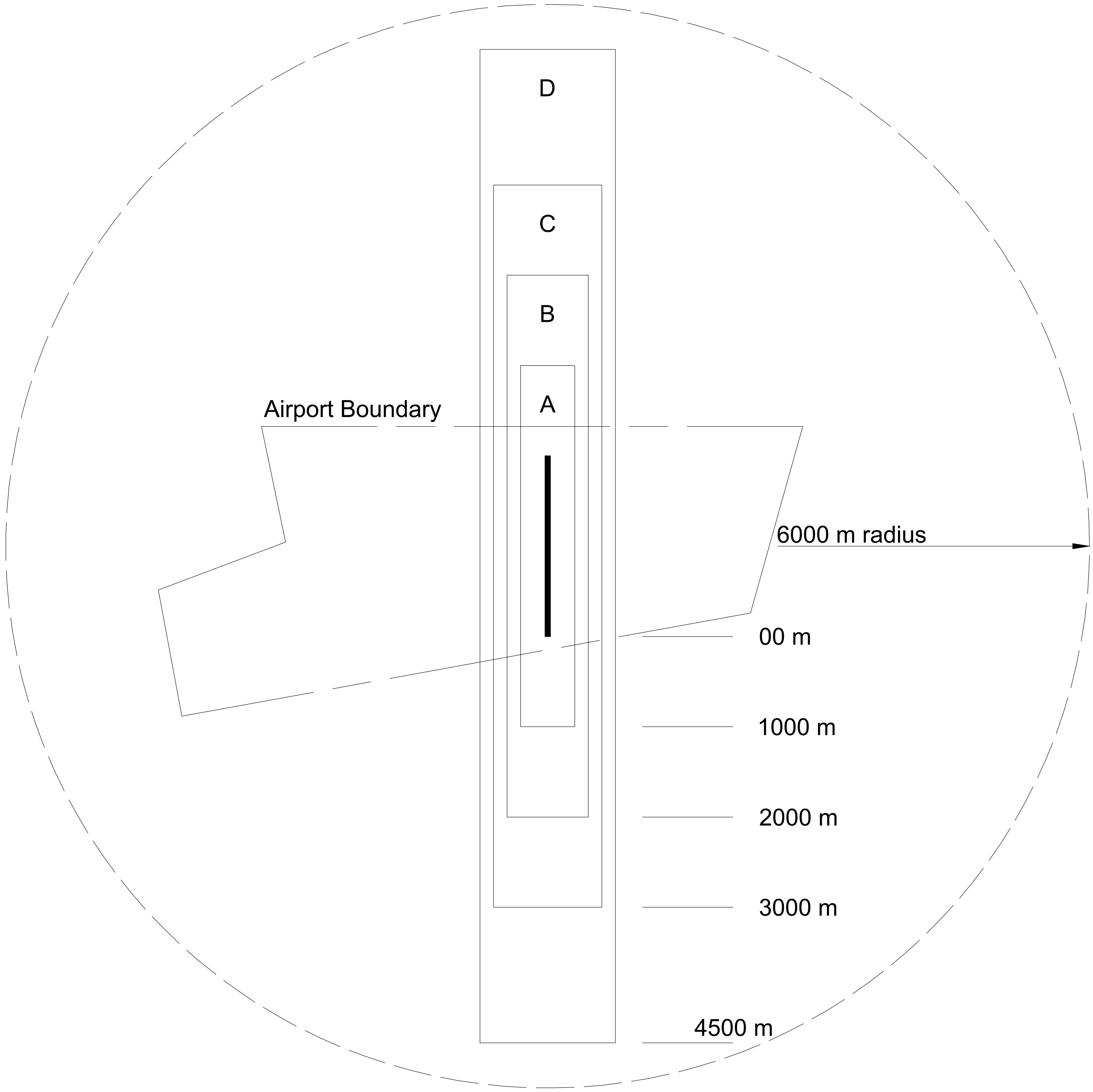
Main Public Lighting Cables Entering Steel Lighting Pole	Loop Impedance of Cable (reference Table 42 of this Design Manual) Ohms/100 m	Maximum Loop Impedance of Cable (being 80 % of Zs from Table 8.1 of AS/NZS 3000:2007 for 32 Amp fuse 0.4 sec. disconnection time) Ohms	Max. Reach For fault clearing time of 0.4 seconds with 32-amp fuse metres
2c 4 mm² Cu PVC/PVC	1.012	1.024	101
2c & 4c16mm² Cu XLPE/PVC	0.252	1.024	406

Note: Hybrid circuits of 16 mm² and 4 mm² cables in series require separate calculations or else fusing down at the change of conductor cross-sectional area.

Appendix 1 – Airport Light Control Zones (Normative)

Maximum intensity of light sources measured at 3° above the horizontal.

ZONE A	0 cd	600 m WIDE 1000 m FROM RUNWAY STRIP
ZONE B	50 cd	900 m WIDE 2000 m FROM RUNWAY STRIP
ZONE C	150 cd	1200 m WIDE 3000 m FROM RUNWAY STRIP
ZONE D	450 cd	1500 m WIDE 4500 m FROM RUNWAY STRIP



Approved A.Bletchly	*Date* 17/10/23		
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Drawn T.Borg	*Date* 13/09/23		
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PUBLIC LIGHTING DESIGN
APPENDIX 1
AIRFIELD LIGHT ZONES

VOLUME	FOLDER	PAGE	ISSUE
8	2	1-1	A

Appendix 2 – Local Authority Requirements

This page is left intentionally blank. Designers may include the specific requirements of the Public Bodies in this section.

Appendix 3 – Revision History (Informative)

Revision date	Version Number	Author	Description of change / revision
	1.0		Initial issue
	2.0		
	3.0		
Oct 2023	4.0	A. Bletchly	Template update Include LED luminaires. Include RCBO as a protective device option, along with application notes. New Section added to cover minimum clearance to driveways. Table 6 updated to match AS/NZS 1158. New Section added to cover inrush current for LED luminaires Worked example – electrical reticulation updated to LED luminaire.