The Lake Lothing (Lowestoft) Third Crossing Order 201[*]

Lake Lothing THIRD CROSSING

Document 7.5: Design Report

Appendix 9

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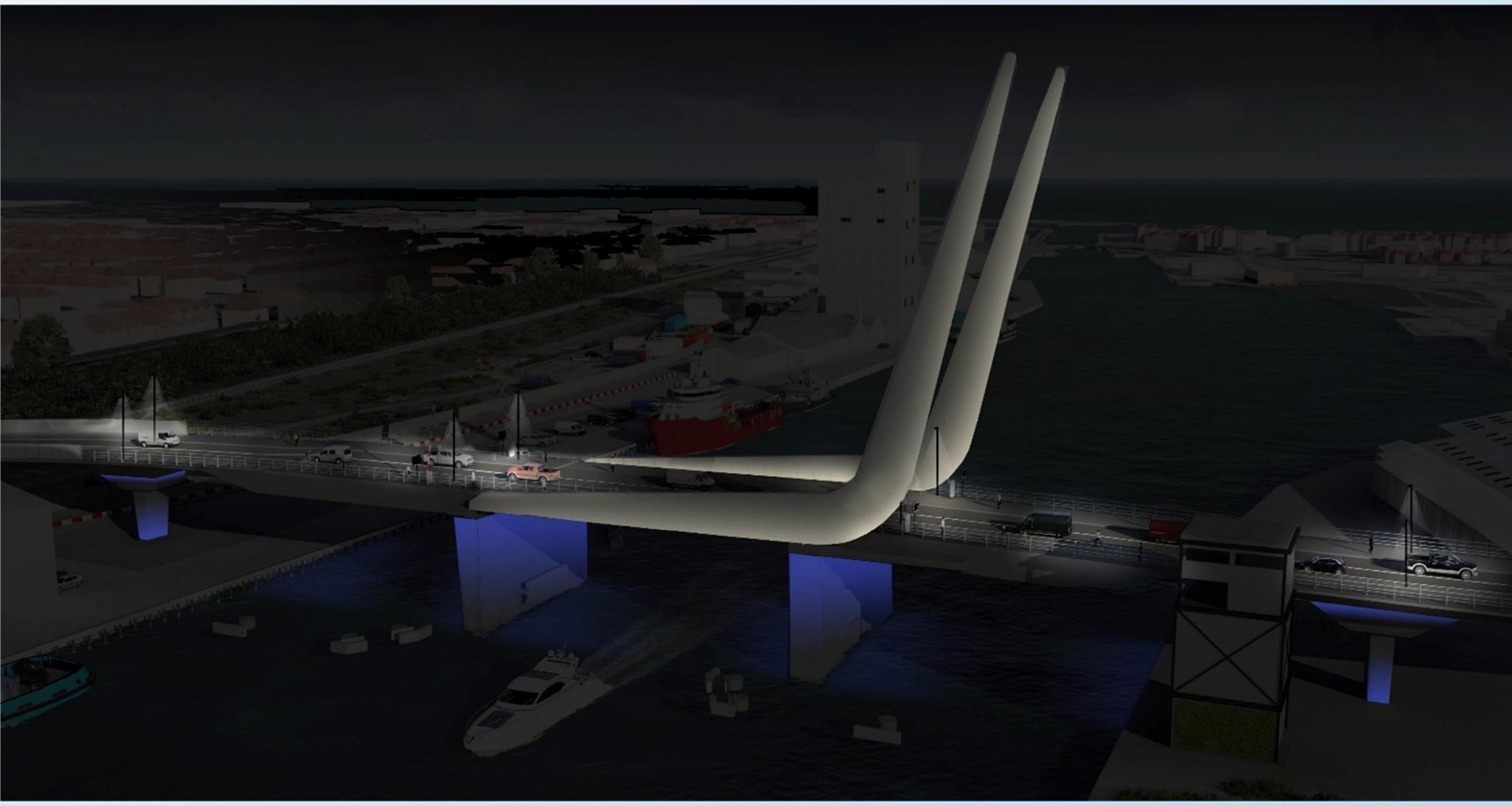
Suffolk County Council

LAKE LOTHING 3RD CROSSING

Lighting Strategy



62240712-WSP-HLG-LL-RP-EO-001
JUNE 2018

PUBLIC

Suffolk County Council

LAKE LOTHING 3RD CROSSING

Lighting Strategy

TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 62240712
OUR REF. NO. 62240712-WSP-HLG-LL-RP-EO-001

DATE: JUNE 2018

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1 INTRODUCTION

Suffolk County Council has commissioned WSP to review the need for, and implementation of, lighting to the Lake Lothing 3rd Crossing and surrounding area. Lake Lothing is a saltwater lake located in Lowestoft. It splits the town in two and it is currently bridged by two crossings, the Bascule Bridge and the Mutford Lock Bridge. The new bridge, the Lake Lothing 3rd Crossing, would link from Waveney Drive on the south side, to Denmark Road and Peto Way on the north side.

Famous for being the most easterly town and the first place to see the sunrise in the UK, Lowestoft has a long history. Some of the earliest evidence of settlement in Britain has been found in the area. Initially a town relying on the fishing industry, Lowestoft grew to become a base of the oil and gas industry in the 1960s. Today it has begun to develop as a centre of the renewable energy industry within the East of England, and remains a traditional seaside resort with its award-winning Blue Flag beach and Victorian seafront gardens. The 3rd Crossing bridge will draw inspiration from the town's imposing wind turbine, 'Gulliver'.

This report will analyse the impact of proposed road, architectural and landscape lighting schemes and make recommendations for the implementation of systems compliant with applicable standards and guidance. The effect on the local environment will be considered, to ensure the right light is provided, at the right place, at the right time. This document will aim to define the following:

- Is lighting required? If so, what standard of lighting will be required?
- What would be the environmental impact? (Visual, energy consumption and carbon emissions.)
- How would the lighting interact with neighbouring services? i.e. rail, waterways, businesses, residential areas, etc.

The report will seek to demonstrate the benefits that can be utilised through the installation of LED luminaires in conjunction with the use of the Local Authority's existing Central Management Systems (CMS).

The main outcomes for this report will be the following:

- Overview of the functional and aesthetic lighting proposals for the bridge.
- Commentary on maximising maintenance regimes.
- Evaluate the impact of the installation of LED luminaires on biodiversity and the local environment.
- Consideration for the profiling of the lighting at suitable times via CMS.

Lighting is reviewed in accordance with the documents listed in the Bibliography, presented at the end of this document.

DESIGN & STRATEGY

2 DESIGN & STRATEGY

2.1 NEED FOR LIGHTING

This section provides an overview of the objective and subjective influences that affect the introduction of lighting.

2.1.1 ARCHITECTURAL LIGHTING

The aim of architectural and landscape lighting is to enhance the user's experience as they move through the development. The eye is drawn to the brightest part of a scene and lighting can therefore influence how vehicles and pedestrians move through the space.

An architectural lighting scheme may promote a unique identity for the bridge after dark. It should create a visual feature without adding clutter or being intrusive to the character of the bridge. It should provide a uniform design which enhances and highlights the structure – complementing the physical bridge as well as emphasising its elements.

An element of overlap may exist between architectural and road lighting: the highway across the bridge being lit for safety and orientation. The two facets of lighting should complement one another – their objectives and functions combining to:

- Create a sense of safety and security
- Aid orientation
- Enhance key features
- Excite, entertain and inform
- Facilitate the extended use of the site after dark

2.1.2 ROAD LIGHTING

There is no statutory requirement on local authorities in the UK to provide public lighting, although it is good practice to provide efficient and useful lighting if a road is to be lit. The law states that:

- The Highways Act empowers local authorities to light roads but does not place duty to do so
- The local authority has a duty of care to road users and has an obligation to light obstructions on the highway
- The local authority has a statutory duty under the Highways Act to ensure the safety of the highway and this includes any physical lighting equipment placed on the highway
- The Electricity at Work Regulations impose a duty on owners and operators of electrical equipment to ensure its safety

2.1.3 SECTION 17: CRIME AND DISORDER ACT 1998

The Act states each local authority needs to do all it reasonably can to prevent crime and disorder and to ensure its services give due regard to crime and disorder. The provision of lighting may be considered good practice and adherence to the lighting levels defined in BS 5489 will prove that recognised guidance is being followed.

2.1.4 DESIGN MANUAL FOR ROADS AND BRIDGES

The Design Manual for Roads and Bridges (DMRB) (as the applicable suite of standards for strategic roads, but otherwise adopted for many more minor road schemes) provides some guidance on the reduction of risk to workers, users of the road and other parties, through GD 04/12 *Standard for Safety Risk Assessment on the Strategic Road Network*. The document accepts that the same level of control cannot be applied to road users as to parties such as maintenance works.

A risk assessment for the provision of lighting may therefore be undertaken in-line with GD 04. Part of the risk assessment would involve the assessment of whether the lighting would be required based on the local environment, crime rates and inherent safety risks.

Such an assessment would be undertaken by specialist road safety engineers, but broad considerations are discussed in Table 2.1.4 below.

Table 2.1.4 – Risks related to the failure to provide road lighting

Hazard	Impact
Queuing traffic	With the presence of signals and barriers intended to halt traffic when the bridge is raised, it is assumed queuing traffic will develop as a result. Road lighting helps drivers to better appreciate the distance to the end of the queue. Without road lighting drivers are less able to judge the distance to the end of a queue and are therefore less able to adjust their speed and apply the brakes appropriately. The number of collisions may therefore increase in unlit conditions. The severity of collisions may also increase as a result of higher speeds at impact.
Glare from headlights of oncoming vehicles	The nature of the approach to the bridge requires an inclined approach. This will raise the beam angle away from the road surface potentially causing glare for oncoming vehicles. If the crossing is unlit headlights could cause disability glare when viewed against a darker background. Lighting to BS 5489 would ensure that levels of uniformity of light are maintained, significantly decreasing the risk of temporarily impairing the vision of oncoming drivers.
Transition from lit to unlit section	The strategic link roads (A12 and Waveney Drive on the south side, Denmark Road on the north side) feeding traffic onto the bridge are currently lit. If the 3rd Crossing is unlit drivers will transition from a lit into an unlit section of road and then back into a lit section in relatively quick succession. Drivers' eyes take some time to adjust from light to darkness (and back again). During this period of adjustment drivers may be less able to see and judge their environment correctly, e.g. distances to other vehicles or obstacles and speed of other vehicles. This may lead to more accidents and / or more severe incidents.
Broken down / stopped vehicles	A broken down or stopped vehicle is more difficult to see in unlit conditions. Drivers may therefore see a stopped vehicle later compared to a lit road. Furthermore, in unlit conditions drivers may find it more difficult to judge the exact position of the vehicle (e.g. in which lane the vehicle has stopped) and the distance to the vehicle. As a result collisions with a broken down or stopped vehicle may increase in both frequency and severity.
Interaction with pedestrians / cyclists	Pedestrian footways and cycleways have been included in the proposals adjacent to the carriageway, thereby increasing the interaction between pedestrians, cyclists and vehicular traffic. If the route were to be lit, identifying potential hazardous scenarios with people and / or cyclists entering the carriageway would allow drivers more time to react and increase the capability of their peripheral vision. Likewise, a lit road would allow pedestrians and cyclists to identify hazards and their route ahead more easily.

Hazard	Impact
Reduced visibility of road works / road workers	Road works and road workers are less visible to drivers in darker conditions. Drivers may find it more difficult to judge distances to road works in the dark compared to a lit road. This may potentially result in a higher frequency (and severity) of accidents where a vehicle enters road works and potentially collides with maintenance operatives.

As a result of the risks identified, it is recommended that lighting the bridge and its approaches should be considered a necessity to aid in mitigating potential risks. The implementation of an efficient lighting design to the current applicable standards, in keeping with the surrounding environment, would maximise the perception of safety whilst not taking away from the functionality or aesthetics of the bridge or harbour area.

The aesthetics of the structure can be further enhanced with the implementation of an architectural lighting scheme, and the provision of a well-designed road lighting installation need not detract from any feature lighting provided.

2.2 DESIGN CRITERIA

2.2.1 LIGHTING CLASS – MAIN ROADS

The applicable standards utilise selection tables, supported by a risk assessment process, to enable accurate selection of the correct level of road lighting. The initial stage is the identification of the route classification. In consultation with Suffolk County Council, the main roads within the scheme have been classified as ‘subsidiary roads with a typical speed of main user’ of 30 mph or less (BS 5489 Table A.5). The ‘main’ roads are considered to be the bridge crossing, the A12, Denmark Road and Waveney Drive. Table A.5 therefore involves the application of the ‘P’ series of lighting classes.

It should be noted that the use of P classes in this scenario is the preference of the Local Authority’s policy and is not derived through strict interpretation of the standards.

2.2.1.1 Risk Assessment Process – Main Roads

The risk assessment process evaluates whether the base lighting class (in the case of the main roads, P2) requires amending up or down based on site-specific criteria. The parameters to consider in the risk assessment process are:

Key Considerations

- Speed
- Pedestrian, cycle and vehicle flow
- Ambient luminance or Environmental Zone

Additional Considerations

- Traffic composition
- Complexity of task
- Risk of crime or need for facial recognition

Table 2.2.1.1 shows the assessment process for the main roads, based on the recommendations of BS EN 13201 and CIE 115 (the relevant adopted European and international standards respectively). It shows that the base lighting class, P2, does not require amending. The selected weighting values have been ascertained from third party data (e.g. traffic modelling projections) or from assumptions:

- It is not anticipated that parked vehicles will be present across the bridge or other main roads.
- The ambient luminance has been assessed as 'normal' due to the neighbouring docks and industrial premises, together with links to large shops and retail parks providing some ambient luminance without directly contributing to the roads.
- The routes have been assessed as easily navigable in the sense that many of the roads are relatively straight and drivers should be able to see unobstructed for some distance.

Table 2.2.1.1 – Weighted risk assessment table for P-classes

Parameter	Options	Description	Weighting Value (V_W)	Selected Weighting Value
Travel speed	Low	V ≤ 40 km/h	1	1
	Very low (walking speed)	Very low, walking speed	0	
Use intensity	Busy		1	1
	Normal		0	
	Quiet		-1	
Traffic composition	Pedestrians, cyclists and motorised traffic		2	2
	Pedestrians and motorised traffic		1	
	Pedestrians and cyclists only		1	
	Pedestrians only		0	
	Cyclists only		0	
Parked vehicles	Present		0.5	0
	Not present		0	
Ambient luminosity	High	Shopping windows, advertisements, sports fields, etc.	1	0
	Moderate	Normal situation	0	
	Low		-1	
Facial recognition	Necessary		Additional national requirements	No additional requirements
	Not necessary		No additional requirements	
			Sum of weighting values V_{ws}	4
			Lighting class P = 6 - V_{ws}	2
			Derived lighting class	**P2**

As per Table 2.2.1.1, the main roads within the scheme will be lit to lighting class P2 (with due variation to account for the S/P ratio of the selected luminaire, as defined in Figure 1). Areas with increased potential for conflict between vehicles and between vehicles and non-motorised users, such as roundabouts and major intersections, will be designated as conflict areas and lit to class C3 (see figures 2 and 3).

Class C3 is derived by selecting the next highest comparable C-class to the main route lighting level. This is standard practice for areas with greater conflicting movements, to ensure the increased hazards are highlighted to users.

Figure 1 – BS 5489 Table A.7

Table A.7 **Variation of maintained lighting level with S/P ratio of light source**

Values in lux

Lighting class	Benchmark (e.g. R_a < 60 or when S/P ratio of light source is not known or specified)		S/P ratio = 1.2 and $R_a \geq 60$ (e.g. some types of warm white lamp such as metal halide)		S/P ratio = 2 and $R_a \geq 60$ (e.g. some types of cool white compact fluorescent or LED)	
	$\bar{E}$	E_{min}	$\bar{E}$	E_{min}	$\bar{E}$	E_{min}
P1 or S1	15.0	3.0	13.4	2.7	12.3	2.5
P2 or S2	10.0	2.0	8.6	1.7	7.7	1.5
P3 or S3	7.5	1.5	6.3	1.3	5.5	1.1
P4 or S4	5.0	1.0	4.0	0.8	3.4	0.7
P5 or S5	3.0	0.6	2.2	0.4	1.8	0.4
P6 or S6	2.0	0.4	1.4	0.4	1.1	0.4

Figure 2 – BS 5489 Tables A.1 and A.4

Table A.1 **Lighting classes of comparable level**

ME or M class	CE or C class	S or P class
—	CE0 or C0	—
ME1 or M1	CE1 or C1	—
ME2 or M2	CE2 or C2	–
ME3 or M3	CE3 or C3	S1 or P1
ME4 or M4	CE4 or C4	S2 or P2
ME5 or M5	CE5 or C5	S3 or P3
ME6 or M6	—	S4 or P4
—	—	S5 or P5
—	—	S6 or P6

NOTE The data in this table is extrapolated from PD CEN/TR 13201-1:2004 (undergoing revision).

Table A.4 **Lighting classes for conflict areas**

Traffic route lighting class	Conflict area lighting class
ME1 or M1	CE0 or C0
ME2 or M2	CE1 or C1
ME3 or M3	CE2 or C2
ME4 or M4	CE3 or C3
ME5 or M5	CE4 or C4
ME6 or M6	CE5 or C5

Figure 3 – BS EN 13201-2 Table 2

Class	Horizontal illuminance	
	$\bar{E}$ [minimum maintained] lx	U_o [minimum]
C0	50	0,40
C1	30	0,40
C2	20,0	0,40
C3	15,0	0,40
C4	10,0	0,40
C5	7,50	0,40

2.2.2 LIGHTING CLASS – RESIDENTIAL AND MINOR ROADS

As with the more major roads, residential and minor roads are assessed based on the selection tables and risk assessment process defined by the applicable standards. In consultation with Suffolk County Council, residential and minor roads within the scheme have been classified as 'subsidiary roads with a typical speed or main user' of 30 mph or less (BS 5489 Table A.5). The more minor roads are considered to be Waveney Drive and Canning Road. Table A.5 therefore involves the application of the 'P' series of lighting classes.

2.2.2.1 Risk Assessment Process – Residential and Minor Roads

The risk assessment process evaluates whether the base lighting class (in the case of the more minor roads, P3) requires amending up or down based on site-specific criteria. The parameters to consider in the risk assessment process are:

Key Considerations

- Speed
- Pedestrian, cycle and vehicle flow
- Ambient luminance or Environmental Zone

Additional Considerations

- Traffic composition
- Complexity of task
- Risk of crime or need for facial recognition

Table 2.2.2.1 shows the assessment process for the minor roads. It shows that the base lighting class, P3, does not require amending. The selected weighting values have been ascertained from third party data (e.g. traffic modelling projections) or from assumptions:

- Parked vehicles were identified as present on the existing road layout and are anticipated to remain under the new scheme.
- The ambient luminance has been assessed as 'normal' due to the neighbouring docks and industrial premises, together with links to large shops and retail parks providing some ambient luminance without directly contributing to the roads.
- Enhanced facial recognition has not been identified as a particular requirement. (Note that the introduction of levels for enhanced facial recognition may additionally impact semi-cylindrical illuminance calculations in tandem with the horizontal illuminance considered under a P-class.)

Table 2.2.2.1 – Weighted risk assessment table for P-classes

Parameter	Options	Description	Weighting Value (V_W)	Selected Weighting Value
Travel speed	Low	V ≤ 40 km/h	1	1
	Very low (walking speed)	Very low, walking speed	0	
Use intensity	Busy		1	-1
	Normal		0	
	Quiet		-1	
Traffic composition	Pedestrians, cyclists and motorised traffic		2	2
	Pedestrians and motorised traffic		1	
	Pedestrians and cyclists only		1	
	Pedestrians only		0	
	Cyclists only		0	
Parked vehicles	Present		0.5	0.5
	Not present		0	
Ambient luminosity	High	Shopping windows, advertisements, sports fields, etc.	1	0
	Moderate	Normal situation	0	
	Low		-1	
Facial recognition	Necessary		Additional national requirements	No additional requirements
	Not necessary		No additional requirements	
			Sum of weighting values V_{ws}	2.5
			Lighting class P = 6 - V_{ws}	3.5
			Derived lighting class	**P3**

As per Table 2.2.2.1, the residential and minor roads within the scheme will be lit to lighting class P3 (with due variation to account for the S/P ratio of the selected luminaire).

2.2.3 S/P RATIO AND COLOUR TEMPERATURE

As described previously, the selected lighting levels for all routes lit to a P-class may be varied according to the S/P ratio exhibited by the proposed luminaire. The range of variation is illustrated by PLG03 *Lighting for Subsidiary Roads* (Institution of Lighting Professionals, 2012).

The S/P ratio is the ratio of the luminous output of a light source evaluated according to the CIE scotopic spectral luminous efficiency function (*V'(λ)*), to the luminous output evaluated according to the CIE photopic spectral luminous efficiency function (*V(λ)*). The greater the value of the S/P ratio, the lower the maintained lighting levels can be without affecting visual performance.

Adjustments to levels for S/P ratio are dependent on the colour rendering properties of the light source (a measure of how accurately colours are represented under the light source), and may only be applied to units with a colour rendering value (R_a) of 60 or greater. Units with these properties are generally referred to as providing 'white light' and with modern technologies generally confines the designer to the use of LED sources.

While higher colour temperatures often exhibit greater colour rendition properties, the higher (cooler, or more blue) temperatures may be perceived as being 'cold' or 'unwelcoming'. Higher colour temperatures may also impact on local fauna more so than warmer sources and a balance should therefore be sought between aesthetic and functional considerations.

LED sources are generally available in three distinct colour temperature ranges: warm white (~3000K), neutral white (~4000K) and cool white (~5000K or above). It is recommended that a neutral white option is pursued for functional road lighting. This range reduces many of the disadvantages of very cool sources, whilst offering the benefits of a white light source to the interaction between different user groups.

A white light source will have the added advantage of being least confused with signals for railways and waterways.

2.2.4 VARIABLE LIGHTING LEVELS

Commentary on variable lighting levels is provided in BS 5489 (§ 4.4.4). Further guidance is available in PLG08 *Guidance on the Application of Adaptive Lighting within the Public Realm* (Institution of Lighting Professionals, 2016). While these documents are produced primarily for road lighting and urban streets, the principles may be equally applied to landscape and architectural lighting installations.

Variable lighting is often referred to as 'dimming', but more appropriately it is lighting to the correct lighting class at a particular time. Establishment of a regime of lowering and raising lighting levels is referred to as 'profiling'. For the purposes of discussion in this report, the term profiling is used.

It may be that the highest lighting level an installation can achieve is only useful on rare occasions, where traffic density is higher than normal (such as match days near to a football stadium), while it may be acceptable to light to a lower level for the majority of the time. Along with technological solutions such as energy-efficient light sources and controls, and using renewable energy sources, simple practices such as the selection of the appropriate lighting class and use of profiling can help to make lighting more sustainable. Additional environmental benefits may include reduced light intrusion and light pollution.

The applicable standards classify the required lighting levels based on usage (traffic or other user flow); therefore when the use of a road or area reduces (often overnight), and provided the equipment is suitable, the lighting levels can be reduced through profiling. Ever-improving technology allows for more flexibility in the variation of lighting levels on all classifications of road and area. As the usage is reduced, typically the lighting level can be reduced, unless there are over-riding reasons not to do so (such as a high dark accident or crime rate). Generally the base lighting class for the route will be maintained in periods of highest traffic flow or user presence.

2.2.4.1 Road Lighting Recommendations

It is recommended that assessment is undertaken to determine if it is suitable to vary the lighting levels proposed for the scheme. In general, two groups of effects may be identified as impacting this decision:

- Level of vehicular and pedestrian activity: all routes have peak and lull traffic times, the latter generally being in the early hours of the morning.
- Level of ambient luminance: urban centres with commercial properties may exhibit a drop in ambient luminance after business hours.

An interconnected effect will be an increase in activity at times of business or leisure facility closure – for example, an increase in pedestrian activity around local public house and restaurant closing times. If such events are identified as occurring within the scheme, it is recommended that base lighting levels are maintained during this period. Not only will the correct lighting levels increase the feeling of security, but they may also assist CCTV equipment, if such provision is made. With these recommendations in mind, the lighting class risk assessment process may be extended to assess the night-time environment and establish a lighting profile. Appendix A shows a typical profile, based on adjusting the level of light dependent on hourly traffic flow and changes in ambient luminance outside business hours.

2.2.4.2 LL3X - Order Limits Change– Revision A

A revised lighting calculation was undertaken to show the effect of Lighting Column relocations due to revised barrier locations and to provide back-up information, to support changes to the design drawing. The affected Lighting Columns are identified on drawing no. 62240712-WSP-HLG-LL-DR-EO-1300 as unit numbers L36, L37, L38 & L39.

Lighting Column relocations have been carried out to accommodate barrier repositioning at both north and south approaches to the lifting section of the proposed Bascule Bridge. The requirement is for lighting columns to be placed on the approach side of each of the north and south bound barriers.

The repositioning of the southernmost barrier requires placement of unit numbers L36 & L37, closer in proximity to Units L34 & L35 thus increasing irregular spacing. The Lighting calculation uses best available optics to achieve as near possible compliance with the relevant lighting class.

The Proposed Lighting Calculation carried out to the requirements of BS 5489-1:2013 & CIE 115:2010 Lighting Class P2, exceeds Eav for prescribed class by 5.05Lux and under achieves Emin for prescribed class by 0.05Lux, the worst affected area being the centre of the bridge span at back of footpath.

Lighting Column spacing at the south section of the bridge is approximately 20.0m, compared with approximately 34.0m on the north section. Whilst this is not detrimental, lighting levels on the approach from the south will appear notably ‘brighter’, than the mid-section of the bridge; this it does portrays the worst case at the present stage of the design. It is recommended that a separate review is undertaken for column spacing on the southern approach to compensate for the higher uniformity at the bridgehead, and that this should be carried out at Detailed Design Stage.

2.2.4.3 Architectural and Landscape Lighting Recommendations

It is anticipated that the architectural and landscape lighting would be controlled centrally, via photo-electric control unit, time clock or a mixture of similar systems. To promote sustainability and reduce energy usage, additional use of time clocks can ensure that not all luminaires switch on at the same time or remain switched on through the entire night.

This approach makes it possible to group luminaires and / or pre-program a number of ‘scenes’ which can be activated at specific times to create a desired mood, aesthetic and light level across the site in conjunction with the bridge feature lighting. An example of pre-programmed or switched scenes may include:

- Scene 1 (sunset): all circulation lighting, such as bollards, markers and tree illumination will be activated.
- Scene 2 (post-sunset / evening): all functional and aesthetic lighting activated.

In the same vein as road lighting, architectural lighting may be profiled through the night dependent on the client’s aspirations.

2.3 OVERALL STRATEGY

2.3.1 OVERVIEW

It is noted that Suffolk County Council have a wider lighting policy for the county. A project-specific strategy has been developed within this document which references BS 5489 Annex D *Sustainability*. The general framework of the strategy follows the key headings of the annex.

2.3.2 ECONOMIC

The economic considerations of the strategy / policy should ensure that the benefits outweigh the costs. The scheme has to be affordable to the public purse throughout its lifecycle. It should also ensure the efficient and effective use of electrical energy and lighting levels. Variable, profiled lighting or other control policies are key to ensuring the economic benefit is maximised.

Design considerations are also pivotal to an economically sound scheme. The design must ensure that intended benefits will be realised, optimise costs of construction, operation, maintenance and electrical energy and optimise function of lighting controls. The need for vandal resistant products in high crime areas, or easily accessed luminaires (such as subway lighting units) should be considered.

The design will directly influence the installation, operational and decommissioning phases of the project. During installation the optimisation of material and installation costs is paramount; during operations the maximisation of material and energy savings may be the key metric on which the scheme is judged.

The level of maintenance applied will adhere to a maintenance policy largely influenced at the design stage and will be a result of the choices made during strategy and preliminary phases. Regular review of the maintenance policy, throughout all phases, should be undertaken to take advantage of changing circumstances, including technical advances and changing legislation.

2.3.3 ENVIRONMENTAL

The policy should seek to minimise environmental impact, including factors directly controllable during design, such as obtrusive light and effects on wildlife. The design process should consider the balance of proposals: safety positives versus environmental negatives, whilst adhering to all regulations and legislative requirements. The design should also aim to minimise obtrusive light through the use of the appropriate glare classification, controllable sources and efficient levels.

Environmental considerations during the installation phase will include minimising the impact of temporary equipment, plant and machinery, and appropriate disposal of packaging and waste.

Operational considerations may include the implementation of variable lighting to minimise obtrusive light and realise electrical and carbon savings. All lighting, both functional and architectural, should seek to minimise glare, light pollution and light trespass. The scheme should provide a sustainable solution with low energy use and straightforward maintenance.

The strategy should consider maintenance operations and the re-use or recycling of replaced components. The appropriate application and use of energy saving components and new technologies should be explored wherever possible.

Environmental considerations for decommissioning should include disassembly, recyclability and disposal of unwanted equipment and materials in accordance with best practice and legislation. At the end of the scheme’s life it will be expected that all components that can be recycled or reused are dealt with appropriately.

2.3.4 SOCIAL

The social considerations of the strategy should aim to optimise the visual impact of architectural elements and consider the benefit of lighting as an amenity. Within the design stages, consideration should be given to the benefits including safety (actual and perceived) and commercial (e.g. increased footfall). The design should aim to minimise the potential adverse effects (e.g. delays) during maintenance.

The policy for the installation, maintenance and decommissioning phases of works should include the aim to minimise adverse effects on nearby residents and consider the safety of road users and the workforce. Similarly, these elements should be realised throughout the operational life and demonstrate that the scheme benefits the community rather than impacting on it.

2.3.5 LIGHTING LEVEL PROFILING

As indicated previously, the use of variable lighting will offer solutions to maximise financial savings and minimise the impact on the environment. However, guidelines should be implemented to ensure that the implementation of variable lighting does not negatively impact on the safety of the people and environment the lighting has been provided for.

The implementation of any variable lighting system should be designed to meet applicable standards and guidance, defining not only the levels designed for peak activity but also the levels where the site-specific parameters allow profiled dimming. The initial consideration for the implementation of profiling should be for the area or route the lighting is intended for and its expected use. The risk assessment process identified in BS 5489 (§ A.3), in conjunction with CIE 115 and BS EN 13201, offers a weighting system for consideration of the natural and social environment.

Further considerations should then be applied in consultation with key stakeholders, including the police. Where crime rates are higher it would be recommended to limit dropping lighting levels. Higher levels may assist in reducing the fear of crime within the local community.

2.3.6 ARCHITECTURAL LIGHTING CONCEPT

2.3.6.1 Bridge Lighting

Bridges can be fascinating pieces of architecture, and when properly lit, they can be transformed into night-time landmarks. An illuminated bridge can reflect light onto the water surface, creating an ever changing image, inspiring visitors and pedestrians.

The architecture of the 3rd Crossing is inspired by the shape of a wind turbine. The lighting design should retain and enhance the structure without introducing new dominant shapes. It should provide functional and aesthetic elements, coupled with considerate design to ensure maintainability and cost-effectiveness.

A new-built bridge offers the advantage that the luminaires and the cabling can be fully incorporated in the structure, creating a seamless design.

Figure 4 – Inspiration for the bridge concept (Infinity Bridge, River Tees)

2.3.6.2 Landscape / Public Realm Lighting

The bridge is the major element of the external scene, but it must be considered in conjunction with other components. The immediate area surrounding the bridge, including pathways, pedestrian areas, soft and hard landscaping and statues, are all elements that contribute to the nightscape. Each may require their own specific lighting approach but have to be considered as a whole to create a coherent scheme.

The main objectives of the landscape lighting are to create a feeling of safety and security for the user, aid orientation, enhance key features, excite, entertain and inform and facilitate the extended use of the site after dark.

The landscape lighting concept would, where possible, integrate lighting within the soft and hard landscaping elements, so it is the lighting effect and not the light fixture that is being seen. Due to the scale of the site some lighting columns would need to be introduced, but these would be kept to a minimum and more ‘architectural’ posts would be employed wherever possible.

Consideration when planning the landscape lighting scheme shall be given to the following:

- The sequential experience through the space
- Appearance and integration of the luminaires
- Direct and reflected glare
- Illuminance and luminance levels
- Light distribution on surfaces
- Light pollution
- Highlighting points of interest
- Creating a feeling of safety and security

The proposed design within this document describes the lighting techniques used to illuminate the individual elements within the landscape. When combined together as a whole these create an exciting sequential experience.

EXISTING LIGHTING INFRASTRUCTURE

3 EXISTING LIGHTING INFRASTRUCTURE

3.1 EQUIPMENT

3.1.1 EXISTING LIGHTING EQUIPMENT

A site survey has been undertaken to assess the positions, condition and type of the existing lighting equipment within the extents of the scheme.

The key strategic approach roads to the crossing, the A12 and B1351 Waveney Drive (south side) and Denmark Road (north side), are all currently lit.

On the south side of the river, the B1351 Waveney Drive is lit using 10m steel columns with an integral 1.5m single bracket arm complete with a Philips Luma LED luminaire. This is replicated on the A12, Riverside Road and in the first column on Durban Road.

On the north side of the river, Denmark Road to the east side of Lake Lothing Pub roundabout is lit using 10m steel columns with an integral 1.5m single bracket arm complete with a Philips Luma LED luminaire. The roundabout itself appears to be lit with the same LED luminaires but mounted on 12m columns. The west side of the roundabout is lit using 10m steel columns with an integral 1.5m single bracket arm complete with Philips Iridium luminaires incorporating a high pressure sodium (SON) lamp.

The LED luminaires are assumed to be a recent installation, however the columns appear to have been in-situ for a longer period. While the columns appeared older, minimal signs of internal degradation were identified from a visual inspection.

3.1.2 EXISTING ELECTRICAL EQUIPMENT

The electrical services to the lighting columns on the north side of the river are mainly provided via sub-feeds from a local feeder pillar (FP814) with individual Distribution Network Operator (DNO) supplies. The pillar itself and subsequent cabling appeared in poor condition. The feeder pillar showed evidence of internal degradation, including on the distribution board casing.

The electrical services on the south side of the river are mainly via individual DNO connections to the respective lighting columns. The electrical equipment appeared in reasonable condition visually.

3.1.3 CONTROL

During the site survey it was noted that the existing luminaires appear to be fitted with Telensa CMS nodes. At this time it is unknown if a specific profile, to adjust the lighting during hours of reduced traffic flow, is in place for these luminaires. It is recommended that any existing profile is revisited during the design with consideration for the change in traffic flow caused by the installation of the bridge.

PROPOSED LIGHTING INFRASTRUCTURE

4 PROPOSED LIGHTING INFRASTRUCTURE

4.1 EQUIPMENT

A proposed design has been developed for the bridge, approaches, adjoining junctions and local access roads to support this strategy (refer to drawing 62240712-WSP-HLG-LL-DR-EO-1300 for details and extents). The design has been completed to achieve the standards previously outlined in this document.

Selected luminaires conform to Suffolk County Council's preference, following a period of consultation.

Figure 5 – Anticipated daytime appearance

4.1.1 PROPOSED LIGHTING EQUIPMENT – MAJOR ROADS

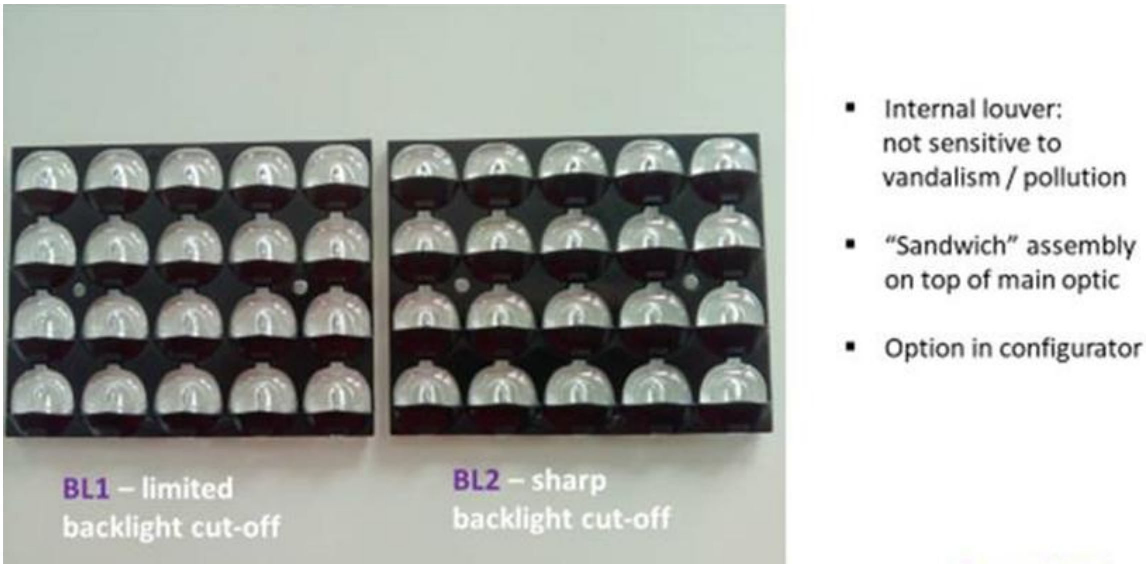
The major roads have been designed using Philips Luma 1 luminaires (image below) with 12.5 klm, 16 klm and 18.5 klm outputs. Luminaires are mounted on 10m steel lighting columns with single bracket arms having an outreach of 0.5m. The luminaires shall each be supplied with a NEMA socket compatible with the Telensa Telecell CMS node.

The columns shall be set back to the rear of the footway to maximise clearances for maintenance operations and ensure the footway is not restricted.

Figure 6 – Philips Luma unit

The optics proposed for the extents of the bridge are specialist optics produced by the manufacturer to include 'baffles' within the individual optic lens, to shield the lens and minimise backward light spill.

Figure 7 – Baffle optics



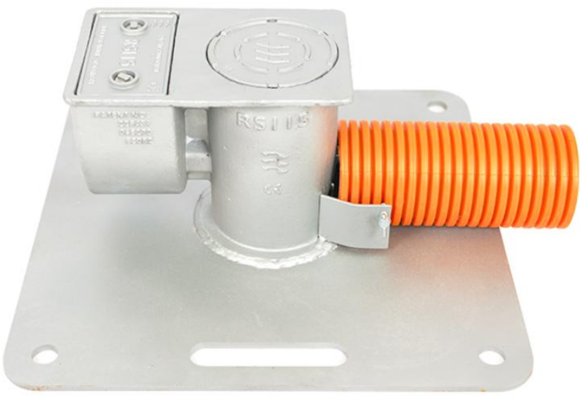
No columns have been mounted on the opening section of the bridge and column spacings have been maximised to offer suitable lighting levels, whilst not detracting from the architectural elements of the bridge. As the spacings have been maximised, the outputs used have been uplifted from 12.5 klm on the bridge approach to 16 klm in proximity to the opening section and associated barriers. Although this section would not be considered a formal conflict area, it has been attempted to uplift the levels of light marginally in proximity to the barriers to highlight the hazard.

Where feasible, it has been proposed to re-use the existing Philips Luma 1 LED luminaires presently sited within the extents of the scheme. This is proposed for Waveney Drive and Denmark Road.

The columns for the major roads are proposed to be planted with the exception of those spanning the extents of the bridge structure. It is recommended that trial hole investigations (where new columns are installed in new locations) and dip tests (for columns installed in proximity to existing units) are conducted in order to establish the existing factors of the site, including location of underground services.

The columns spanning the extents of the bridge shall utilise a shallow base retention socket with concrete foundation (dimensions to be agreed with the manufacturer). The shallow base retention sockets require only 350mm depth for the installation of a 10m column and are purpose-built for scenarios such as bridge decks. They also provide an effective means for replacing the columns in the event of damage. An example product which may be suitable for this scenario is shown below.

Figure 8 – Shallow base retention socket example



4.1.2 PROPOSED LIGHTING EQUIPMENT – MINOR ROADS

The minor roads have been designed using Philips Mini Luma luminaires with 7.6 klm outputs. Luminaires are mounted on 8m steel road lighting columns with single bracket arms having an outreach of 0.5m. The luminaires shall each be supplied with a NEMA socket compatible with the Telensa Telecell CMS node.

The optic for the minor roads has been selected with consideration for the level of obtrusive and intrusive light demonstrated, whilst ensuring the levels on the route meet the required standard. As such, the luminaire utilised achieves a Luminous Intensity Class of G4, with no output above the horizontal.

The columns shall be set back to the rear of the footway to maximise clearances for maintenance operations and ensure the footway is not restricted. The columns shall also be sited on property boundaries, where feasible, to minimise light spill onto residential properties and to take the columns out of the immediate eye-line of residents' windows.

The columns for the minor roads are proposed to be planted. It is recommended that trial hole investigations (where new columns are installed in new locations) and dip tests (for columns installed in proximity to existing units) are conducted in order to establish the existing factors of the site, including location of underground services.

4.1.3 PROPOSED LIGHTING EQUIPMENT – ARCHITECTURAL LIGHTING

Two options have been developed for the aesthetic lighting of the bridge structure, and general proposals developed for the lighting of the public landscape.

4.1.3.1 Bridge Option 1: Continuous Effect

The form of the bridge is to be revealed by an integrated LED lighting installation. Linear LED luminaires with warm white light (3000K) will be employed to graze the aluminium panels and will themselves be concealed by additional panels. The luminaires can either be fixed to the back or front of the face panels to form an integral part of the structure.

Units will be aimed to graze the panels continuously, with a panel in front to hide the light source. It is important that the bridge structure has a light finish to maximise the reflected light. The LED strips will be positioned continuously around the structure to create a regular array of lighting. The lighting control system can allow the intensity of the light to be increased in certain areas. This would create a more intense effect where desired, for example at the 'nose' of the bridge.

The LED light sources have a rated life of approximately 50,000 hours with minimised maintenance requirements. If a luminaire needs to be accessed the facade panel will need to be removed.

Two manufacturer's systems have been reviewed to achieve the desired effect: Philips eW Graze Powercore and GVA Lighting, the drivers for which may be housed remotely or located alongside the LED strips in an IP-rated enclosure. It is recommended that a mock-up be created at full scale to illustrate this lighting effect and resolve the integration details with the facade.

Figure 9 – Bridge option 1 visualisation

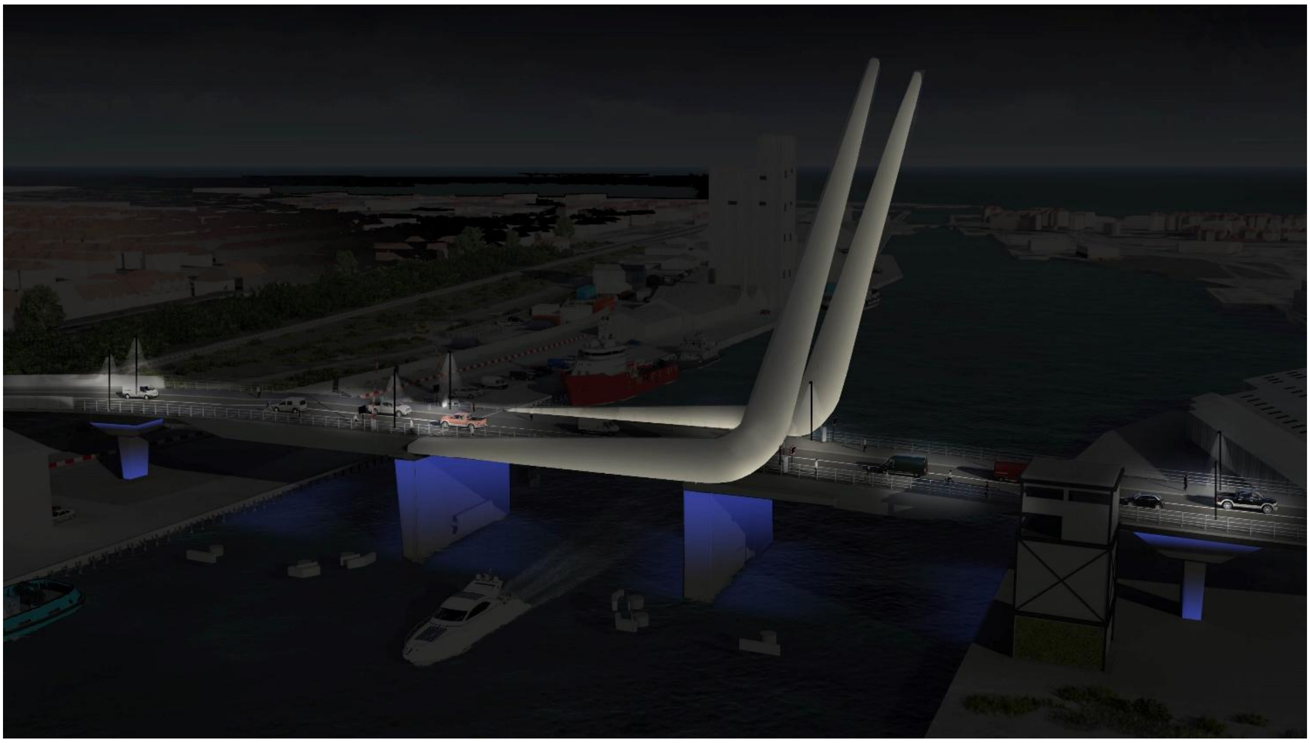


Figure 10 – Bridge option 1 plan, section and elevation arrangements

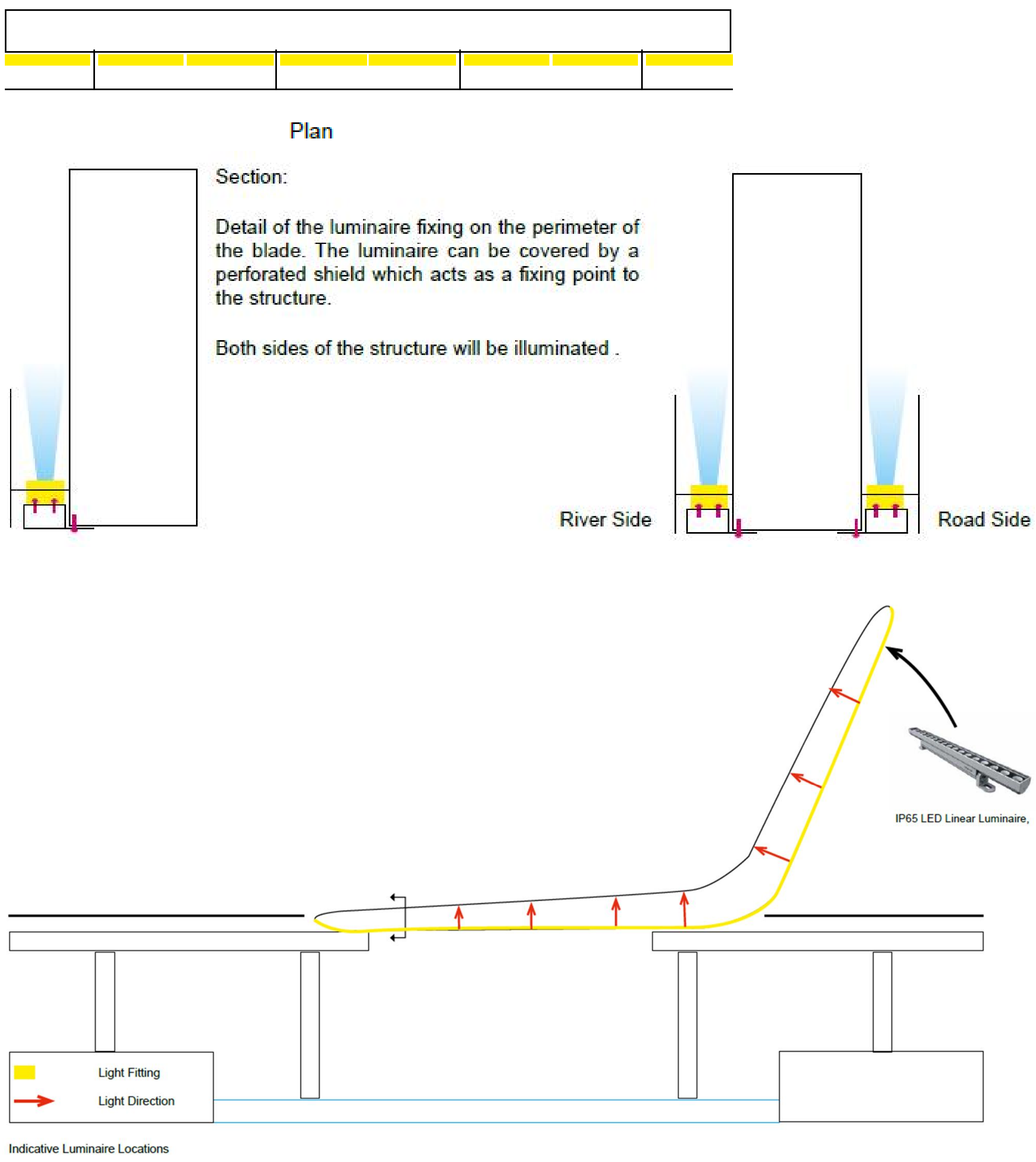


Figure 11 – Bridge option 1 shielding

- minimise light spill
- fixing point to the structure
- covers the fitting and the cabling
- it acts as glare control
- creates a unique light pattern

Figure 12 – Bridge option 1 grazing effect reference

4.1.3.2 Bridge Option 2: Floodlighting Scheme

An alternative lighting proposal is to illuminate the bridge structure by grazing either side of the blades from the central pivot point of the bridge. Floodlights can be attached to the structure and aimed so that the light creates a soft wash effect.

This illumination effect will wash light either side of the blade structures. A shield fixed to the structure will prevent the luminaires from being seen and help to minimise light pollution. Continuous illumination while the bridge is opening and closing can be achieved by fixing the luminaires to the structure.

To alert pedestrians, vehicles and cyclists to the bridge's opening and closing, the colour or dynamism of the light could change. This would inform the pedestrians, vehicles and cyclists from a distance whether they are likely to be able to use the cross the bridge at that time. To avoid conflicts with maritime navigation, colours used should be confined to whites and blues, and dynamic or colour changing effects should not be used when the bridge is open and vessels are transiting.

Figure 13 – Bridge option 2 visualisations

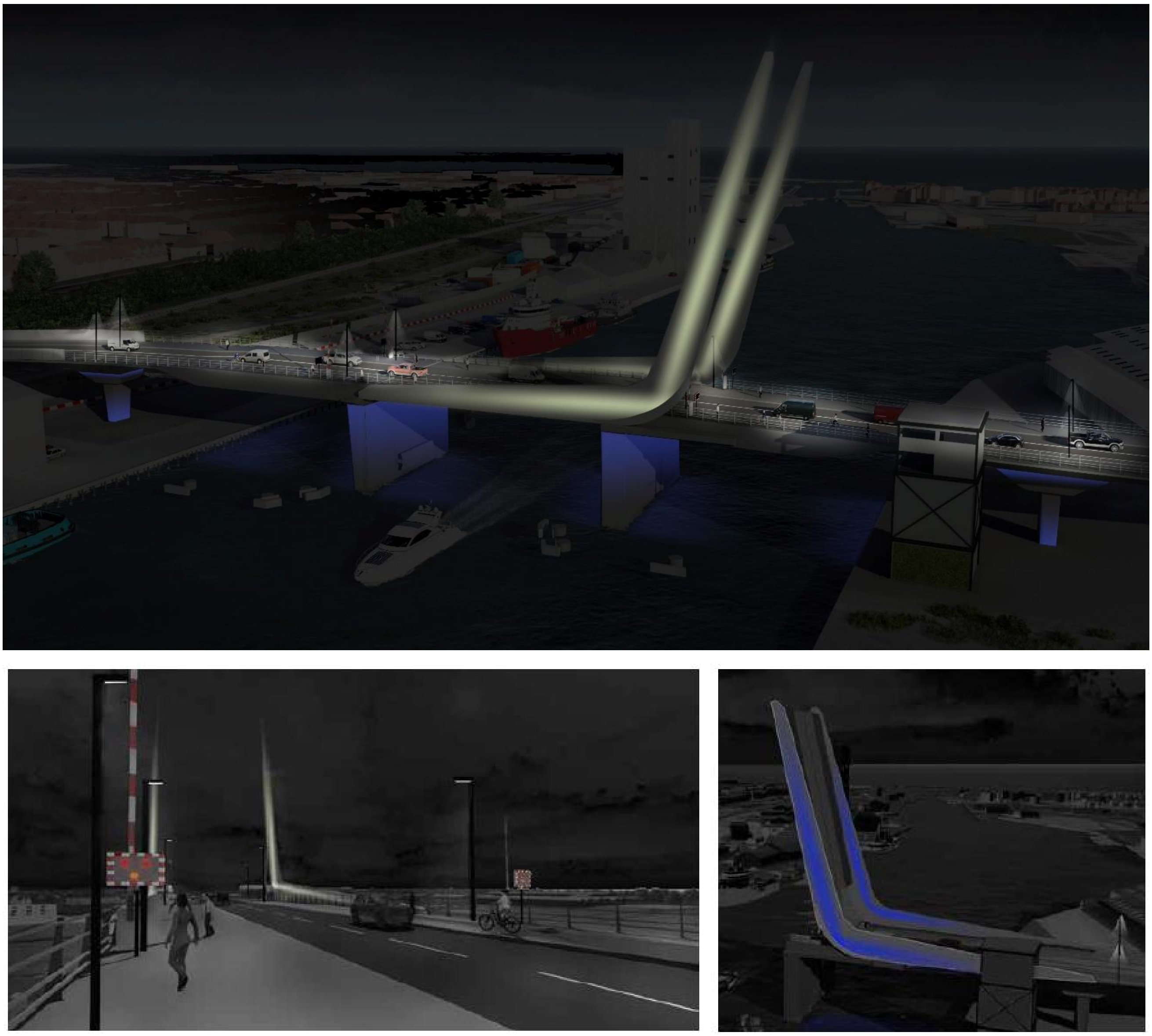
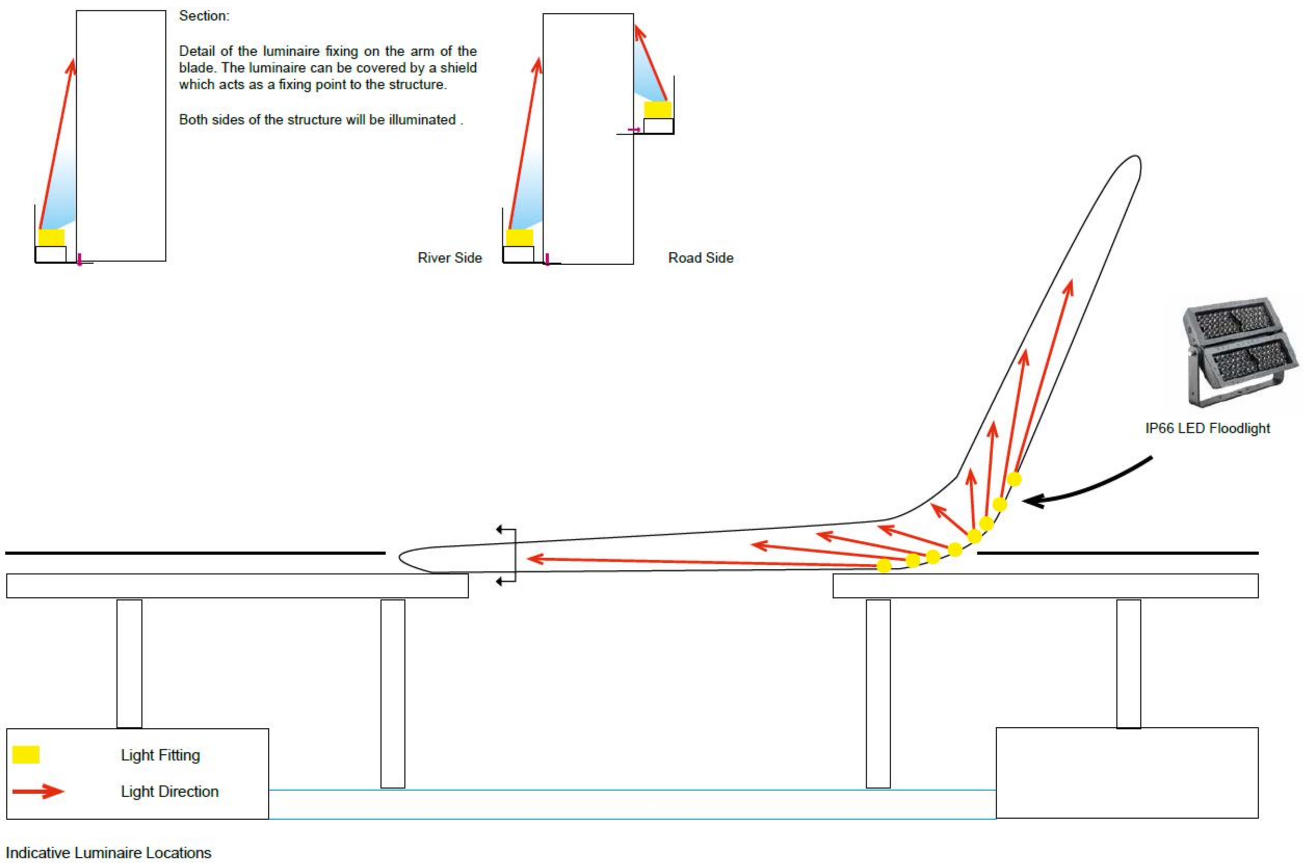


Figure 14 – Bridge option 2 section and elevation arrangements



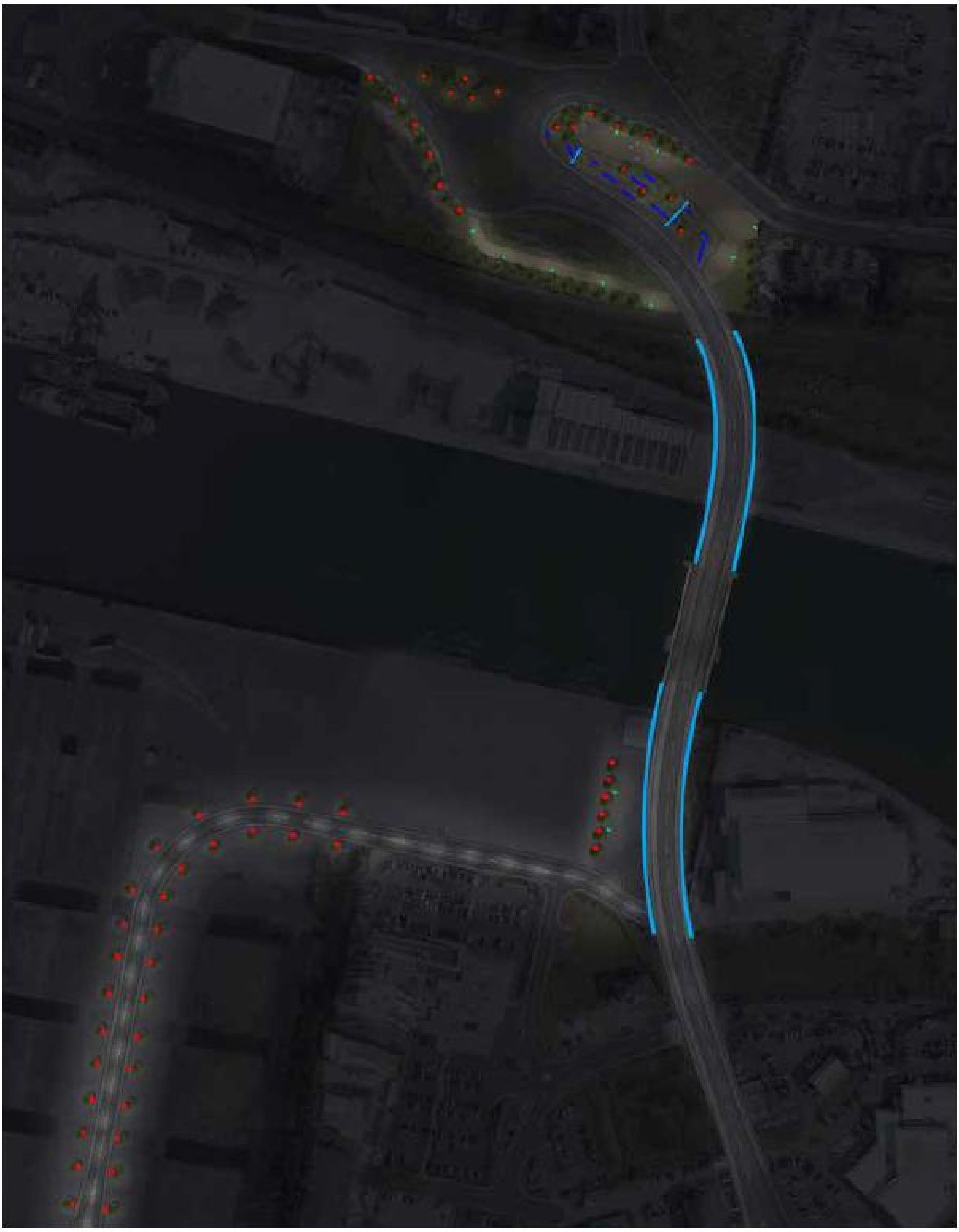
4.1.3.3 Landscape Lighting

Lighting is proposed to the public landscape on the northern and southern approaches to the bridge, as shown below.

Figure 15 – Proposed landscape lighting

The proposed equipment includes tree uplighters, aesthetic lighting columns, linear luminaires integrated into street furniture and handrail lighting.

Figure 16 – Indicative luminaire layout and examples



Selected Trees to be Uplighted

Lighting Columns with a clean Linear Line form

Linear Light to be integrated in street furniture

Handrail Lighting

The landscape lighting has been designed to enhance the perimeter bench areas, resulting in a localised effect that is not sufficient to light the pathways. To provide additional pathway lighting it is proposed that 4m lighting columns are introduced, as shown below. These are proposed to be positioned at uniform spacings using 45W LED projectors. The projectors will have a narrow beam distribution with a spreader lenses to create an elliptical beam of light. This is to ensure that only the pathway is directly illuminated and any spill onto the surrounding landscaping and railway is avoided.

Figure 17 – Perimeter pathway lighting visualisation

Trees are proposed to be lit with in-ground 30W narrow beam uplighters, with good optical control to avoid glare to pedestrians. Trees located within the park area and by the park entrances would each be lit by one uplighter. The unit would be located close to the trunk to ensure that the trunk is illuminated as well as the tree canopy.

Figure 18 – Street furniture and handrail lighting visualisations

Each underpass created by the bridge provides opportunities for transformative lighting installations, which can help to lessen the often harsh visual aesthetic of the space. With the correct LED lighting system it is possible to create striking ambiance and redefine these otherwise functional spaces.

It is proposed that the ceiling of underpasses is illuminated by linear LED uplights mounted on the side walls. General lighting can be provided by a continuous line of linear LEDs mounted in the centre of the ceiling, as shown in the example below.

Figure 19 – Examples of underpass lighting concept and reference product

4.1.3.4 Maintenance

The interface between the proposed luminaires and structural panels will require further consultation with the structural engineers, to ensure the scheme is feasible and maintainable. The provisional strategy for the blade lighting it to maintain it via MEWP and by way of the gantry on the water-side. The bridge would be required to be raised and lowered to maintain both blades.

Lighting to the underside of the bridge and piers may require maintenance from the gantry or from the water via boat.

4.1.4 PROPOSED ELECTRICAL EQUIPMENT

The electrical design for the associated lighting design works shall be undertaken to achieve full compliance with BS 7671. An outline design has been completed to enable assessment of the scheme requirements, but these indicative calculations should not be relied upon in later stages of design.

4.1.4.1 North of the River

On the north side of the river, low voltage mains were limited to the vicinity of the roundabout adjoining Rotterdam Road with Denmark Road and the roundabout adjoining Denmark Road with Peto Way. As a result, DNO services for the proposed design are limited. New supplies have therefore been designed based on the installation of a new feeder pillar (FP01) sited at the junction of Denmark Road and Rotterdam Road.

The proposed pillar would have a new 100A single phase DNO supply and would incorporate a 12-way distribution board. The pillar would utilise eight outgoing circuits, six of which would service the highway lighting columns on the north side of the river including those on the bridge structure up to the opening section of the bridge. The two remaining circuits would provide sub-main supplies to mini feeder pillars (MP01 and MP04). These mini pillars would be situated near the footpath and feature areas and would service architectural and landscape lighting on the north side of the river. At present the full extent of the electrical requirements for this section are unknown, therefore an assumed ‘worst case’ load of 25A for the lighting element of the respective feature areas has been used for cable calculations. These circuits would be supplied via 25mm^2 3-core Cu/XLPE/PVC/SWA/PVC cable and protected by a 32A BS88-2 cartridge fuse.

The remaining highway lighting circuits would all be separate 6mm^2 3-core Cu/XLPE/PVC/SWA/PVC cables each protected by a 16A BS88-2 cartridge fuse.

4.1.4.2 South of the River

On the south side of the river, a low voltage main has been identified to the south side of the roundabout at the A12 / Waveney Drive, on the southernmost footpath adjacent to both routes. It is therefore assumed that a new DNO supply can be established for these units. The remaining columns on the Riverside Road approach to the bridge are proposed to be supplied via private network cable from a new feeder pillar (FP02) situated on the footpath near the Riverside Business Centre.

The proposed pillar would have a new 100A single phase DNO supply and incorporate a 12-way distribution board. The pillar would utilise five outgoing circuits, three of which would service the highway lighting columns on the south side of the river (including those on the bridge structure up to the opening section of the bridge). The two remaining circuits would provide sub-main supplies to mini pillars MP01 and MP02 sited near the bridge ‘blades’, to provide localised power supplies to architectural lighting. The sub-main supplies would be via individual 70mm^2 3-core Cu/XLPE/PVC/SWA/PVC cable each be protected by a 32A BS88-2 cartridge fuse. The remaining highway lighting circuits would all be separate 6mm^2 3-core Cu/XLPE/PVC/SWA/PVC cable each protected by a 16A BS88-2 cartridge fuse.

In order to minimise clutter, consideration has been given for pillars to be ‘underfloor distributors’, to hide the equipment from the general public. The distribution board would be located in a recessed chamber and accessed via lifting of the chamber lid. An example of such a system is shown below.

Figure 15 – Typical underfloor distribution board with chamber cover to match surface

4.1.4.3 Architectural Lighting Control and Containment

The lighting installation may be controlled using DMX or Pharos lighting control systems. The lighting system may track changing factors as the bridge opens and closes, triggering various lighting effects and making the structure more of an interactive feature and attraction. Example effects include:

- a gradual 'heartbeat' of light
- presenting information on wind speeds through light

The lighting effect would not be uniform, but would produce a gradient effect across the membrane as the intensity of the effect fades gradually with distance from source. By additionally introducing coloured (RGBW) LED luminaires, various scenes can be created through programing of the system. This feature may be used for seasonal events and occasions and can be programmed to respond to a wide variety of input signals, from the opening and closing of the bridge, to pedestrian footfall.

The luminaire control (DMX – two wire and shield) and power (three wire) wiring will be combined into one multi-core cable before installed inside the bridge structure. Cables would be installed within the energy chain that controls the blade structure raising and lowering.

Where each blade is attached to the bridge, one or two clusters of six multicore cables would travel up and land on the inside of the bridge structure. Each of the multi-core cables would be assigned a given set of luminaires along a structural band.

The containment system would be an extruded aluminium section, resting on the inside surface of the structure. It is envisioned that the containment would be cut to length and fitted with cabling before arriving on site. Upon arrival on site, each section would be fastened to its corresponding structural member with a thin piece of Teflon between the extrusion and the structural steel, to provide thermal isolation between the cables and the structure. The containment would stop short of the node with enough space to allow the cables to extend out and turn up into the luminaire.

The intent is that each luminaire is manufactured with two multicore cable leads, one with a male and the other with a female twist lock plug. Each cable run within the containment would also contain a male and female twist lock plug. The luminaires along each structure can then be quickly daisy-chained from the bottom of the structure to top on site, or prefabricated off-site as an integral part of the cladding, with connections concealed inside the structure.

4.1.4.4 Ducting

All distribution and road lighting cable would be run in 100mm diameter orange UPVC duct, with the exception of ducting through the structure. Where road crossings are proposed, it is recommended to install a spare parallel 100mm diameter duct for any future additional supplies or works.

Within the extents of the structure, a 75mm diameter orange UPVC duct would be located in a purpose built bore at a depth matching the cable access points of the shallow depth retention sockets.

BIBLIOGRAPHY & GLOSSARY OF TERMS

5 BIBLIOGRAPHY & GLOSSARY OF TERMS

5.1 BIBLIOGRAPHY

- *Artificial Lighting and Wildlife – Interim Guidance* (Bat Conservation Trust, 2014)
- BS 5489-1:2013 *Code of practice for the design of road lighting – Part 1: Lighting of roads and public amenity areas* (British Standards Institution, 2013)
- BS EN 13201 *Road lighting* (all parts, British Standards Institution, 2014 – 2015)
- CIE 115:2010 *Lighting of roads for motor and pedestrian traffic* (International Commission on Illumination, 2010)
- GN01:2011 *Guidance Notes for the Reduction of Obtrusive Light* (Institution of Lighting Professionals, 2011)
- PLG03 *Lighting for Subsidiary Roads* (Institution of Lighting Professionals, 2012)
- PLG08 *Guidance on the Application of Adaptive Lighting within the Public Realm* (Institution of Lighting Professionals, 2016)
- TR22 *Managing a Vital Asset: Lighting Supports* (Institution of Lighting Professionals, 2007)

5.2 GLOSSARY OF TERMS

Table 9.2 - Glossary of terms

Term / Abbreviation	Definition
CCTV	Closed Circuit Television
CLO	Constant Light Output
CMS	Central Management System
CRC	Carbon Reduction Commitment Tax
DNO	Distribution Network Operator
IET	Institution of Engineering and Technology
ILP	Institution of Lighting Professionals
LED	Light Emitting Diode
klm	Kilo-lumen; measure of the output of a luminaire
Lux	Measure of illuminance; the amount of light falling on a surface
MF	Maintenance factor
NEMA	National Electrical Manufacturer Association
S/P Ratio	Scotopic / Photopic Ratio
SON	High pressure sodium (lamp type)
tCO2	Total carbon emissions

Appendix A

TYPICAL PROFILE EXAMPLE

Parameter	Options	Weighting Values *Vw*	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value	Selected Weighting Value
		Time	18:00	19:00	20:00	21:00	22:00	23:00	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00
		Volume	B	B	B	N	N	Q	Q	Q	Q	Q	Q	Q	N	B	B	B
		Ambient Luminance	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Speed	Low	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Very Low (Walking Speed)	0																
Traffic volume	Busy	1	1	1	1	0	0	-1	-1	-1	-1	-1	-1	-1	0	1	1	1
	Normal	0																
	Quiet	-1																
Traffic composition	Pedestrians, cyclists and motorized traffic	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Pedestrians and motorized traffic	1																
	Pedestrians and Cyclists only	1																
	Pedestrians only	0																
	Cyclists Only	0																
Parked vehicles	Present	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Not present	0																
Ambient luminance	High	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Moderate	0																
	Low	-1																
Facial recognition	Necessary	Additional Requirements																
	Not Necessary	No additional requirements																
		Sum of Weighting Values *Vws*	4	4	4	3	3	2	2	2	2	2	2	2	3	4	4	4
		Lighting class P = 6 - *Vws*	2	2	2	3	3	4	4	4	4	4	4	4	3	2	2	2
		Recommended Lighting class for Main Carriageway	P2	P2	P2	P3	P3	P4	P4	P4	P4	P4	P4	P4	P3	P2	P2	P2

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