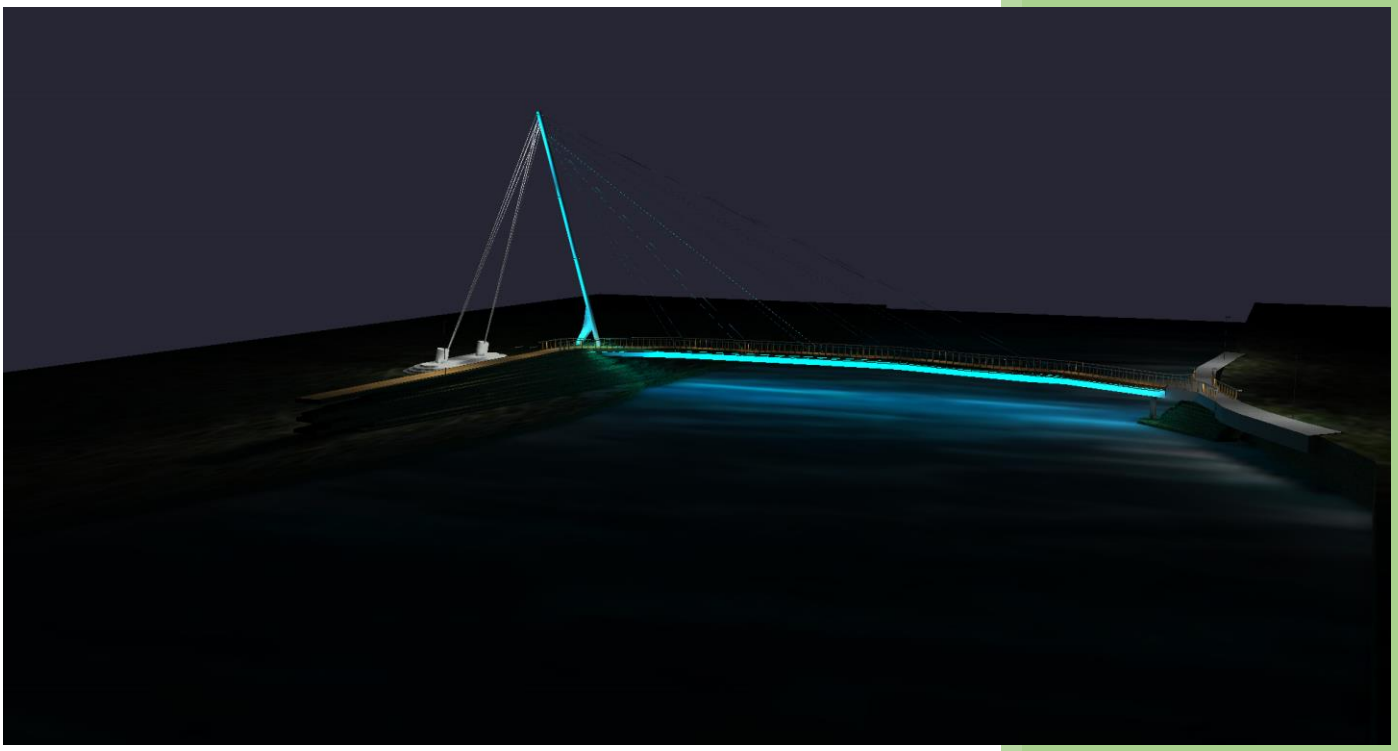
Longford Bridge and Shared Pathway Lighting in Gore.



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Lighting Design and Environment Report for Longford Bridge and Shared Pathway - Gore.

Date of Issue: 6–11-20 Revision C

Project Personnel

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Full Description of Work

The scope comprises of the lighting design for a proposed new cycleway bridge over the Mataura River and the lighting required for a shared pathway linking the bridge to the township of Gore. There is currently no existing lighting and it is proposed to use efficient LED luminaires throughout.

The new installation has been designed to comply with the requirements of AS/NZS 1158.3.1;2020 subcategory PP4 / PP5 for shared Pathways. This classification is based on pedestrian or cycle movement with medium/low cycle activity and low fear of crime. The technical parameters for this subcategory are shown in the table below.

TABLE 3.4

VALUES OF LIGHT TECHNICAL PARAMETERS FOR PATHWAYS AND CYCLIST PATHS

1	2	3	4	5
Lighting subcategory	Light technical parameters (LTP)			
	Average horizontal illuminance[a,b] ($\bar{E}_h$) lx	Point horizontal illuminance[a,b,d] (E_{Ph}) lx	Illuminance (horizontal) uniformity[c] Cat. P (U_{E2})	Point vertical illuminance[a,b] (E_{Pv}) lx
PP1	10	2	5	1
PP2	7	1	5	0.3
PP3	3	0.5	5	0.1
PP4	1.5	0.25	5	0.05[e]
PP5	0.85	0.14	5	0.02[e]

[a] These values are maintained. See Clause 3.2 pertaining to lumen derating values for non-white light sources.

[b] Conformance is achieved by being greater than or equal to the applicable table value.

[c] Conformance is achieved by being less than or equal to the applicable table value.

[d] Conformance of 50% of E_{ph} shall also be demonstrated over an area of 5 m either side of the pathway—where a verge exists—or up to any structure/fence/property boundary that forms the edge of the pathway, unless deemed otherwise by the relevant authorities (see Clause 3.1.3.5).

[e] For luminaires with mounting heights of 1.5 m or less, the E_{Pv} values need not be applied.

NOTES:

1 Validation of the values in Columns 2 to 5 is by calculation, not field measurement. This is particularly relevant to small values in Columns 2, 3 and 5, which will typically be difficult to validate by field measurements.

2 See Section 4 for the design methods and requirements for use in assessing conformance to the specified light technical parameters.

* Standards New Zealand *

Feature and functional lighting are proposed on and across the new bridge with all lighting effects being assessed via AS/NZS4282;2019 Control of obtrusive effects of outdoor lighting.

Anticipated lighting levels have been calculated and indicated by isolux lines on the attached calculations, drawings, and appendices in this report. Values indicated are based on maintained lux values from calculation points on the ground at maximum of 2m centres.

Calculations have been carried out using AGI32 version 18.3.2 from Lighting Analysts and Perfect Lite version 3.10 with photometric data supplied by luminaire manufacturers.

All luminaires specified indicate the technical attributes expected from well manufactured good quality luminaires with as many as possible being on the NZTA M30 Acceptable luminaire list as at 17-12-19. Individual luminaire attributes, performance expectations and warranty periods are noted on the attached lighting schedule. Refer appendix 2.

Installation contractor is to locate columns on site in conjunction with all other services, cables, kerbs, driveways, trees, landscape items and swales etc. All trenching back fill and compaction to be completed and left in a completed state as per the Road Controlling Authorities requirements.

All cabling to be installed as per the Network Owners specifications, standards, and safety requirements.

We have developed the design documents to include 3 options which are.

Option A – conventional mains powered lights and columns located on the roadside of the stop bank aimed back towards the river (away from the houses) outside the flood zone, plus with wrap around solar columns with DC powered light within the flood zone.

Option B – solar powered bollard lights at 0.6m to 1.5m high. This option has been considered to mitigate build-up of debris from a possible flood (where used on the flood plain) and to minimise disturbance to existing flood banks (where being considered along existing flood banks).

Option C - is as per Option A outside the flood zone (mains powered lights and columns) and within the flood zone an integral column with light, solar panel, and battery all as one unit.

The purpose of this approach is to; design, assess and consent all options so that the most economical solution can be found once detailed construction costs are known. It also allows us to determine the preferred approach with Environment Southland in respect to co-ordinating this work with any future intentions they may have with improvements to the stop banks and restrictions or limitations of flood damage. It is assumed that each of these options is then interchangeable for optimization purposes so that for example a “wired + solar column + bollard” configuration could be used if deemed most appropriate.

Luminaire Maintenance Factor OR Light Loss Factor (LLF)

Luminaire light loss factor used in the calculations is based on the following characteristics’

- Luminaire has an IP65 rating or higher
- A six-yearly cleaning regime is recommended to be implemented on completion and the luminaire is located within a rural environment. Hence luminaire dirt depreciation factor (LDD) from Table 3.2 AS/NZS1158.3.1:2020 is 0.92 or where it is considered dirt can build up quicker the value of 0.84 has been used.
- Light Lumen Depreciation (LLD) after 85,000 hours (4250 per year for 20 years) in accordance with manufacturers data.
- Overall (LLF) or Maintenance Factor (MF) is derived from = LLMF x LEF x LODV x LODR x LODL x LDD where.
  - LLMF = lamp lumen maintenance factor from TM21
  - LEF = luminaire electronic failure
  - LODV = luminaire optical depreciation for visor

LODR = luminaire optical depreciation for reflector
LODL = luminaire optical depreciation for lens

Based on the luminaires used in this project the following table results are achieved.

	LRL-NXT	EWO Handrail	LRL-NXT Solar	LED Strip	Mast lights	SBL2 Bollard
LLMF	0.92	0.9	0.92	0.9	0.9	0.9
LEF	0.99	0.99	0.99	0.99	0.99	0.99
LODV	1	0.99	1	0.97	0.97	0.97
LODR	0.99	1	0.99	1	0.99	1
LODL	1	0.97	1	0.97	0.97	0.97
LDD	0.92	0.84	0.84	0.84	0.92	0.84
MF	0.83	0.72	0.75	0.7	0.76	0.7

For compliance with ALL parts of AS/NZS1158 we have capped the maintenance factor at a maximum value of 0.8.

Control of Glare, Upward Waste Light, BUG ratings and Threshold Increment (Environmental considerations)

Upward Waste Light Ratio's (UWLR), BUG ratings and Threshold Increment are all indicated on the attached calculations and all the recommended luminaire options are compliant with the standards AS/NZS1158.3.1:2020, and AS/NZS 4282;2019.

Design Summary and Departures.

Three design options have been considered. These are referenced as

Option A – underground mains power supplied NXT lights mounted on columns on the roadside of the flood bank aimed back towards the river outside the flood zone and wrap around solar columns with DC powered lights within the flood zone.

Option B – SBL2 solar powered bollards everywhere.

Option C - underground mains power supplied NXT lights mounted on columns on the roadside of the flood bank aimed back towards the river outside the flood zone and integral GES solar panel and lighting unit mounted on a column within the flood zone.

There are no known departures or non-compliance concessions resulting from the recommended designs for Option A or C.

Consideration or Concession of using Solar Bollards – Option B.

In consultation with the hydrological designers (Riley Consultants Limited) and structural designers (DC Structural Studio Limited) a significant issue has been raised where it is unlikely that lighting columns through the flood zone will become an accepted long term solution by Environment Southland.

Lighting columns – typically around 7.5m height - would create a vertical obstruction for flood forces and debris to accumulate through the full circa 5.5m vertical range of the flood. Where the flood reaches levels as per the 2020 flood event, debris rafts and associated forces acting at the top of the lighting columns could result in overturning of the columns. One way to mitigate this would be to adopt fender piles around the lighting poles and thus introduce further unwanted obstructions in the flood plain. Both Riley and DC Structures Studio are in favour of more closely spaced lower height lighting bollards (rather than widely spaced lighting columns) through the flood zone to minimise any

overturning effect caused by debris and minimise overall flood impacts. This is a view shared by Gore District Council (GDC).
Early consultation with Environment Southland has indicated that low height bollards maybe preferred (although we note that their preference was for bollards less ≤400mm in height). This is just not possible or practical from a lighting perspective.

In reviewing a range of solar bollards available in NZ, we have been reviewing a solar bollard provided by "Solar Bollards NZ Ltd" manufactured in Australia. These bollards have particularly good strength and anti-vandalism properties. They come with a 10-year warranty. They also appear to have well suited attributes when solar power, low-height, low-maintenance installations are required.

To minimise the overall cost of a bollard installation, GDC and the design team have elected reduce the design compliance scope and area of the Pathway through the flood zone. Hence it is intended to only light 33% of the path width (1m width of the 3m available) to a PP5 standard. The net effect of this decision is to create an industry standard lighting for a designated usable width of path that would enable commuters to safely navigate the path at night (noting the need for a full 3m wide recreational path is significantly reduced at night). The rest of the path width would still have some light on it but would be below the technical parameters indicated in Table 3.4 AS/NZS1158.3.1;2020 for PP5 level (the minimum level noted in this standard). This approach is considered a design mitigation that:

1. Creates a usable width of path to an industry standard.
2. Permits the use of low-height lighting fixtures in the flood zone.
3. Limits the number of bollards required in the flood zone.
4. Reduces the capital cost and ongoing maintenance cost to Gore District Council.

Overall, this is considered a suitable compromise for functional purposes where other options are deemed less suitable by others hence could result in "no lighting" being the only available default option. The argument in this case is that 1m of path to PP5 is better than no lighting. The reduced width approach has been discussed and accepted by Gore District Council.

Bollards have also been discussed with Environment Southland (Colin Young, late October 2020) as an alternative to traditional lighting columns when used to light the path on the flood bank. Environment Southland have raised concerns that digging a 1.5m deep hole to ground plant a column could have significant detrimental effect on the structural integrity of the stop bank. Also, they are concerned at the possible damage to the flood banks if these columns were to be struck by errant public and or maintenance vehicles.

Design Records

The following design records have been produced and are appended:

- Drawings numbered ELC001 to ELC 009 (including ELC002A, ELC003A & ELC004A) Revision B inclusive plus with two other options for lighting in the flood zone labelled ELC002B, ELC003B & ELC004B (SBL2 Bollard option B) and ELC002C & ELC003C (GES Solar column mounted option).
- Luminaire Lighting Schedule
- Luminaire data sheets
- Perfect Lite luminance calculations
- AGI illuminance calculations

Environmental Considerations

Background and Standards Reference.

This lighting design package forms part of a Resource Consent application with respect to light technical parameters and compliance with Gore District Council district plan lighting rules.

Currently this ruling is: "*maximum permitted spill light of 5 lux onto any adjoining site measured at the boundary of the site generating the light spill" Rule 4.6.1.*

Reference is also made to AS/NZS4282;2019 Control of the obtrusive effects of outdoor lighting for other light technical parameters. Different parameters are recommended for different conditions to which the installation is going to occur. From Table 3.1 below the bridge/shared pathway is located within Zone A3 medium district brightness, suburban area of a township.

TABLE 3.1

ENVIRONMENTAL ZONES

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

NOTE: Recreational areas are not considered commercial.

From this Zone description maximum light technical parameters are identified to be 2 lux spill light during curfew time (11pm to 6am) and an upward light ratio of 0.02 (2%) via Table 3.2 as referenced below. Hence this design is expected to result in less spill light, less glare and less upward waste light than that permitted by both the district plan and AS/NZS4282.

TABLE 3.2

MAXIMUM VALUES OF LIGHT TECHNICAL PARAMETERS

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

The reason for this standard reference is because it refers to.

- different Environmental Zones relating to the ambient light conditions

- curfew time between 11pm and 6am
- an indication of maximum illuminance levels both inside and outside curfew time
- where no building line is adjoining, the calculation plane is taken at 10m from the boundary
- and at a general height of 1.5m (eye level when standing) above the ground is where the calculation plane has been taken.

Bridge Feature Lighting (Mast Lighting & LED strip).

To limit the obtrusive effects of any bridge feature lighting all the Mast Lighting and LED strip lighting across the bridge is directed downwards. Although the installation cost of this method of lighting is more expensive, in my opinion it will result in the best possible lighting solution and the ultimate outcome. Resulting calculations show an exceptionally low amount of upward waste light, good glare control and an incredibly low amount of spill light. High quality luminaires with specific optics (narrow beam) and additional accessories such as snoot are also specified to ensure optimum performance, glare, and spill light are controlled to the maximum levels.

In addition, all lighting will be controlled remotely via gateway protected Casambi Bluetooth controls hence the hours of operation, colour changing frequency, intensity and or dimming facilities can all be changed remotely. The visual render gives an indication of the intention of this lighting design while the lighting calculations show favourable results of limited light technical parameters complying with all standards referenced in this report.

It is proposed all feature mast lighting and LED strip lighting across the bridge can be switched OFF during curfew time (11pm to 6am) to further limit the environmental effects.

Bridge Handrail Lighting.

This is considered functional lighting and is required for safety reasons. Our proposal is to light via warm white 3000K LED luminaires installed within the bridge handrail in a staggered arrangement across the bridge. Maximum design spacing between luminaires in a staggered arrangement is intended to be set at 10m.

Switching and output controls will also be via Casambi Bluetooth controller, but it is unlikely these lights will be switched off during curfew time and hence it is proposed they remain operational throughout night-time hours but they could be dimmed if required.

Shared Pathway Lighting – mains power (outside flood zone).

This is considered functional lighting and is recommended for safety reasons. Our proposal is to light via warm white 3000K LED luminaires installed on columns mounted at zero-degree tilt, aimed away from residential houses. These luminaires have good recognised technical attributes that enable a minimal number to be installed to achieve the recommended standard of lighting. Typically, they will be mains power operated and located along the pathway at 43m – 48m intervals. They will be fully compliant with recommended standards (AS/NZS1158.3.1;2020). Glare and upward waste will be limited and will comply with all standards.

To minimize damage to the existing embankment it is proposed the lighting columns are located on the street side of the pathway with all cabling being laid at the base of the bank or within the road reserve area with laterals up and down the bank only occurring at each column location. Columns are ground planted so that any damage from a flood should result in the column being realigned or repositioned. Any future upgrade of any embankment can result in the columns and lights easily being reused.
There is no intention to concrete the columns in place although cable can be in 50mm or 100mm PVC ducts.

Switching and output control will be set as an extension to the existing streetlight network but the luminaires will be future proofed to enable any possible future streetlight network controls to be added to these luminaires should that occur in the future. Initially these lights will not be dimmed or switched off during night-time hours.

From a day or night-time visual perspective an increased number of bollards (6 or 7 times) the number of columns will create a more visible presence of obstructions in ones viewing environment as well as more upward waste light.

Shared Pathway Lighting - solar powered (inside flood zone area's).

This is considered functional lighting but because of the risk of damage from the river flooding three options have been considered.

1. Option A – column mounted DC LED luminaire powered via wrap-around solar panels
2. Option B – solar powered bollard lighting
3. Option C – column mounted solar panel with an integral LED luminaire.

It is intended that all options will incorporate warm white 3000K LED luminaires.

- Option A is using a column mounted 28W DC LRL-NXT luminaire at 7.5m high with 2 x 140W wrap around solar panels that can be located up to a maximum distance of 54m apart.
- Option B requires 1.5m high SBL2 bollards using 120W spaced at maximum distance of 7m apart where they are in full sunlight for a full width path. If a narrower 1m width pathway is acceptable this spacing could increase to 8.7m apart. If lower height (0.6m) high bollards are required due to risk of flooding, then the bollards could be spaced at 6.4m apart where a lower light level is accepted over a narrower width pathway (1m) wide. Where bollards are to be located in shade or partial shade then 1.2m high SBL2 bollards using 40W spaced at 2.2m apart are required (over the full pathway width) or up to 4m apart if a 1m narrower path is accepted.
- Option C is using a column mounted luminaire at 7.5m high with an integrated solar panel such as GES Group Ltd G03 Series up to 42.8m/42.5m apart for a 2.2m/3.0m wide pathway.

None of these options are ideal and or are 100% practical because of the environment they are located within. Based on this we need to ask the question is no lighting on the Pathway within the flood zone an acceptable option OR is orientation lighting only based on nominal reduced pathway width of 1m to an overall reduced lighting standard acceptable. Note from AS/NZS1158 Table 3.4 above PP5 is the lowest recommended lighting classification for Shared Pathways in New Zealand. This average horizontal illuminance is considered low because it is possible to achieve 0.3 – 0.5 lux on a full moonlit night or 0.01 lux on a quarter moonlit night.

Option A is a 28W DC LED manufactured by LRL with similar attributes to the mains operated pathway luminaire. This is installed on a column that incorporates internal batteries and wrap around solar panels manufactured by Ligman. However, because of the height and weight of these columns they are at considerable risk of serious damage from a river flooding.

SBL2 bollards from Solar Bollard Lighting NZ Ltd (see pages 4 & 5 above) have incredibly good technical attributes however to achieve the desired light level (PP5) they are required to be located closer together (≤ 7m). Hence because of this and their higher upward waste light ratio (6.1%) and lower BUG rating (backward light, upward light and glare rating B0-U1-G0), I do not consider such an installation will result in having little impact on the surrounding environment when they are fully illuminated. This option is indicated on drawings ELC002B, ELC003B & ELC004B.

During the later stages of this bollard design option and in consultation with Solar Bollard Lighting Ltd we expressed our concern at the high upward light component and they agree hence have been working on an improved optic where they hope to start manufacture in February 2021. Attached to this report in Appendix 7 is calculations done by SBL on a possible improved optic that will result in 1.5%

upward waste light ratio. These calculations also show for a 0.6m high bollard we can achieve PP5 requirements at 6.4m spacing over a 1m wide path. This indicates compliance with AS/NZS4282;2019 Table 3.2 (refer page 6 above). This result is not as good as the column mounted option A of 0% upward light but is below the permitted 2% value within AS/NZS4282.

GES Group Ltd G03 Series also appears to have very good technical attributes and being an integral unit with an LED luminaire, adjustable solar panel, column and occupancy sensor all as one unit it could provide a suitable solution in many circumstances but because of the risk of flooding the height and or weight of the unit could be at risk of serious damage during a flood. This option is indicated on drawings ELC002C & ELC003C.

From an environmental perspective in my opinion luminaires mounted at 54m apart are going to be considerably less visual and less obtrusive than bollards at 2 - 7m apart. Plus, the fact that a column mounted luminaire has a better BUG rating with less upward waste light, less reflected light, less glare, and less spill light the overall impact on the environment is minimised.

Results

Refer to the attached calculations in the Appendices.

Illuminance calculations at 1.5m above the ground over the bridge area indicates compliance with GDC district plan of 5 lux and 2 lux permitted under AS/NZS4282. With the calculation plane at 10m from the Pathway as recommended within AS/NZS4282 all vertical illuminance levels at 1.5m height are below the 2 lux permitted level for A3 Environmental Zone and all are below the 5 lux permitted by Gore district plan. No excess spill light is beneficial to properties nearby and is represented by the render views where they show a visual representation of none or little spill light into adjoining properties.

Most of the nearby properties are located some distance away from both the bridge and the pathway hence any obtrusive light that is going to be visible from afar is not spill light it is either upward waste light where the flux distribution from a luminaire is lost upwards or it is the intensity (brightness) of being in direct line of sight of the lamp source. Both of these factors have been mitigated against with this proposal by specifying all luminaires have controlled distribution (narrow or sideways beam optics) with no upward waste light element plus are concealed out of direct line of sight and are aimed in the downward direction. Additional accessories such as ‘snoots’ to further restrict direct line of sight are also available.

Maximum luminous intensity per luminaire is below the maximum permitted 2500cd hence all luminaires pass the A3 Environmental Zone parameter.

We achieve a maximum upward waste light ratio 1.7% which is below the maximum permitted value of 2% as recommended within AS/NZS4282 Table 3.2 for Environmental Zone A3.

All Pathway lighting results are summarised in the maximum design spacing table on drawing ELC001 and are supported by calculations in Appendix 5 to 8 attached.

Summary / Recommendation

This installation proposes to use good quality luminaires throughout that results in limited glare, little upward waste light and small amount of light spill. This is indicated via the render views that will be beneficial to nearby properties. The lights are located and oriented away from adjoining houses, aimed downwards with zero-degree tilt, discretely mounted out of direct line of sight, mounted at optimum mounting height to achieve maximum spacing from minimum number of lights. The pathway columns will also be painted black to blend into the environment.

Majority of cabling can be located off the embankment to limit the risk of damage.

Luminaire accessories such as glare shields, spreader lens or specific sideways distributing optics to maximise light distribution are included within each luminaire specification.

Bluetooth controls are recommended to enable remote adjustment of all bridge lighting throughout all fixtures expected life. Incorporate a curfew time (11pm to 6am) when all non-essential feature lighting will be switched off.

As the proposed installation is going to operate in a restrictive time period, has a limited number and discretely mounted luminaires, uses painted columns, is using fit for purpose narrow beam optics, asymmetrical optics, mounted in the horizontal plane, shining light downwards and orientated away from adjoining properties to restrict the overall effect on the environment, glare and spill lighting resulting in minimal upward waste light hence, in my opinion no further lighting mitigation can be achieved.

The least number of bollards installed will result in the least visual clutter in the overall environment.

Project Management

The Project Manager (PM) for this project is to be confirmed. The PM will co-ordinate the design, construction, and the supply of all the lighting requirements with the Client (GDC), Lighting & Network Cable Contractors / Designers.

Upon receipt of completion paperwork from the contractor the project manager will check compliance certificates, “as built” drawings etc. The PM will visit site on completion to ensure all equipment is installed to meet the design requirements. The PM will issue a “Completion Certificate Design”, or a defects list forwarded to the contractor for remedial work before the project is signed off as being complete.

Communication with stakeholders and other parties

Communication with other parties will be via telephone, email or written.

Producer Statement Design is attached

This Design Report has been:
Prepared by: Steve Muir 6-11-20
(Designer) (Name/Signature/Date)

Appendices

Appendix 1 – Design drawings ELC001 to ELC009 inclusive plus options B & C within the flood zone ELC002B, ELC003B & ELC004B & ELC002C, ELC003C.
Appendix 2 – Lighting Schedule and Specification.
Appendix 3 – Lighting Renders.
Appendix 4 – Luminaire data and installation information.
Appendix 5 – Mains Pathway calculations.
Appendix 6 – Bridge calculations.
Appendix 7 – Solar Pathway calculations.
Appendix 8 – Obtrusive light calculations.