Public Lighting Design Manual

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1. FOREWORD

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 HPS and MV luminaires have been used for minor road applications. It is recognised however that the use of mercury vapour lamps is now being discouraged. Accordingly designs incorporating mercury vapour lamps for minor roadways in Queensland will not continue. Instead, designs for minor roadways should incorporate HPS, compact or linear fluorescent lamps.

Acknowledgement is given to the *AS/NZS1158* series for a number of drawings and sketches that have been incorporated into this manual.

The Public Lighting Design Manual (PLDM) has been compiled in conjunction with the Engineering Standards and Technology of Energex Limited and the Asset Management Standards Department of Ergon Energy.

Note: Printed versions of the PLDM are 'uncontrolled copies' - the latest version is available on the Energex website (www.energex.com.au) or Ergon Energy website (www.ergon.com.au).

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.

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 designs 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.

Copyright

2. 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.

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.

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)

3. DEFINITIONS, ABBREVIATIONS AND ACRONYMS

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. An undivided road, either one way or two way, comprises a single carriageway. A road divided longitudinally by a median or similar comprises two 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.

DNSP (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.

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.

4. REFERENCES

AS 4282 – Control of Obtrusive Effects of Outdoor Lighting

AS/NZS 1158 series – Lighting for Roads and Public Spaces

AS/NZS 1170 – Structural Design Actions

AS/NZS 1798 – Streetlight Poles and Outreaches

AS/NZS 3000 – Wiring Rules

CASA Manual of Standards Part 139 – Aerodromes

Queensland Public Lighting Construction Manual

Standard Conditions for Public Lighting Services

National Electricity Rules

Queensland Electricity Act and Regulations

Queensland Electrical Safety Act and Regulations

Queensland Police – Crime Prevention through Environmental Design (CPED) Guidelines

Queensland Transport Infrastructure Act

Queensland Transport Operations Act (Road Use Management) Act

Work Health and Safety Act

5. BASIC LIGHTING CONCEPTS

5.1 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).

5.2 Geometry and Terminology

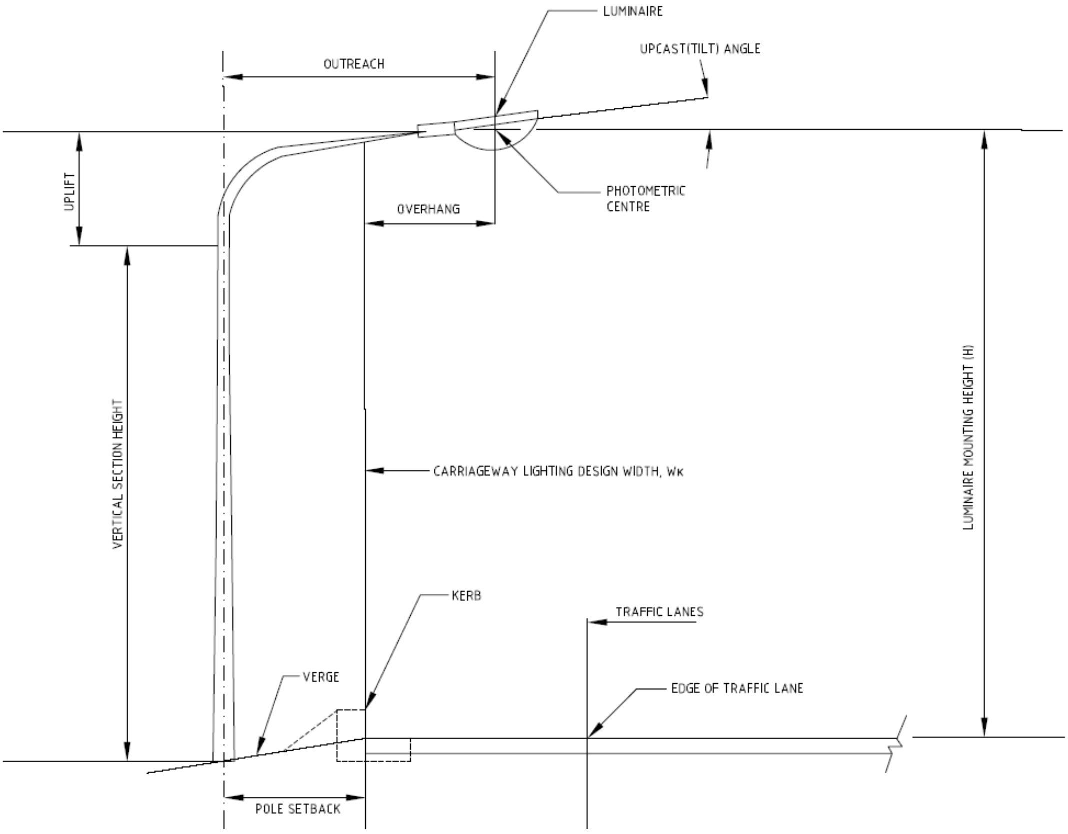


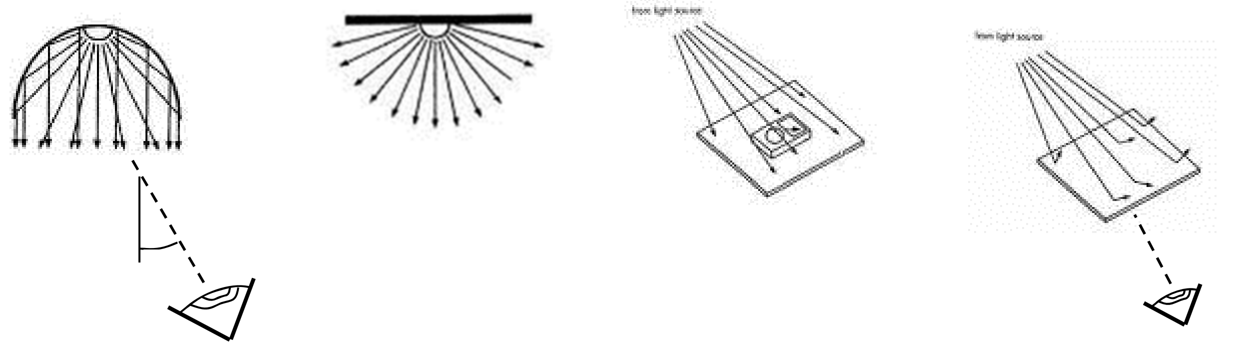
Figure 1: Geometry and Terminology used in a Typical Road Lighting Installation

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.

Table 1: Key Lighting Terminologies and their Application

5.3 Photometric Quantities and Units

5.3.1 *Key Lighting Quantities*



Luminous Intensity	Luminous Flux	Illuminance	Luminance
The perception of a light source intensity measured in candelas (cd) as perceived from a defined observer position.	Total amount of light emitted by a light source (lumens)	Light falling onto a specified flat surface measured in lux (lx or lm/ m^2)	The perception of the surface brightness measured in cd/m^2 as perceived from a defined observer position.

Figure 2: Typical Road Lighting Quantities

5.3.2 *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

Table 2: Typical Road Lighting Technical Parameters

5.3.3 *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 (E_h) is the value of illuminance on a designated horizontal plane or at level ground.

Vertical illuminance (E_v) 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).

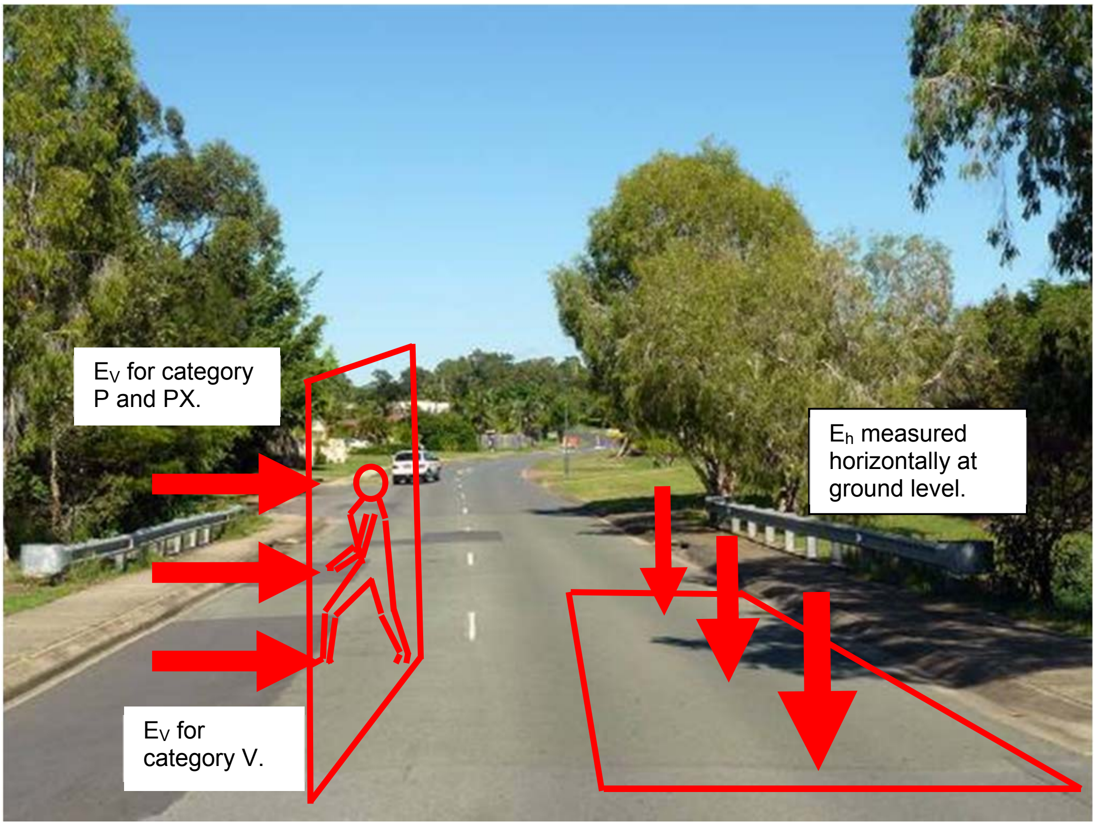


Figure 3: Horizontal and Vertical Illuminance Planes

5.3.4 *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.

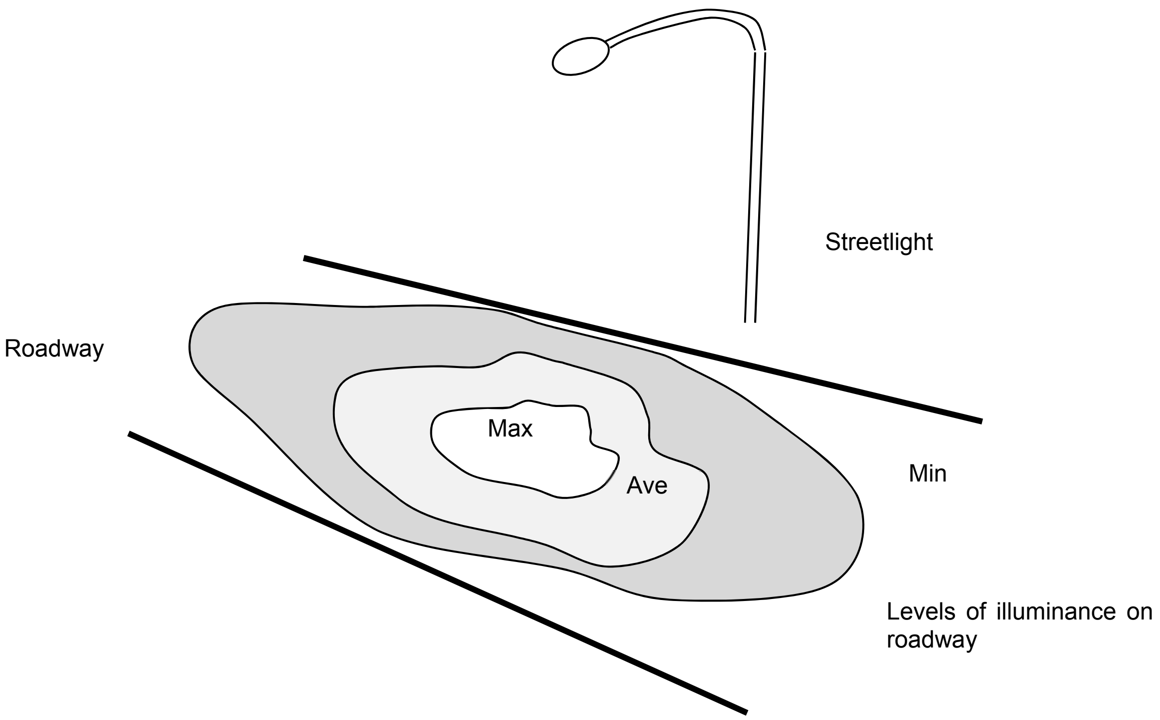
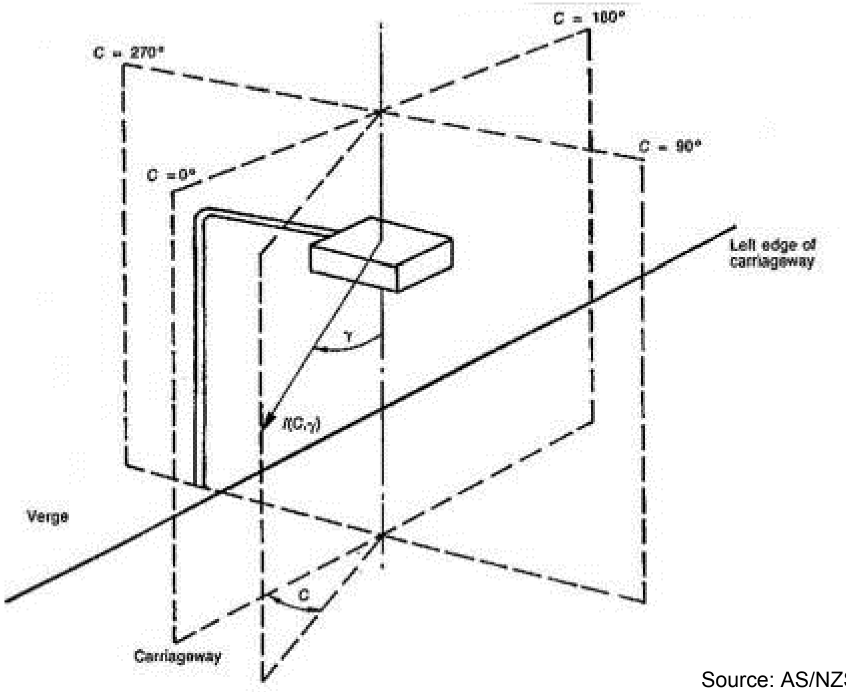


Figure 4: Typical Isolux Diagram Indicating Levels of Illuminance

5.3.5 *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.

5.3.6 *I-Tables*

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

98262 - ROADSTER S100C

γ 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 street light at a specified mounting height and upcast angle.

5.3.7 *Isolux Diagrams*

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

0.5 lx

1 lx

2 lx

5 lx

10 lx

20 lx

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 street lights is determined by integrating the two concepts described above.

5.3.8 *Inverse Square Law*

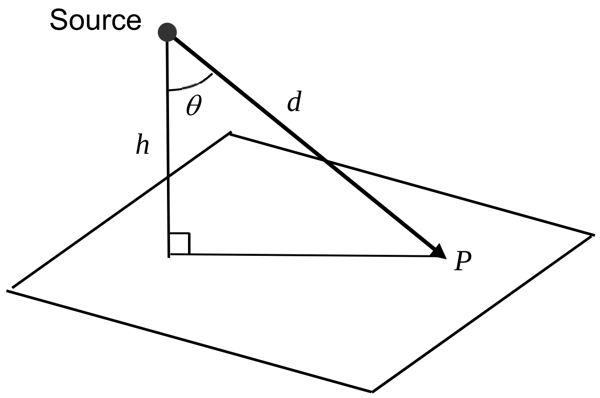


Figure 8: Illumination of a Plane

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.

5.3.9 *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.

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

Table 3: Colour Rendering for the Various Lamp Types available

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.

5.3.10 *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.

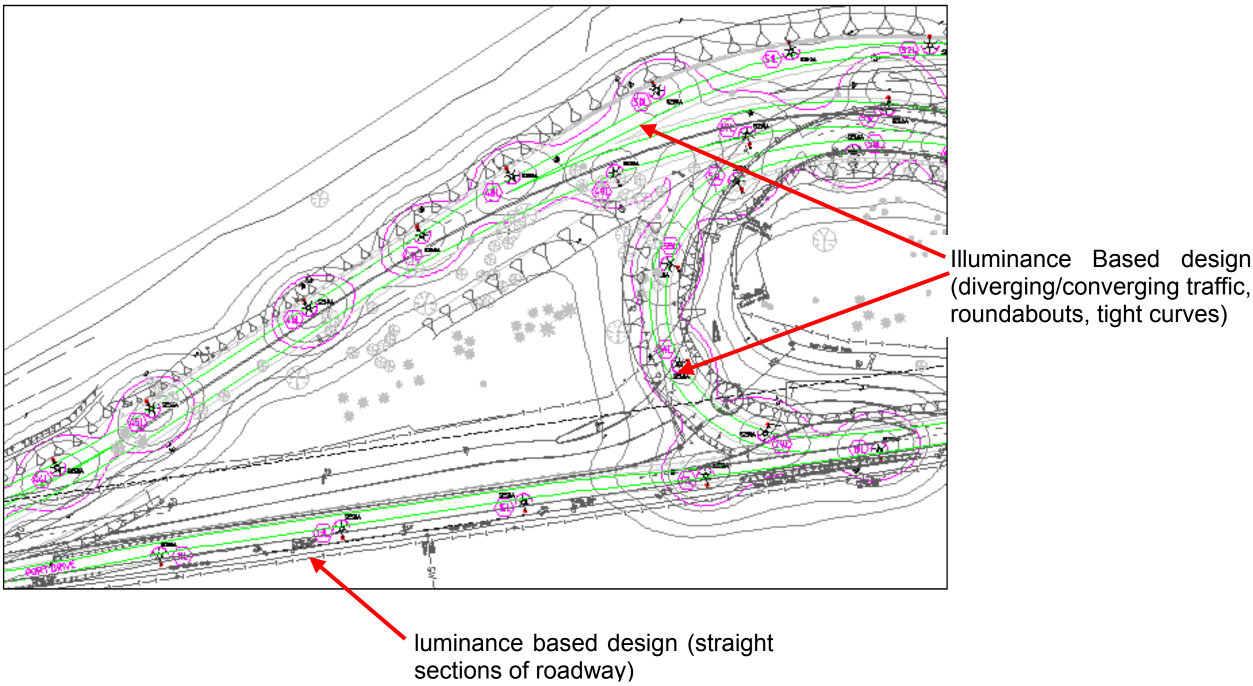


Figure 9: Typical Luminance and Illuminance Lighting design

5.4 Lighting Standards and Categories

5.4.1 *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.

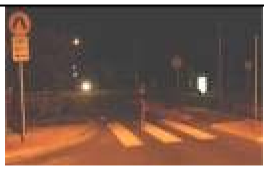
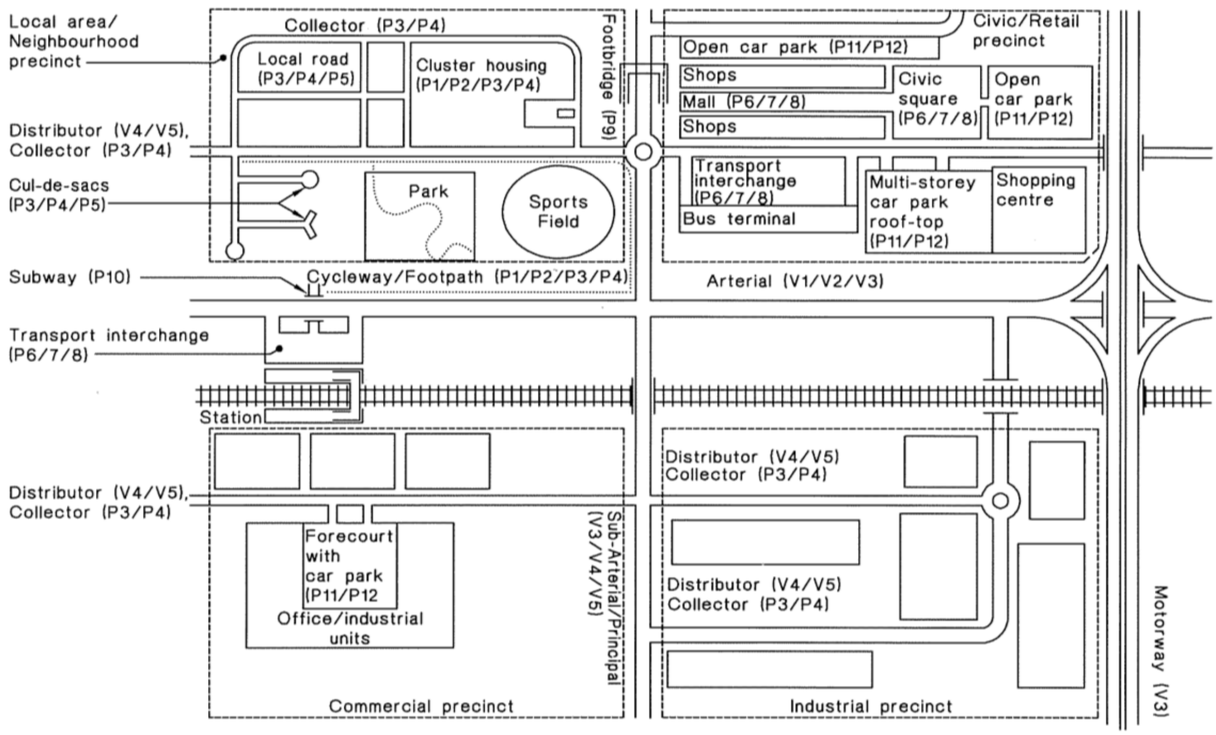
Category	Typical Example	Applications
		Non *AS/NZS1158* Private roadways, existing rural roadways
V		*AS/NZS1158 part 1* Used for high traffic volume roadways where the requirement of <u>motorists</u> is dominant. Includes provision for motorways, arterial and sub arterial and main roads, speed zoning, 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* Used for low volume traffic roadways and other outdoor public spaces where the requirement of <u>pedestrians</u> 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		Used for both traffic and pedestrian underpasses, tunnels where the lighting is fixed directly to walls.

Table 4: *AS/NZS1158* Public Lighting Categories

5.4.2 *Subcategories of Category V and P Public Lighting*

Figure 10 shows typical applications for the various categories and subcategories of lighting in *AS/NZS1158* series.



Source: AS/NZS1158:3.1

Figure 10: Examples of Public Lighting Categories

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.

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

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

There are 12 subcategories for Category P identified in the *AS/ZNS 1158* series; nine are utilised by the Queensland DNSPs. They are identified in Table 6.

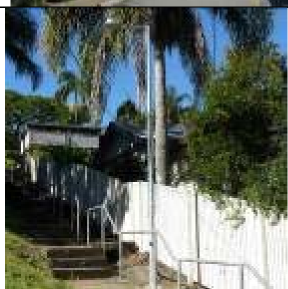
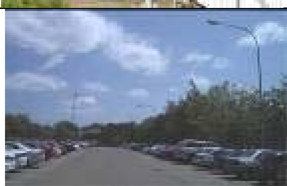
Sub Section	Typical Example	Application
P3 - 4		Local collection roads used for accessing abutting properties and common areas, pedestrian path and cycle ways.
P5		Local roads used for accessing abutting properties and common areas
P6 - 8		Outdoor shopping precincts, malls, open arcades, town squares, civic centres , transport terminals and interchanges
P9		Stairs and ramps
P11		Public car park spaces, aisles, circulation roadways. There are three sub categories for this category.
P12		Designated parking spaces specifically intended for people with disabilities

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

5.4.3 *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.

5.4.4 *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.

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

Table 7: Subcategories of Category PX Lighting

5.4.5 *Technical Parameters relevant to each Lighting Category*

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

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

Table 8: Lighting Technical Parameters

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.

5.4.6 *Typical Luminaires used for Different Categories*

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.

Table 9: Typical Luminaire Application

5.5 Ownership, Responsibilities, and Rates

Lighting is provided under a number of DNSP funding arrangement schemes which allow for the installation of standard and non standard 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.

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 TMRD
3	Public Body	Up front by developer	Standard or non-standard Cabling to *AS/NZS3000*	• TMRD where maintenance access is difficult • Decorative special • Tollways

Table 10: Basic Requirements and Responsibilities for Public Lighting Schemes

5.6 Lighting Styles

5.6.1 *Standard, Decorative, Post Top, High Mast, Bulkhead*

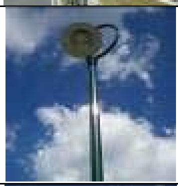
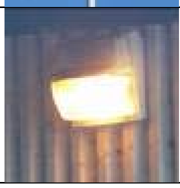
Light	Typical Example	Application
Standard		This is the most common street light column. It may support single, or multiple outreaches and luminaires. Generally steel columns and outreaches (Ergon Energy use some concrete in certain circumstances).
Decorative		There is a variety of decorative lighting 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. They can present problems with glare.
Post Top		Post top lighting is 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 street lighting 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.

Table 11: Lighting styles available

5.6.2 *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.

Type	Typical Example	Application
Semi Cut Off (SCO)		The most commonly used for road lighting Designed to reduce the glare impact on drivers
Aeroscreen (cut off)		Aeroscreen luminaires are used: • 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. They are spaced closer together than SCO lighting due to reduced lateral light dispersion.

Table 12: Typical Luminaire Types

5.6.3 *Lamps*

The type of lamp used can affect the performance of the luminaire. The lamps are selected based on colour rendering, photometric performance and Public Body preference. Table 13 shows the range of the more common lamps used by the DNSPs in Queensland.

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	No new installations. Used in residential estates. Some lamps still maintained for existing installations.

Table 13: Typical Luminaire used by Queensland DNSPs

Low pressure sodium lamps are no longer used. However, they are still utilised in special cases e.g. in some coastal areas where the light from standard lamps could confuse marine animals that use moonlight for night time navigational guidance.

5.6.4 *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 road luminaires can be fitted to minor road columns using adaptors. However, the minor road luminaires cannot be fitted to major road columns.

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

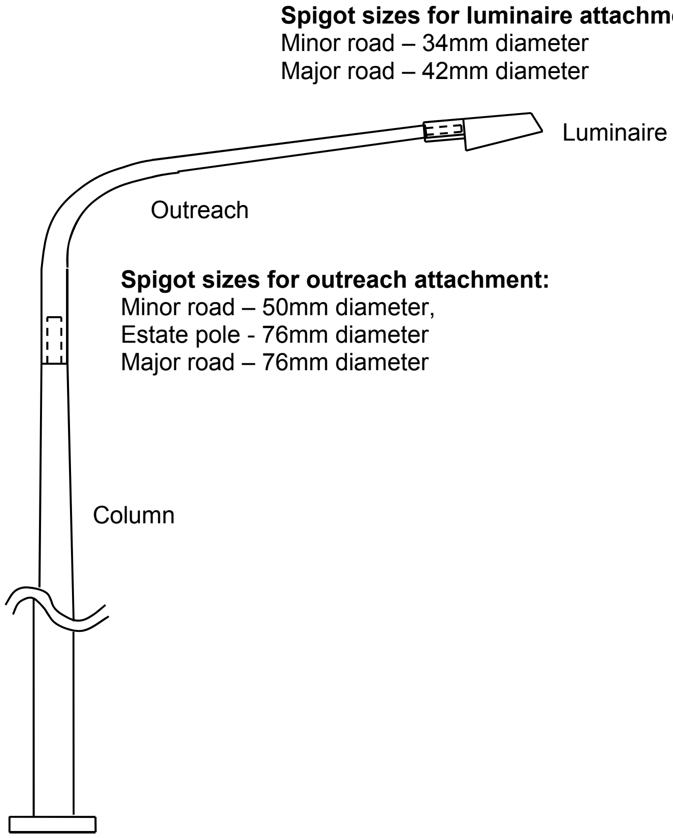


Figure 11: Range of Spigot Sizes for Major and Minor Road Lighting

5.7 Lighting Arrangements

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

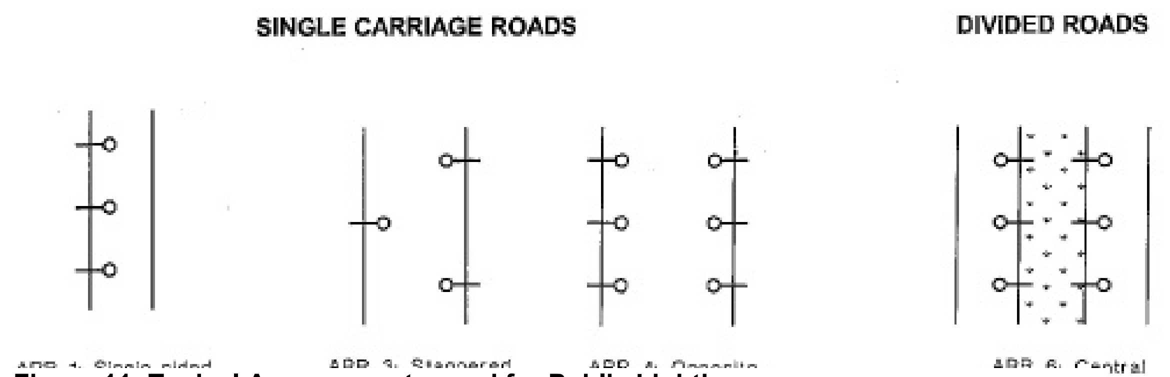


Figure 11: Typical Arrangements used for Public Lighting

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.

6. STANDARD HARDWARE

6.1 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.

6.1.1 *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 set back on a sloping bank adjacent to the carriageway, due allowance needs to be made for the altered mounting height.

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
CFL32A	Minor	7.5	5.0	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
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 A = Aero LF = Linear Fluorescent S = High Pressure Sodium

Table 14: Typical Mounting Height for Standard Luminaires

Luminaire Type/Wattage	Lighting Style	Type of Pole	Nominal Mounting Height (to Photometric Centre of Fixture)	
			Energex (m)	Ergon Energy (m)
CFL32, S70	Nostalgia Type 1	Nostalgia	5.1	5.1
CFL32, S70	Nostalgia Type 2	Nostalgia	5.1	5.1

Table 15: Typical Mounting Height for Decorative Luminaires

6.1.2 *Available Types including Photometric Files*

Type/Wattage	Manufacturer	Design Lumens	I-Table No
Standard Minor Road luminaires			
CFL32D	Sylvania Suburban ECO*	2400	206243.cie
CFL32D	Sylvania Urban Aero ECO	2400	207270.cie
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			
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
Refer to Public Lighting Construction Manual for available range of colours			
Standard 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
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

C – Clear lamp A – Aeroscreen H (prefix) – Metal Halide H (suffix) – High Mast
PT – Decorative post top D – Diffuse
WL – Wide beam with louvre NL – Narrow beam with louvre
* - used by Energex only ^ - used by Ergon only # - transition of supplier to Sylvania

Table 16: Photometric References for Existing Contract Luminaires

Type/Wattage	Manufacturer	Design Lumens	I-Table No
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
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
M50*	Bega	1,800	BE1083.ies
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

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

Table 17: Photometric References for Obsolescent Luminaires

6.1.3 *Wattage / Current – Starting and Running Current*

Luminaire	**Starting Current** (amps)	**Running Current** (amps)	**Power factor**
Minor Road including Standard Range, Nostalgia, Post Top and Bulkhead			
CFL32	0.15	0.15	>0.95
2 x LF14	0.15	0.15	>0.95
2 x LF24	0.24	0.24	>0.95
S70	0.48	0.38	0.9
H35	0.2	0.2	>0.95
H70	0.48	0.38	>0.95
Major Road including Standard Range and High Mast			
S100	0.68	0.52	0.9
S150	0.97	0.75	0.9
S250	1.57	1.23	0.9
S400	2.48	1.94	0.9
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

H – Metal Halide M – Mercury vapour S – High pressure sodium

Table 18: Starting and Running Currents – Existing Contract

Luminaire	**Starting Current** (amps)	**Running Current** (amps)	**Power factor**
M50	0.35	0.27	0.9
M80	0.57	0.41	0.9
M50(old)	0.76	0.61	0.43
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	1.4	0.93	0.36
S100	1.5	1.2	0.4
S150	2.21	1.8	0.39
S250	3.8	3.0	0.38
S400	5.9	4.6	0.4
F1x18	0.4	0.37	0.3
F2x18	0.52	0.41	0.48
F4x18	1.1	0.74	0.5
F2x36	1.26	0.83	0.44
F3x36	1.9	1.29	0.44
F4x36	2.5	1.73	0.44

F – Fluorescent Light M – Mercury vapour S – High pressure sodium

Table 19: Starting and Running Currents – Obsolescent Luminaires (Energex Only)

6.2 Columns

6.2.1 *6.2.1 Summary of Available Types*

Tables 20 and 21 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.

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) • Standard Minor road normal CFL32, 2 x LF14, 2 x LF24 & S70 • Standard road Aeroscreen CFL32A & S70A
	6.5m steel (3 bolt base plate – 187 PCD)# (4 bolt base plate – 350 PCD)			Integral 0.5m bracket*	
	4.5m Estate steel (350 PCD)		Green	Single or twin*	Decorative luminairesCFL32 & S70
	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	CFL32, 2 x LF14, 2 x LF24 & S70 (Normal and Aeroscreen)
	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	CFL32, 2 x LF14, 2 x LF24 & S70 (Normal and Aeroscreen)

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 non stock 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 20 – Street light Columns (Minor 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	S150H, S250H, S400H
	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

Table 21: Street light Columns (Major Roads)

6.2.2 *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.

6.2.3 *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.

6.2.4 *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.

6.2.5 *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.

6.2.6

6.2.7 *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.

6.2.8 *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 22 shows the two types of footings used for public lighting poles.

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.
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.

Table 22: Pole Footing Types and Applications

Concrete buried-in-ground (BIG) poles are used in Ergon Energy in rare situations where it is not possible to install the BPM or SBM foundations.

6.2.9 *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 street lighting, a foundation depth of 1.2m is required for single outreach streetlights and 1.5m for double outreach streetlights.

For major street lighting, 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 of high wind loads e.g. North Queensland
- areas where the depth is restricted due to the presence of other services etc

6.3 Outreaches

6.3.1 *6.3.1 Summary of Available Types*

Table 23 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.

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	

Table 23: Outreach Arms

6.3.2 *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 5° above horizontal. No upcast angle is available for Nostalgia, Avenue, Bourke Hill, high mast, bulk head and category PX installations.

6.3.3 *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.

6.3.4 *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.

6.4 Wood Pole Brackets

6.4.1 *Summary of Available Types*

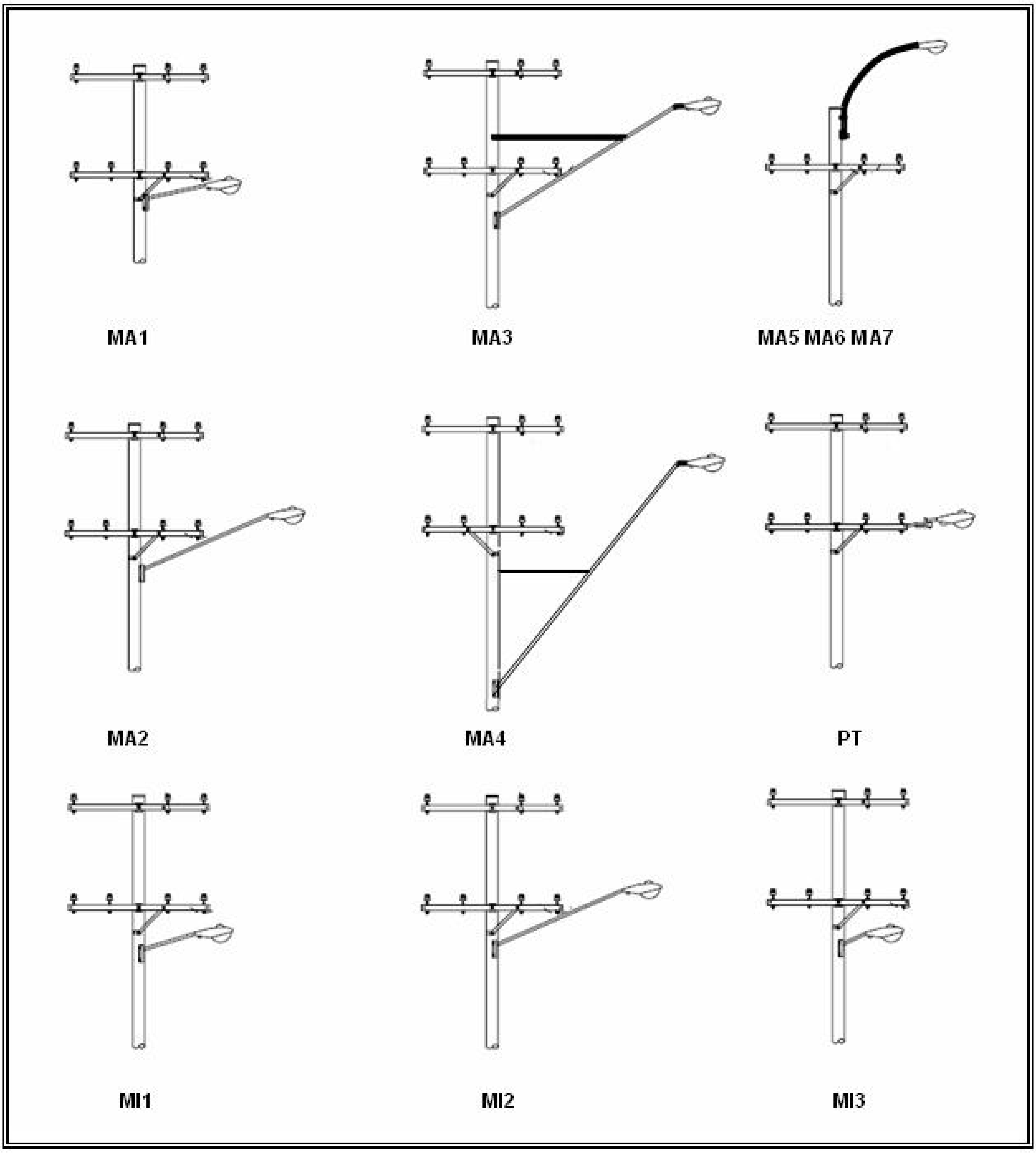


Figure 13: Range of Wood Pole Brackets

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.

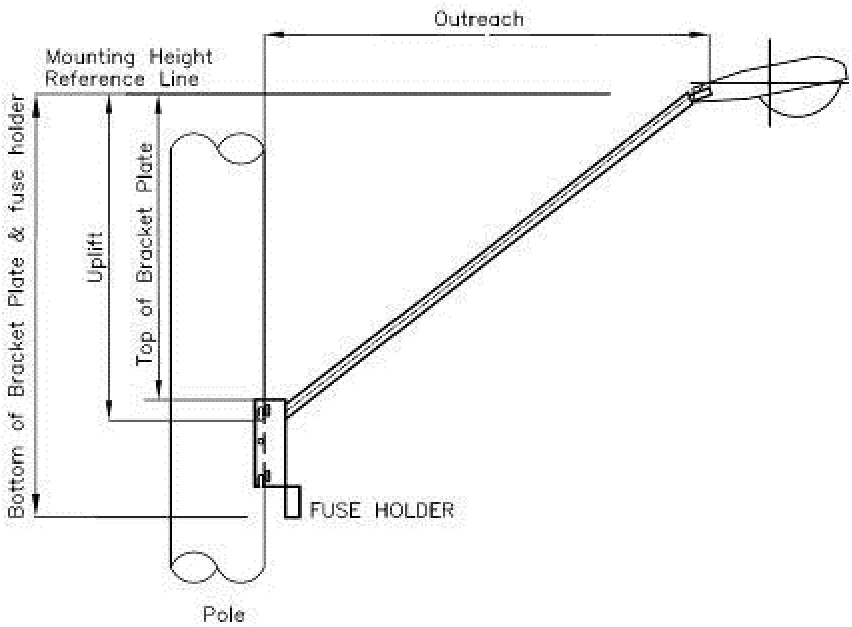


Figure 14: Pole Mounting Dimensions

Table 24 shows the recommended bracket base plate attachment dimensions (in relation to the luminaire mounting height) for the range of available brackets.

Bracket ID	Application	Outreach (mm)	Uplift (mm)	Top of Bracket Plate (mm)	Bottom of plate and Fuse Holder (mm)
MA1	Major Road	1500	130	50	450
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	-	-

Table 24: Attachment Dimensions for Wood Pole Brackets

6.4.2 *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.

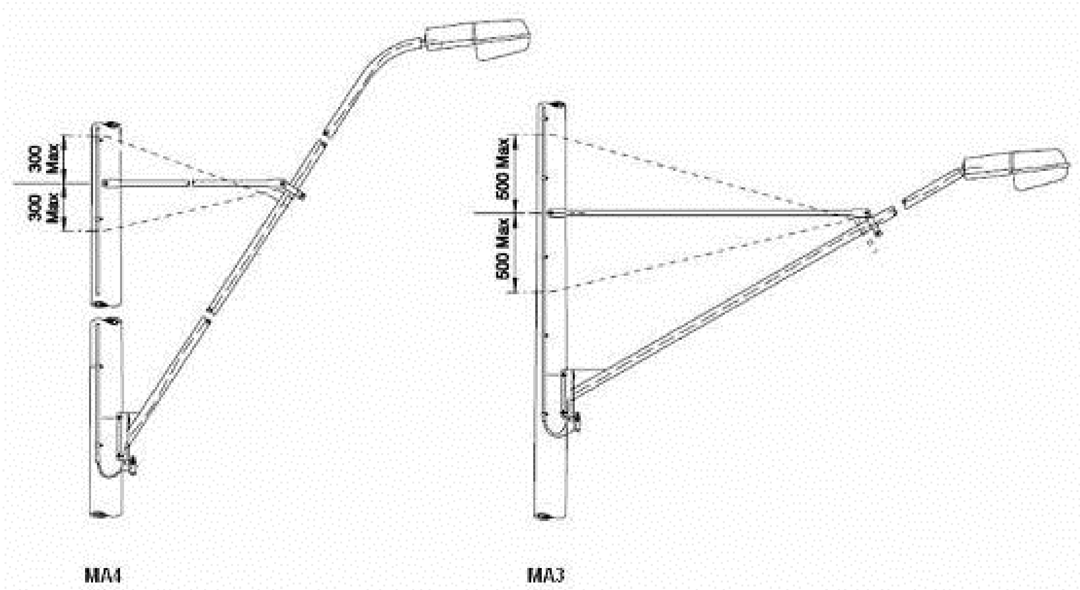


Figure 15: General Arrangement for MA3 and MA4 Wood Pole Bracket Stay

6.4.3 *Maintaining Clearance from Mains*

Where street lights 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 25 shows the required DNSP installed minimum clearances from the live overhead mains to any part of the bracket or luminaire.

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.

Table 25 – Clearances to Streetlight Brackets

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.

7. DESIGN PROCESS

7.1 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.

7.2 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

7.3 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.

7.3.1 *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.

7.3.2 *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

7.3.3 *Lighting Category*

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

7.3.4 *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.

7.3.5 *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:

- set backs from the kerb 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

7.3.6 *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 street lights 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 street lights on same pole) for the purpose of rationalisation of street furniture
- Clearances of street lighting structures from DNSP overhead mains including easements for OH transmission

- Maintenance factor of luminaires

•

7.4 Site Inspection and Base Plan

7.4.1 *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 street lights and underground or overhead electricity supply to the new installations.

Table 26 shows typical physical site features that could impede the positioning of lighting infrastructure and electricity supply.

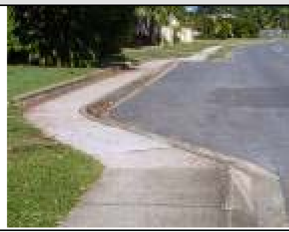
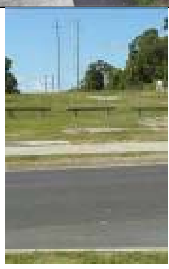
Physical Site Feature	Typical Example	Physical Site Feature	Typical Example
Stormwater, drainage conduits and collection devices, bridges & culverts, entry/exit driveways and other street furniture		Road geometry e.g. kerbs,	
Driveways impinging on possible pole location		Vegetation interference	
Other 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	

Table26: Typical Physical Site Features

7.4.2 *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.

7.4.3 *Identify the Attributes of the Site*

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

Attribute	Cat V	Cat P	Cat PX
Roadway layout and direction of traffic flows	√		
Posted traffic speed	√		
Carriageway widths	√		√
Existing pole set back 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			√

Table 27: Site Specific Physical Attributes for Lighting Categories

7.4.4 *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.

7.4.5 *Basic Design Elements*

The site should be inspected to determine the site geometry and features that will affect the locating of the street lighting 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

8. GENERAL DESIGN APPROACH FOR VARIOUS SITUATIONS

8.1 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 28 shows the type and method of lighting analysis to be used for the design.

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

Table 28: Identifying the Type and Method of Lighting Analysis

8.2 Establish Roadway Elements

The next step is to identify the separate sections of the roadway (elements) that require public lighting. Table 29 shows the technical parameters that are required for the individual roadway elements that will be incorporated into the design.

Attribute	Cat V				Cat P			Cat PX
	GC	($\bar{L}$)	S_c	E_h	GC	E_h	E_v	E_v
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

Table 29: Roadway Elements and Technical Parameters

8.3 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.

Design Category	Arrangement	Carriageway Width W_k	Mounting Height	Typical Luminaire
V3	1	Up to 12m	10.5 – 12m	S150 or S250
V3	3	12m to 16m	10.5 – 12m	S150 or S250
V3	4	16m to 20m	10.5 – 12m	S150 or S250
V3	6	Up to 16m	12 – 15m	S250 or S400
V5	1	Up to 12m	9 – 10.5m	S100 or S150
V5	3	12m to 16m	9 – 10.5m	S100 or S150
V5	4	16m to 18m	9 – 10.5m	S100 or S150
V5	6	Up to 14m	10.5m	S150
P5	1 or 3	¼ road reserve width	5.1*/6.5-7.5m	CFL32 or 2 x LF14
P4	1 or 3	¼ road reserve width	5.1*/7.5m	CFL32, 2 x LF14, 2 x LF24 or S70
P3	1 or 3	¼ road reserve width	7.5m	S70

* For luminaires mounted on estate poles

Table 30: Typical Arrangements used for DNSP's in Queensland

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,.

8.4 Straight Sections

Determine the maximum spacing given a lighting configuration.

Table 31 shows the data and process required for the Category V and P public lighting.

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

Table 31: Process for determining Luminaire Spacing for Straight Sections

8.5 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.

8.6 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.

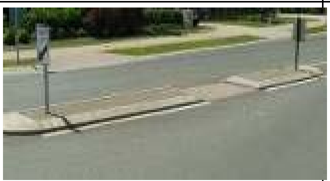
Description	Typical Streetscape	Design requirements
Non-channelised		One only luminaire of the higher category of the two intersecting roads shall be required within 10m from the projected property boundary of the intersecting roadway
Channelised (raised islands including speed humps, roundabouts but 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 32: Lighting Design Requirements for Category P 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.

Table 33: Lighting Design Requirements for Category V Intersections

8.7 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:

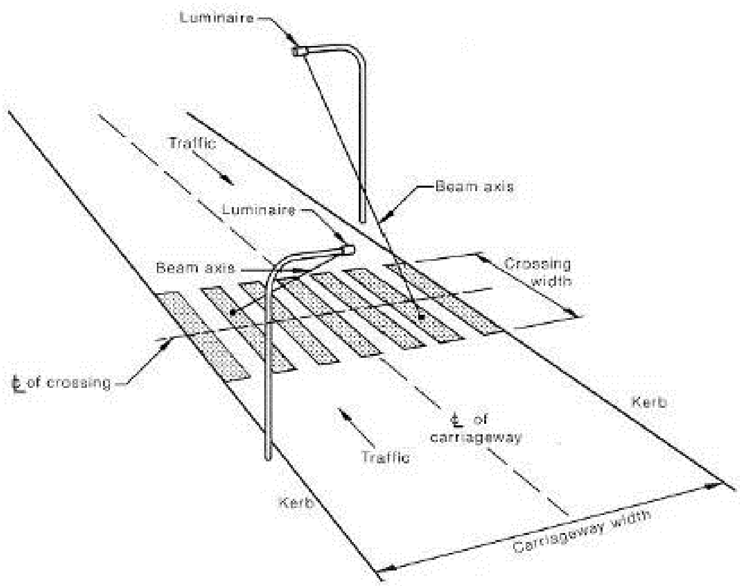
- Veiling luminance to pedestrians and motorists traversing the installation
- Night sky viewing conditions
- Spill light and glare into adjacent premises

Table 34 shows the range of floodlights used for the subcategories of pedestrian crossing lighting.

Category	Floodlight Type	Application
PX3	S70 standard beam A2 Mini	Category P roadways where reduced vertical illuminance and greater glare control is required
PX1, PX2	S250 wide beam	Smaller dimension road crossings with minimal setback from leading edge of crossing, typically 3 – 7m
PX1, PX2	S250 narrow beam	Smaller dimension road crossings with average setback from leading edge of crossing, typically 7 – 12m
PX1, PX2	S400 wide beam	Larger dimension road crossings with minimal setback from leading edge of crossing, typically 3 – 7m
PX1, PX2	S400 narrow beam	Larger dimension road crossings with minimal setback from leading edge of crossing, typically 7 – 12m

Table 34: Typical Louvred Floodlight used in Category PX Lighting

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



Source: AS/NZS1158:4.0

Figure 17: Typical Category PX Lighting Arrangement

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 35 shows the data and process required for the category PX public 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/NZS 1158.4*

Table 35: Determining Optimum Arrangement for Category PX Lighting

It is important to ensure that the aiming angle is adjusted to achieve a minimum Point Vertical Maintained Illuminance (E_{PV}) 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 street light 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*

9. LUMINAIRE POSITIONING AND OTHER DESIGN ISSUES

9.1 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 36 shows some typical positioning limit factors that may impede the positioning of public lighting and provides some possible solutions.

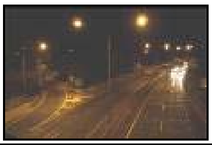
Positioning Limit Factor	Typical Example	Possible Solution
Physical and non-physical site features including driveways, vegetation, overhead and underground utility infrastructure, pram ramps, barricades		Locate lights clear of obstructions. Clearances will depend on statutory clearances, adequate physical separation or as required by the Public Body.
Conflict points including roadway narrowing		Highlight by adjacent streetlight installations
Street light 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.
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.

Table 36: Typical Position Limiting Factors for Luminaire

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 two consecutive spans.

9.2 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 37 shows the set back 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

Table 37: Set Back Zones

9.3 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 DNSP Overhead Design Manual. These clearances allow for conductor blow out and sag under maximum conductor temperature conditions.

9.4 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)

10. RETICULATION DESIGN

10.1 Wiring Diagrams for Rate 1 and 2 Lighting

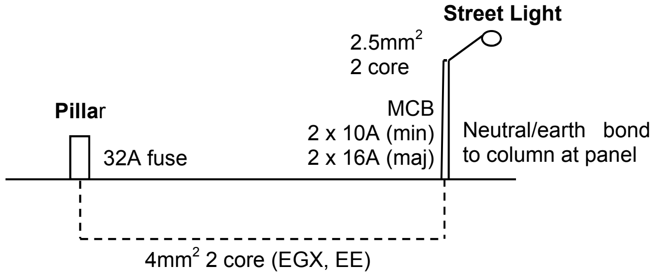
The following diagrams show the typical cabling and protection requirements for the more common streetlight schemes. Note the separate Energex (EGX) and Ergon Energy (EE) specific requirements as appropriate.

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

Single (or Multiple) Streetlight Scheme

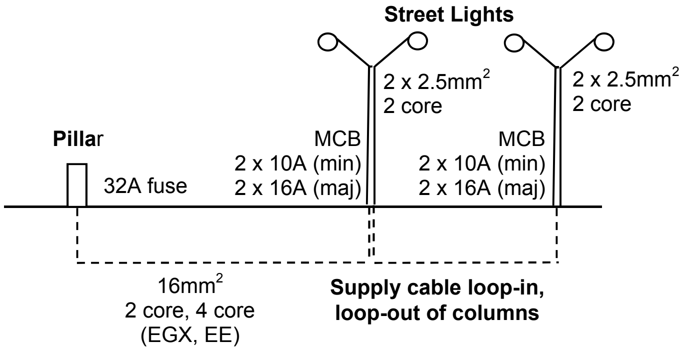
(Including pedestrian floodlighting)

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



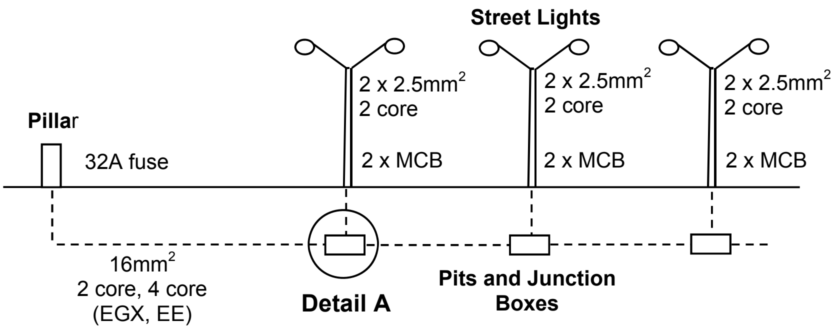
Multiple Streetlight Scheme (BPM) – Loop-in and Loop-out – ENERGEX ONLY

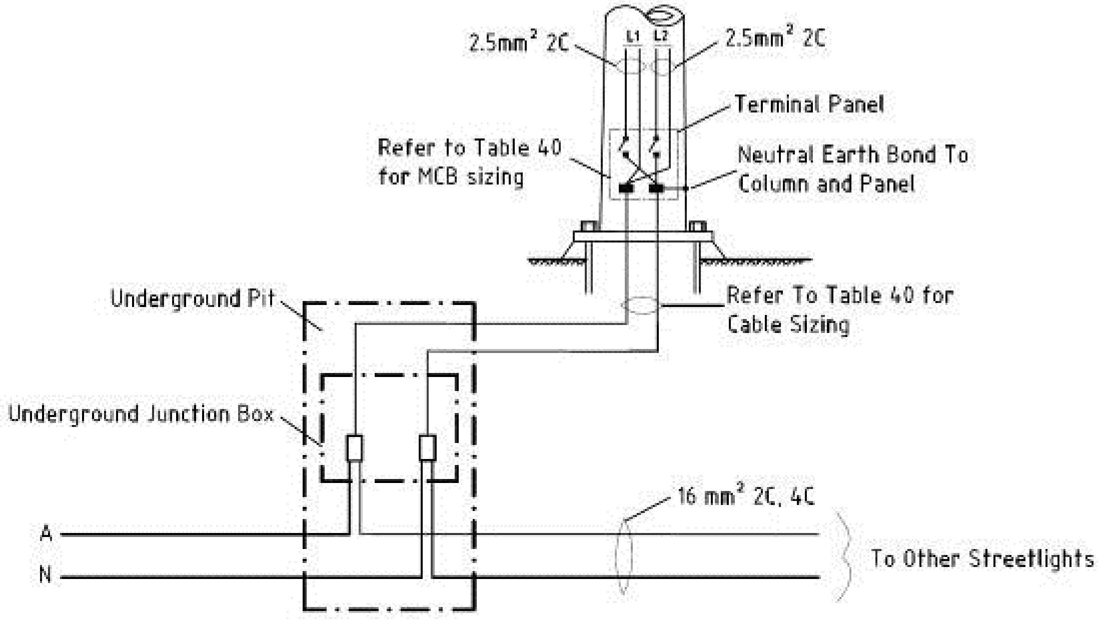
Subject to voltage drop limitations and maximum fault-loop impedance criteria



Multiple Streetlight Scheme (BPM) – Pit and Junction Box

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





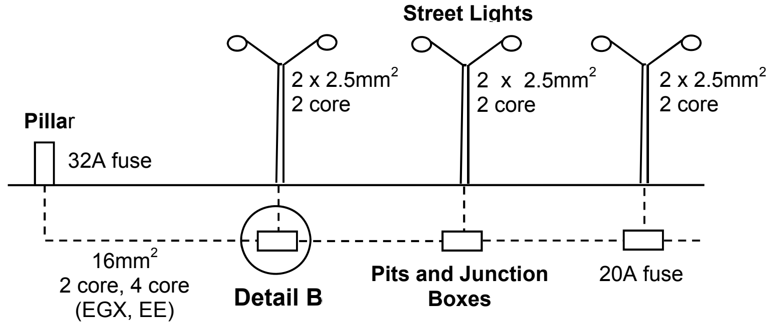
Detail A

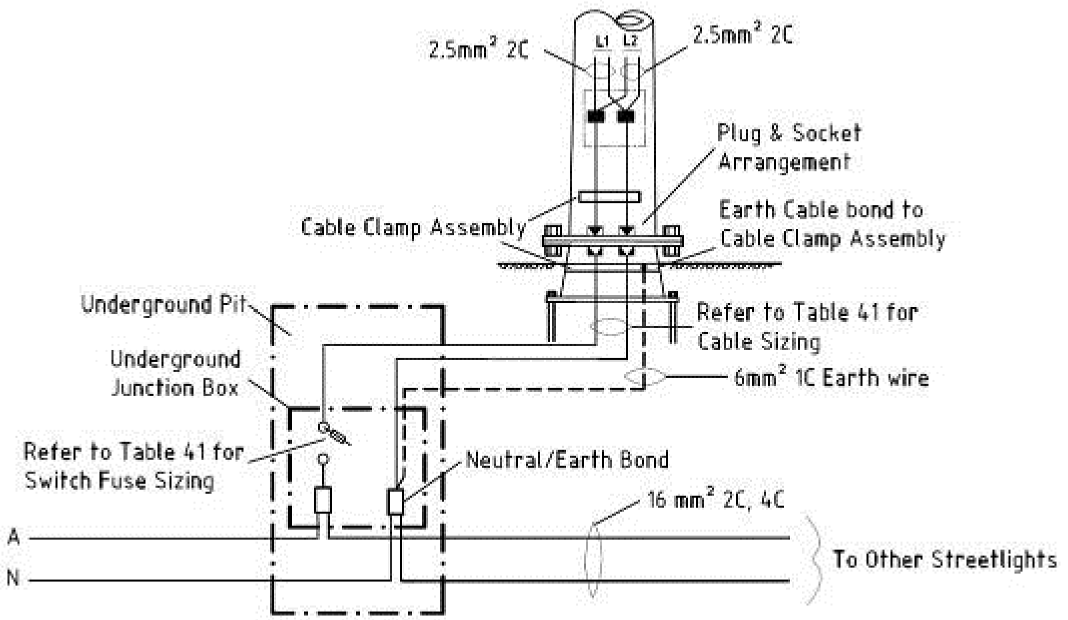
DNSP	Supply (pit – pit)		Pit – Column		Column	
	Cable	Protective Device	Cable	Protective Device	Cable	Protective Device
EE	$16mm^2$ #	32 amp fuse	$4mm^2$	none none	$2.5mm^2$ $2.5mm^2$	10 amp MCB (Min) 16 amp MCB (Maj)
EGX	$16mm^2$ #	32 amp fuse	$4mm^2$	none none	$2.5mm^2$ $2.5mm^2$	10 amp MCB (Min) 16 amp MCB (Maj)

Notes& Abbreviations:
Min – Minor Road lighting scheme
Maj – Major Road lighting scheme
\# - $16mm^2$ circuit cable may be connected into the terminal panel of the last street light in a circuit (if junction box is not required).

Table 40: Cable and Protection for BPM Scheme

Multiple Streetlight Scheme (SBM) – Pit and Junction Box





Detail B

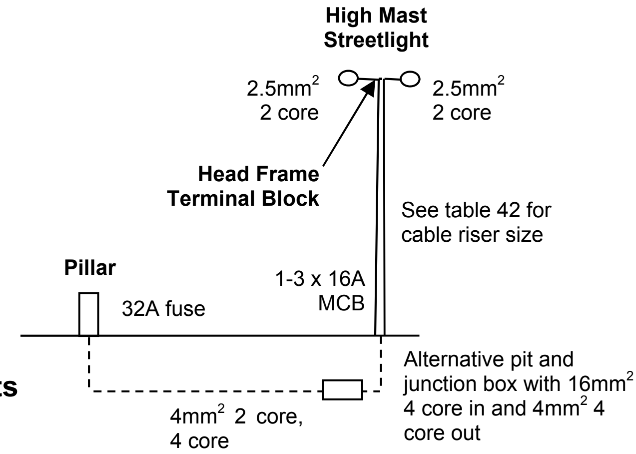
DNSP	Supply (Pit – Pit)		Pit – Plug/Socket		Plug/Socket – Terminal Panel		Terminal Panel – Luminaire	
	Cable	**Protective Device**	**Cable**	**Protective Device**	**Cable**	**Protective Device**	**Cable**	**Protective Device**
EE	$16mm^2$	32A fuse	$4mm^2$	20A fuse	$4mm^2$	none	$2.5mm^2$	none
EGX	$16mm^2$	32A fuse	$4mm^2$	20A fuse	$4mm^2$	none	$2.5mm^2$	none

Notes:

1. Table 41 relates to double outreach columns (EGX and EE) and for single outreach columns (EE). For single outreach columns (EGX), there is no terminal panel and the $2.5mm^2$ cable from the luminaire will connect directly to the plug/socket arrangement.
2. SBM poles used for major road lighting only.
3. The $6mm^2$ 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.

Table 41: Cable and Protection for SBM Scheme

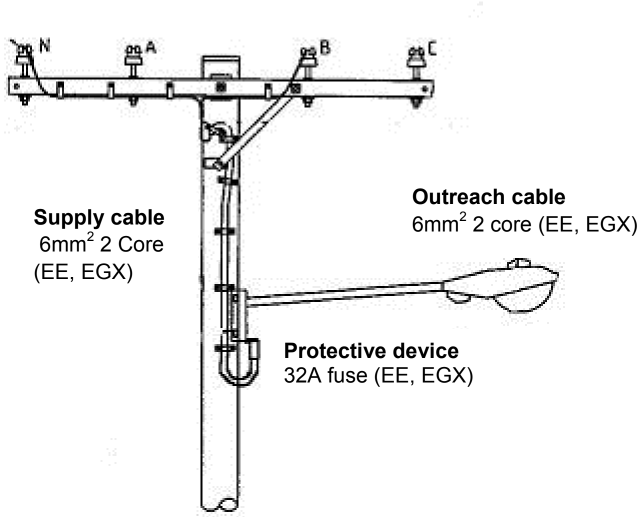
High Mast Installation – ENERGEX ONLY
(One MCB per luminaire)



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 street lighting circuits, the standard installation will include the pit and junction box arrangement. The loop-in, loop-out arrangement cannot be used in Ergon areas. In Energex areas it will only be used where two or more streetlights are installed over a short distance or on roadways where pits and junction boxes cannot be installed
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 street lighting 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. 25mm^2 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 6mm^2 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.

10.2 Cable and Cable Protection

Table 43 shows the cables and types of protective devices used for various applications 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 street light terminal panel inside BPM pole (EE, EGX) or BIG pole (EE) to luminaire	10A MCB (Minor Road lighting), 16A MCB (Major Road lighting) – Streetlight terminal panel
		Final sub circuit from street light terminal panel to luminaire for double outreach SBM pole (EE, EGX) and single outreach SBM pole (EE, EGX)	None
		Final sub circuit from street light terminal panel to each luminaire spider bracket (EE)	16A MCB for each circuit – Street light terminal panel
		Final sub circuit from street light 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 PVC/PVC flat	UG	2 core/4 core circuit from pillar to single or multiple streetlight, flood light or high mast pole (EGX)	32A fuse - Pillar
		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

Table 43 – Cabling and Protective Devices for Public Lighting
(continued next page)

Cable	OH/UG Supply	Application	Protective Device & Location
2C 4mm^2 Cu XPLE/HDPE neutral screened	UG	2 core/4 core circuit from pillar to single or multiple streetlight, 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 street light terminal panel inside BPM pole (Minor Road) (EE)	None
		Circuit from plug/socket arrangement to street light 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

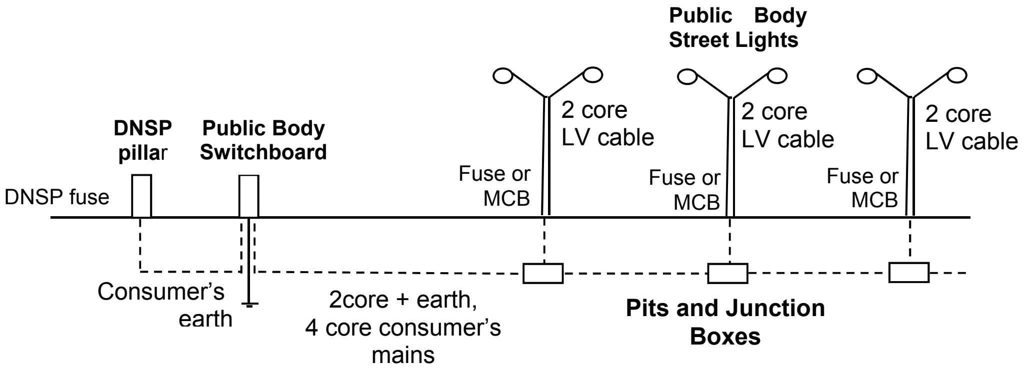
Table 43 – Cabling and Protective Devices for Public Lighting
(continued from previous page)

10.3 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 then 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*.

Figure 18 shows the typical cabling and protection requirements for a Rate 3 streetlight scheme.

Figure 18: Typical Rate 3 Underground Electrical Reticulation Layout



10.4 Positioning the Pits and Cables

Underground supply cables owned by the DNSP can be installed on the standard Public Body roadway alignments. However, 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.

Supply cables owned by the Public Body must be installed according to *AS/NZS 3000* requirements.

In circumstances where there is a combination of ownership DNSP and Public Body, the supply cables must be installed in separate trenches.

10.5 Volt Drop Calculations

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

Figure 19 shows a typical median strip lighting layout where the effects of voltage drop should be considered.

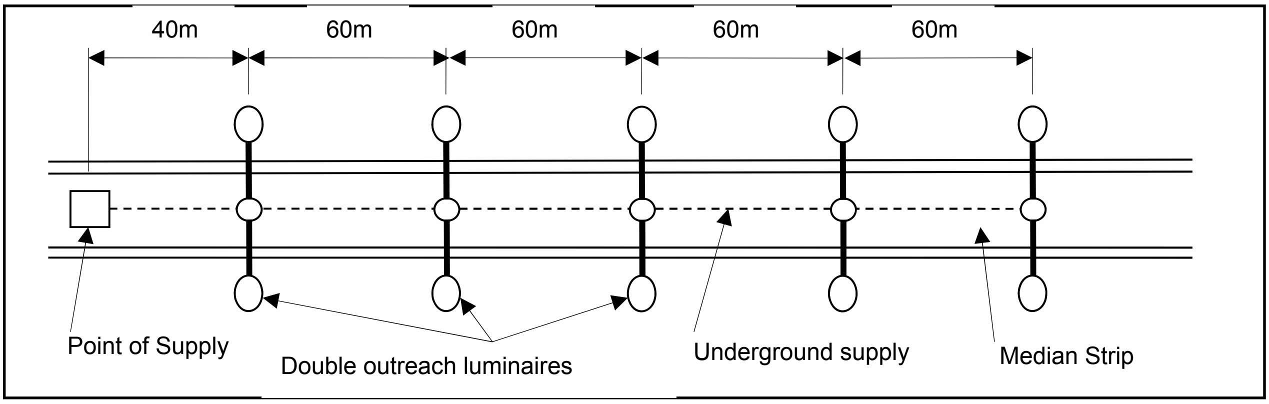


Figure 19: Typical Layout where Voltage Drop may exceed Voltage Limits

The voltage at the point of supply where the public lighting circuit leaves the LV mains reticulation shall be regarded as being within the statutory limitations of 240 volts ± 6%.

This means that, in a worse case scenario, the allowable voltage drop for a nominal 240 volt power supply will be no more than 225V - 216V i.e. 9 volts in the public lighting circuit to the last luminaire.

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)

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*

Table 44: Cable Electrical Characteristics

The starting/running currents for the luminaires are shown in Table 18.

For a bulk switched scheme, the sum of the starting current for all of the luminaires in the circuit must be used in the volt drop calculation.

If the luminaires at the remote end of the circuit have adequate starting voltage then the cable length can be extended.

If the voltage drop for the selected cable exceeds the accepted levels, then a cable with greater cross sectional area or multi-phase cable may be required.

10.6 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.

Street light 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.

Calculations shall be undertaken as per AS/NZS3000 requirements.

Impedance for single phase street light 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.

10.7 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 20 shows some typical street lighting control mechanisms.

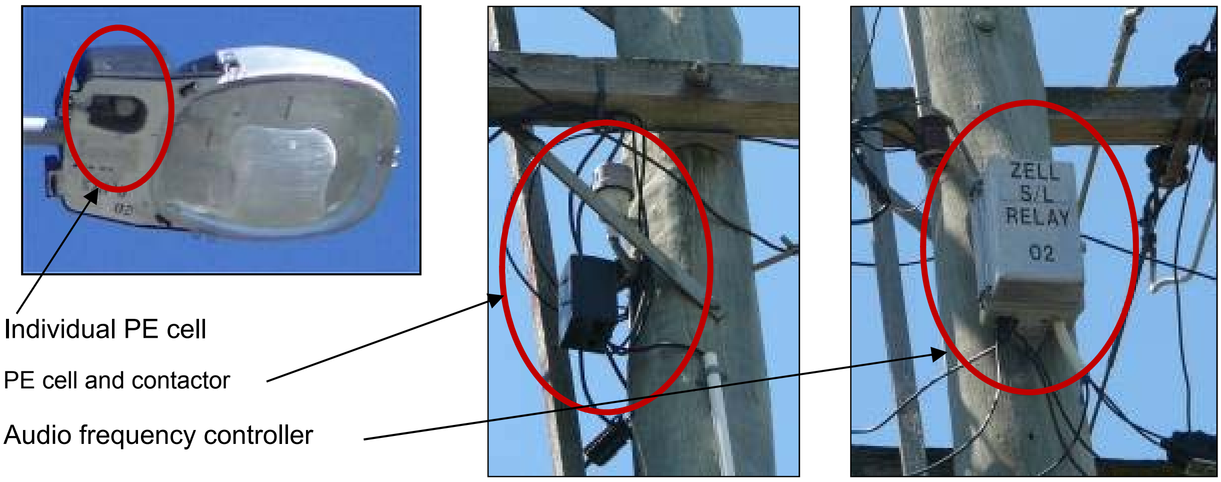


Figure 20: Typical Lighting Control Mechanisms

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

Streetlight contactors are used:

- if a group of Rate 3 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.

Joint Manual between ENERGEX and Ergon Energy
ENERGEX Limited ABN 40 078 849 055 ■ Ergon Energy Corporation Limited ABN 50 087 646 062

10.8 Earthing

10.8.1 *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 6mm^2. 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 6mm^2 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 (eg: 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 – Ergon only.

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

10.8.2 *Rate 3 Lighting Arrangement*

All rate 3 lighting arrangements must comply with the requirements of *AS/NZS3000*. The Public Body must install a switchboard containing a main switch, circuit protection, neutral link and MEN connection. The consumer's street light supply cable must contain an earth wire that is connected to each streetlight in the circuit.

Poles that incorporate a rag bolt foundation do not require a separate earth electrode as the foundation provides a sufficient means of earthing. However, the earth conductor must be attached to the earth connection point on the streetlight footing.

10.8.3 *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 similar to that required for a Rate 3 installation.

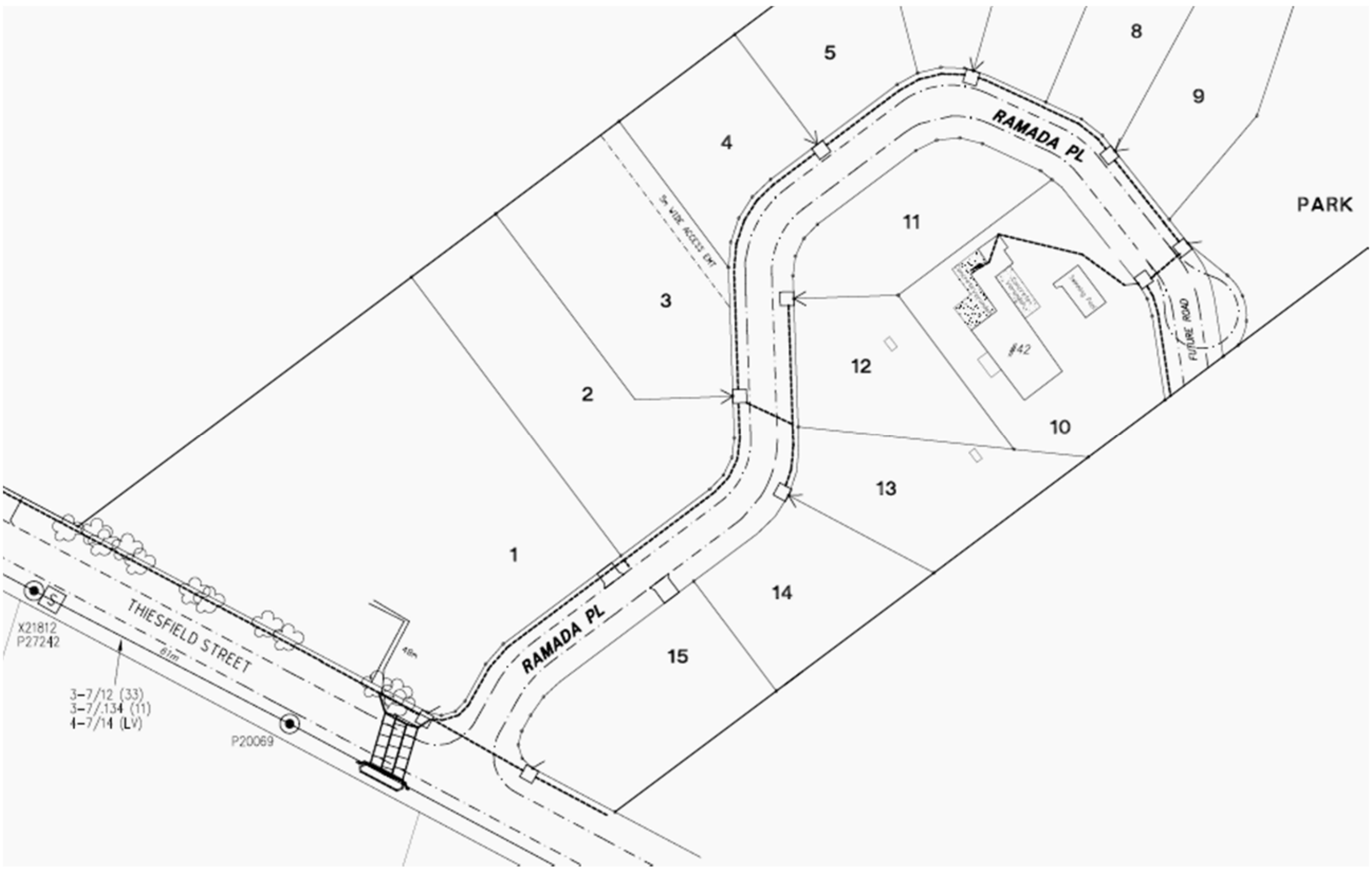
10.9 Joint Use Poles - Isolation

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.

11. 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

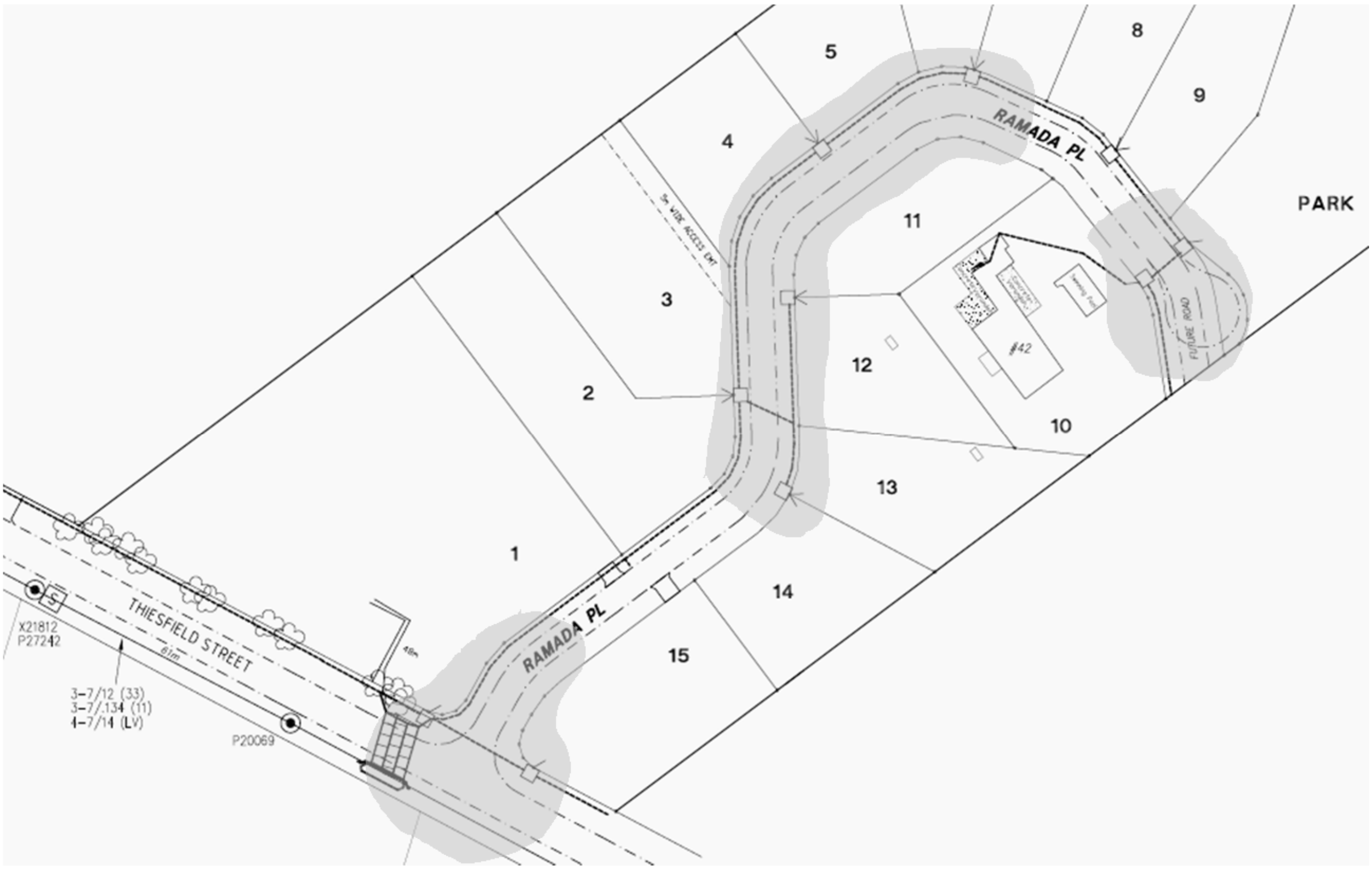
Calculation Grid: 20 x 11 points - Figure 3.7 of AS/NZS1158.2

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 street light 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.

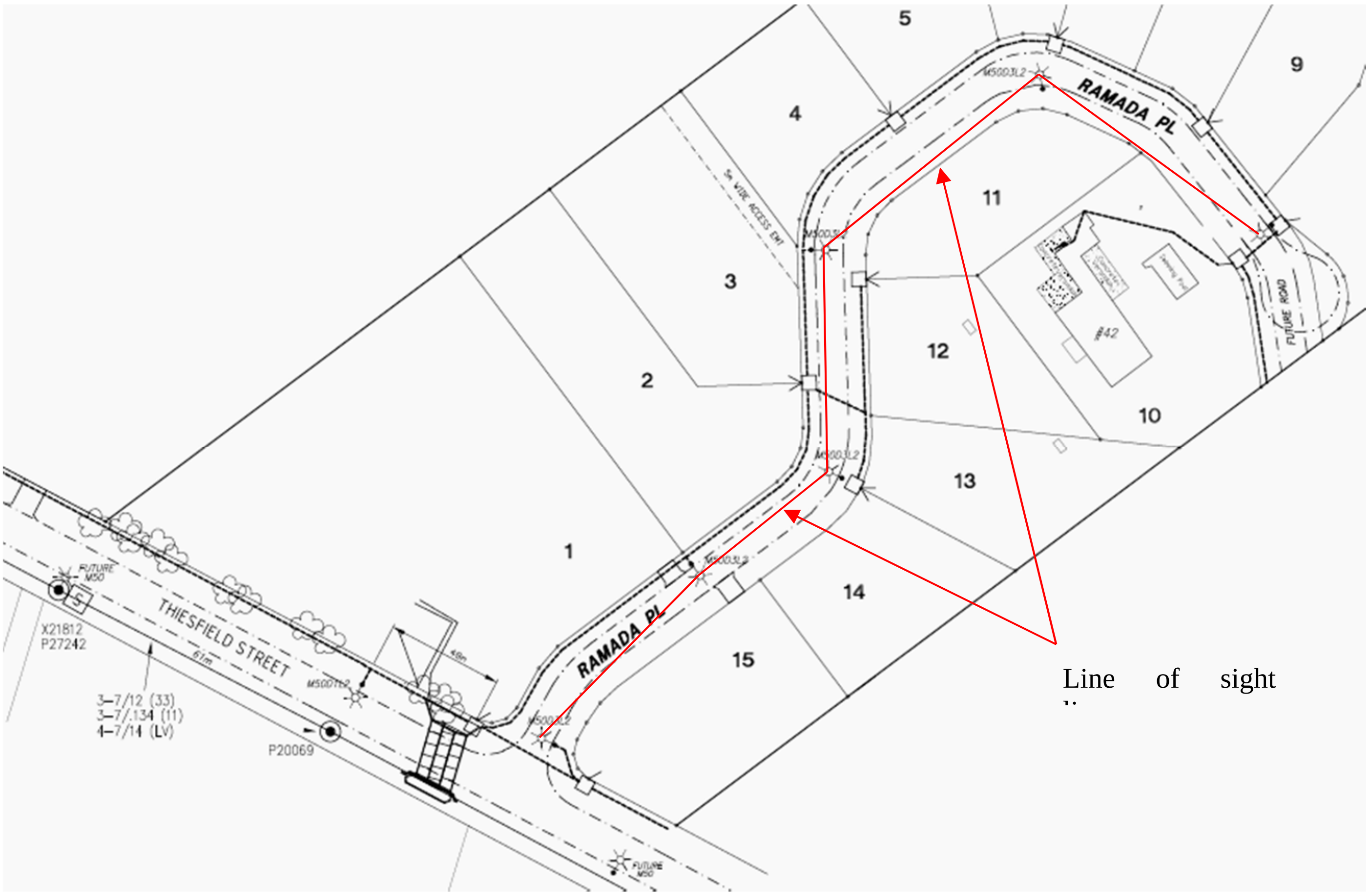
In accordance with category P lighting standards, a light must be placed at the end of a cul-de-sac but due to the temporary nature of this cul-de-sac and the location of this light falling within the future road works, this will not be considered in the design.

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 54.8m. It also requires that a light be placed within a radial distance of 10m 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.

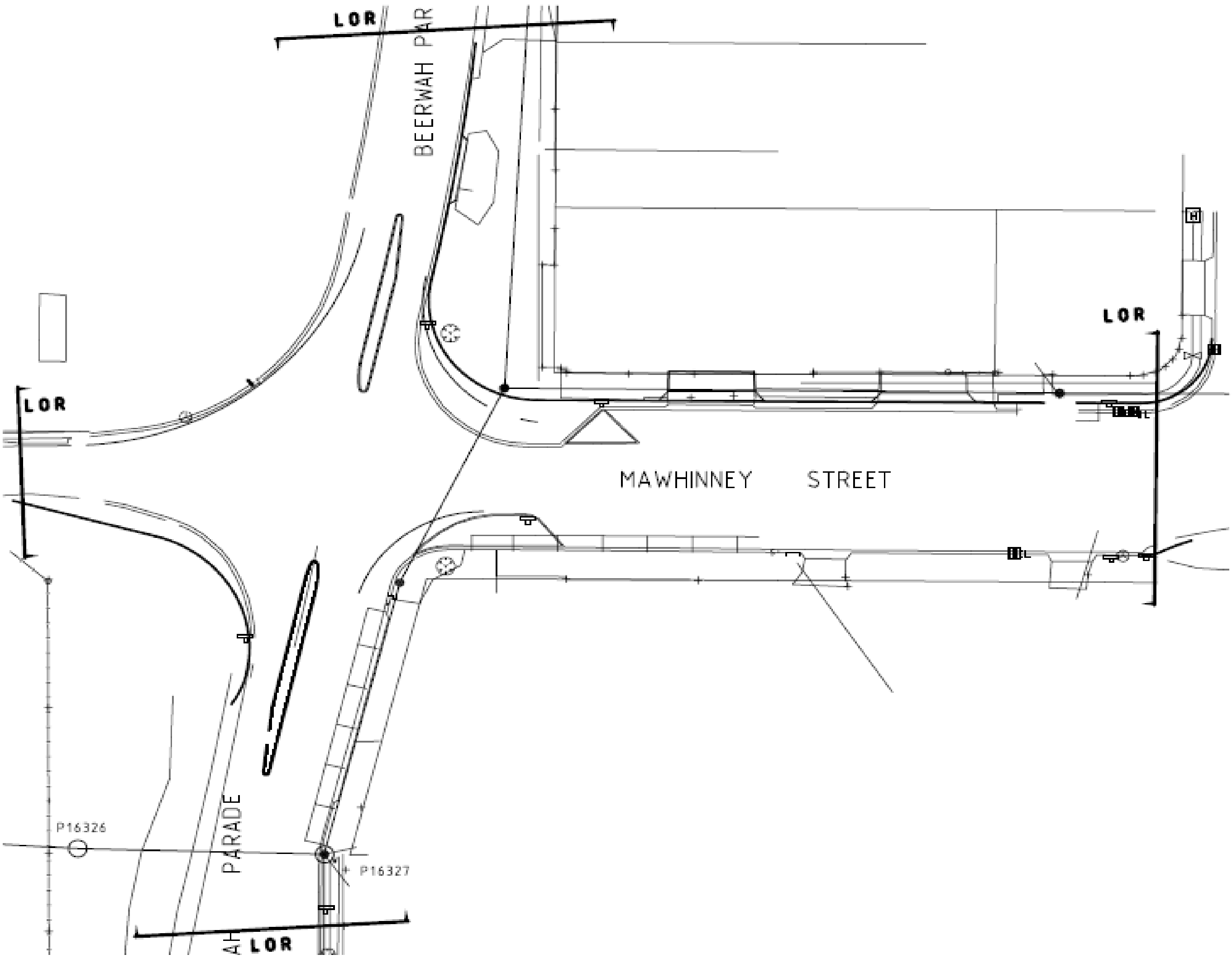
The remaining area to be designed for is the subdivision's Thiesfield St frontage. Keeping in mind that lights proposed on the opposite side of the street can be shown as future streetlights to be installed at a later date by council or other property developers, we can start by placing a future light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

The final arrangement is shown below.



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 30m wide. A 60km 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.

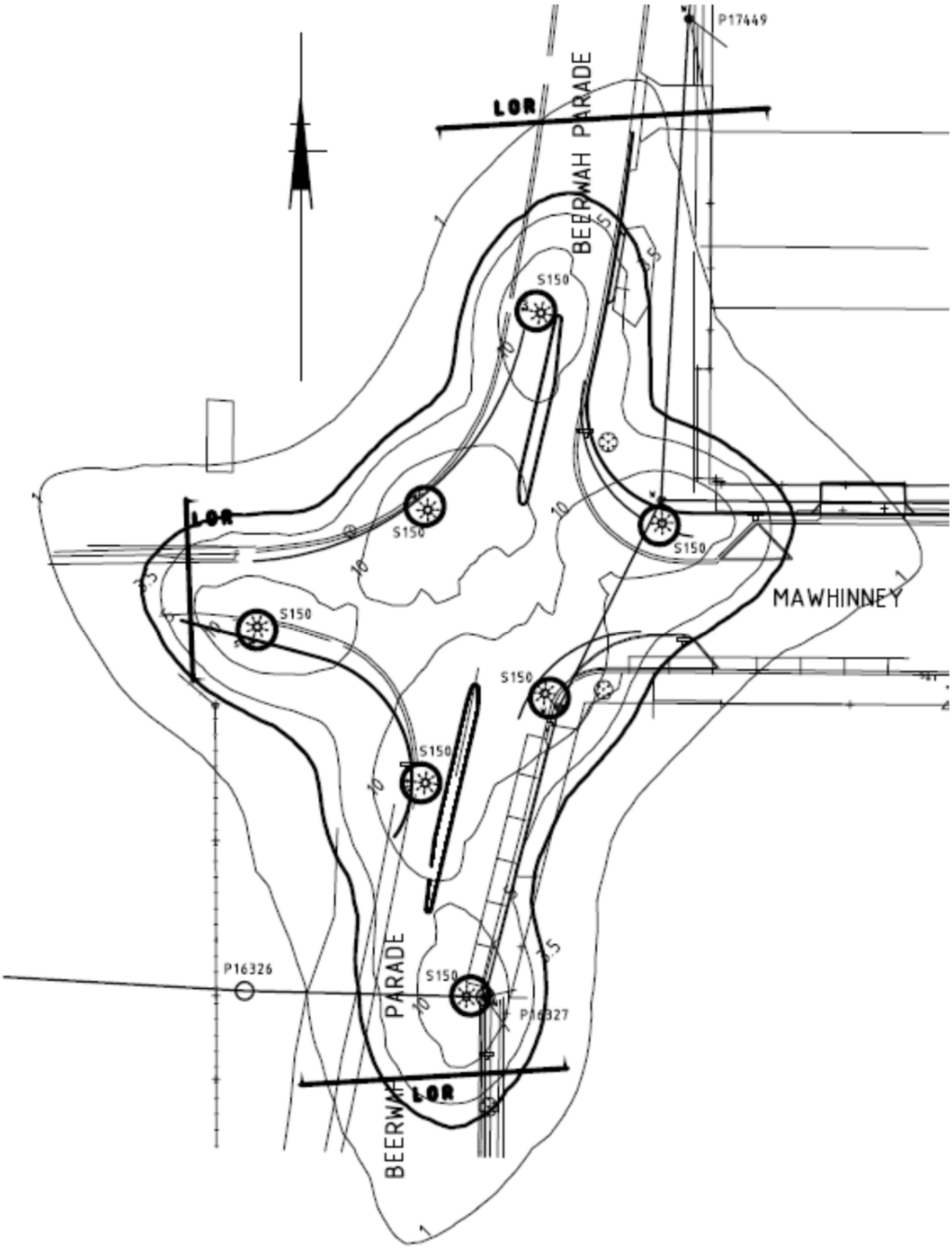
Using a top down approach, start by designing areas that will fall under the illuminance section of the standard first, followed by areas that will fall under luminance.

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 street light 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:

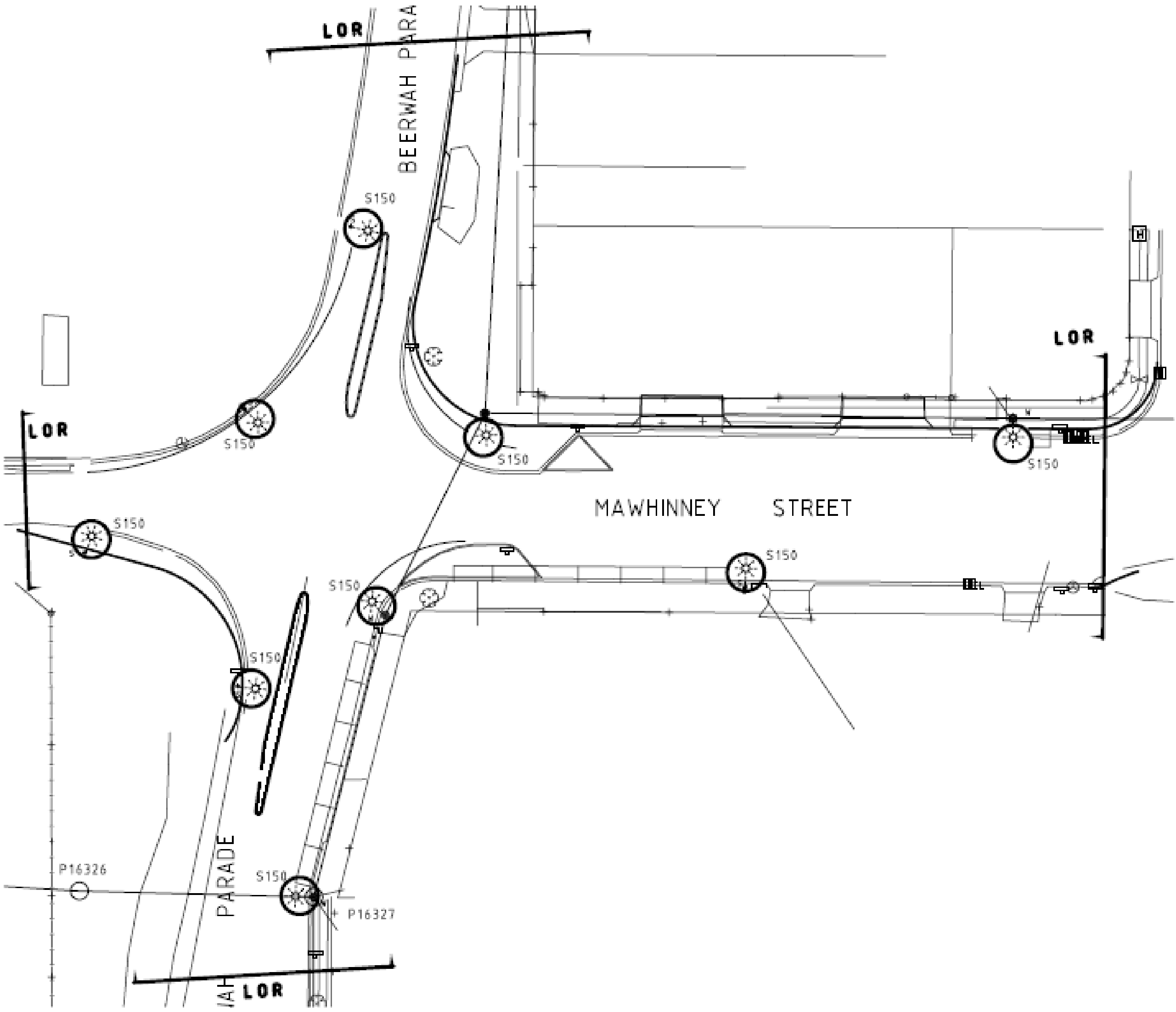
```
Job name: Mawhinney St

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 (m)	Traffic Direct-ion	Lbar (>=0.35) or (>=0.38)	Uo (>=0.33) (>=0.31)	Ul (>=0.5) "	UWLR (=<3) "	TI (=<20) "	Esl (>=50) "	Esr (>=50) "	Comply with 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
```

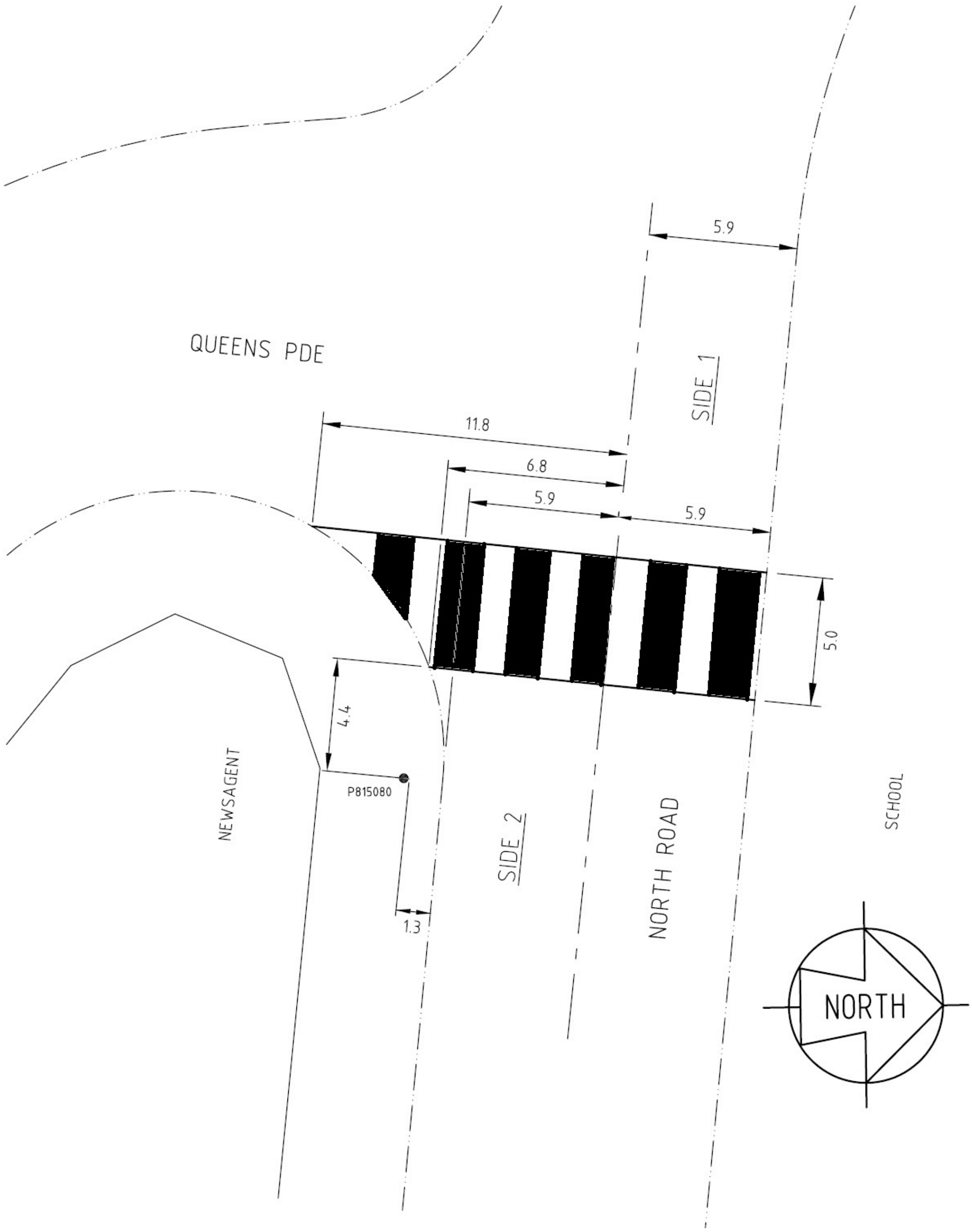
Making use of existing infrastructure, a light is placed at the eastern end of Mawhinney St. Using our spacing results, another light is placed clear from the driveway on the southern side of the street as shown. The spacing distances measured parallel along the carriage way are 31m and 34m respectively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

The final lighting design is illustrated below.



13. 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. street light 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.

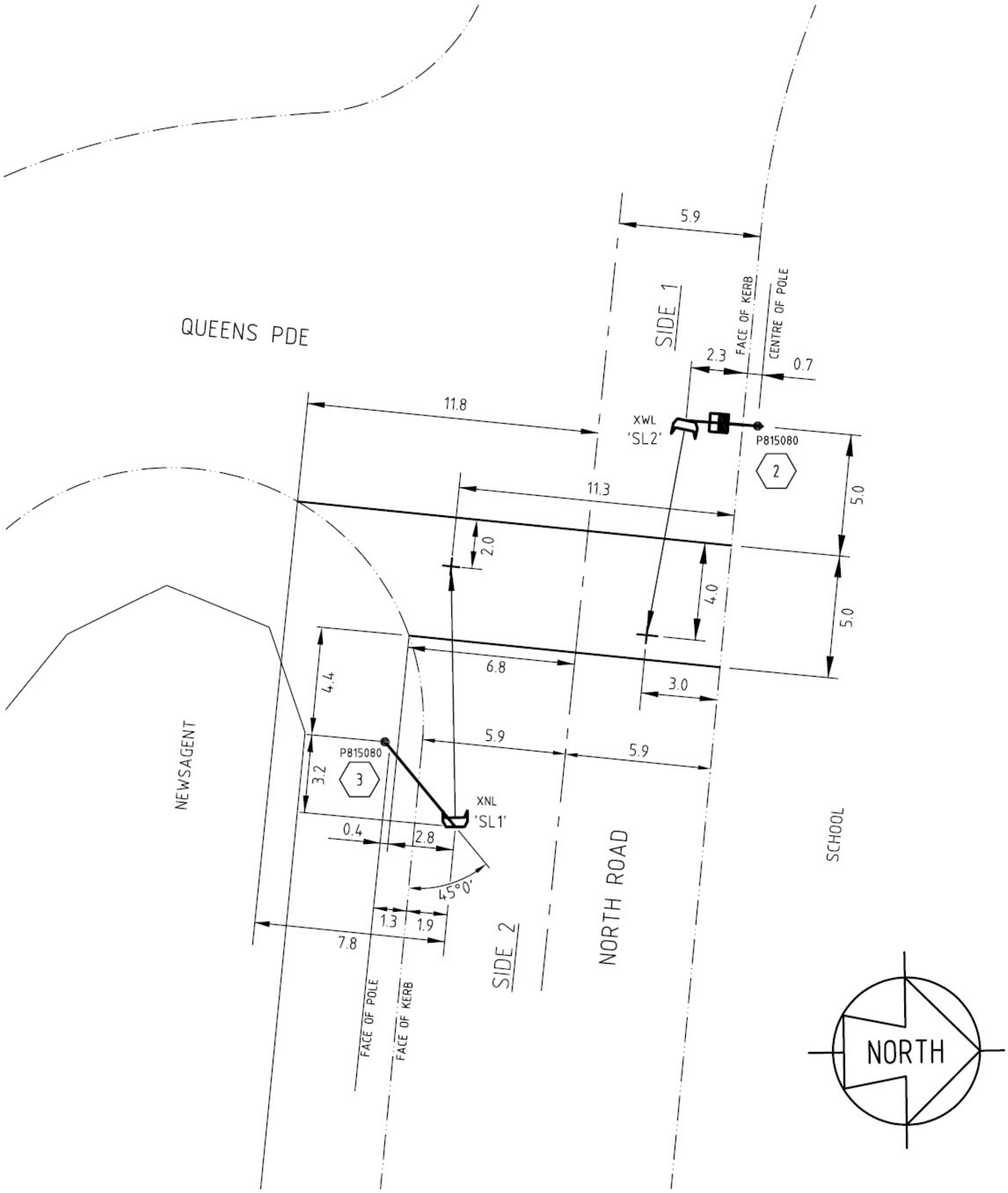
```
                                        Carriageway                 Carriageway
------ Glare Results ------               edge                      centre line
 70 =3893 cd   80 =887 cd            |----- 3      -----+              |
 72 =3295 cd   82 =643 cd   Ht=1.5m  |59 lx         67 lx              |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

 6/ 5/2010 11:32:18                                        Version 4.89

               ---- 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.



14. WORKED EXAMPLE – ELECTRICAL RETICULATION

Consider the case of the circuit shown above. It shows five double outreach street lights

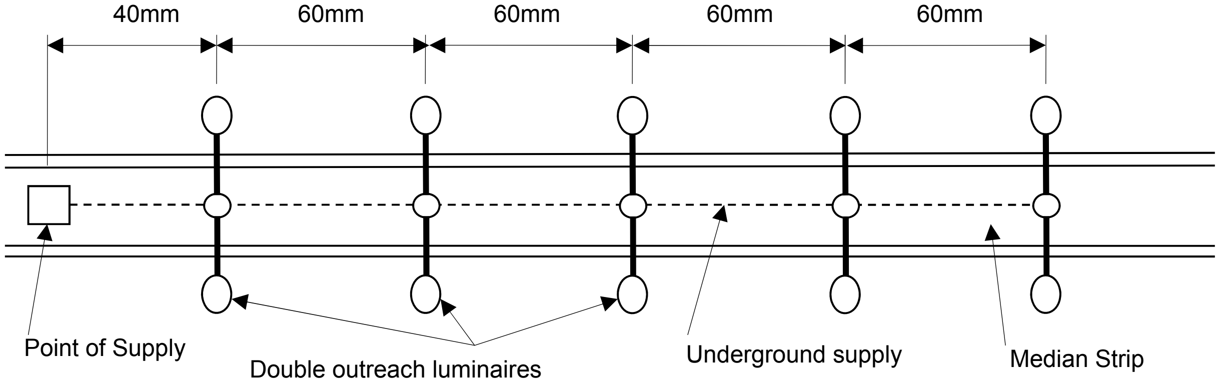


Figure 12: Electrical Reticulation Example

spaced at 60m intervals with the supply pillar located 40m from the first street light. The luminaires are S250. The circuit is 2C 16mm^2 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 and the fault loop impedance for the circuit protective device.

From Table 18, the starting current for a power factor corrected S250 lamp is 1.57 amps.

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

(1.57 x 5 x 2) amps = 15.7amps.

Determine the circuit cable size.

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

Now determine the voltage drop.

Firstly, consider a bulk switched circuit:
The voltage moment method can be used here. The distance to the load centroid is 40 + (60 x 2) = 160 m. From table 44, the resistance is 0.00126Ω/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 x 0.00126 = 0.00252Ω/m.
Voltage drop is then 15.7 amps x 160m x 0.00252Ω = 6.33 V. The maximum allowable voltage drop is 9 volts which is derived from the minimum voltage at the point of supply being 225 V (240 – 6%) less the minimum luminaire starting voltage of 216 V leaving a lighting circuit voltage drop of 9 Volts. Hence the voltage drop for the circuit is within limits.

Secondly, consider the same bank of luminaires with individual control via integral PE cells:
For the first four poles, the contribution to voltage drop from the running current of 1.23 amps per S250 luminaire is (8 x 1.23 x 130 x 0.00126 x 2) = 3.22 V.
For the last pole, the contribution to voltage drop from the starting current of 1.57 amps per S250 luminaire is (2 x 1.57 x 280 x 0.00126 x 2) = 2.22 V
The total calculated voltage drop is (3.22 + 2.22) = 5.44 V which is less than the allowable voltage drop of 9 Volts. Hence the voltage drop for the circuit is within limits.

Now determine the fault loop impedance.

From *AS/NZS3000*, the maximum fault loop impedance allowable for the 32amp 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 x 1.28 = 1.024Ω.

The total circuit length is 40 + (4 x 60) = 280m. For a 2 core 16mm^2 Cu XLPE/PVC cable, the impedance is:
2 x 280 x (22.5 / 1000) /16 = 0.79Ω. This is less than the limit of 1.024Ω and therefore acceptable.

Calculation of fault loop impedances for 2 core 4 mm^2 Cu PVC/PVC and 2 core 16mm^2 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 street light 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.

Main Public Lighting Cables not Entering Steel Lighting Pole	Loop Impedance of Cable (reference Table 44 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 mm^2 Cu PVC/PVC	1.012	1.752	173
2c & 4c16mm^2 Cu XLPE/PVC	0.252	1.752	695

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

Main Public Lighting Cables Entering Steel Lighting Pole	Loop Impedance of Cable (reference Table 44 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 mm^2 Cu PVC/PVC	1.012	1.024	101
2c & 4c16mm^2 Cu XLPE/PVC	0.252	1.024	406

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

Note: Hybrid circuits of 16 mm^2 and 4 mm^2 cables in series require separate calculations or else fusing down at the change of conductor cross-sectional area.

APPENDIX 1 – LOCAL AUTHORITY REQUIREMENTS

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