A47 Blofield to North Burlingham Dualling

Scheme Number: TR010040

Volume 6
6.2 Environmental Statement Appendices
Appendix 7.8 – Lighting Assessment

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

December 2020

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

A47 Blofield to North Burlingham Development Consent Order 202[x]

ENVIRONMENTAL STATEMENT APPENDICES
Appendix 7.8 Lighting Assessment

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Table of contents

Figures

Tables

Appendix 7.8 Lighting assessment

7. Lighting assessment

7.1. Introduction

7.1.1. This technical appendix presents the findings of the lighting assessment. This comprises a review of the existing environment and identification of the potential impacts of the Proposed Scheme from lighting. The technical appendix also outlines proposed design measures to help mitigate potential lighting impacts.

7.2. Competent expert evidence

7.2.1. The competent expert holds a Higher National Diploma in Electrical Engineering and is an affiliate of the Institution of Lighting Professionals (ILP). The competent expert has over 9 years' experience in the field of lighting design and in the production of lighting assessments.

7.3. Legislation and policy framework

7.3.1. The following identifies national and local planning policies along with guidance relevant to lighting for the Proposed Scheme.

Legislation

7.3.2. The Clean Neighbourhoods and Environmental Act (CNEA) 2005 amended Section 79 of the Environmental Protection Act 1990 to include "artificial light emitted from premises so as to be prejudicial to health or a nuisance".

7.3.3. The CNEA states that this does not apply to defence infrastructure, airports, harbour premises, railway premises, tramway premises, bus stations and any associated facilities, public service vehicle operating centres, lighthouses and prisons. Additional guidance is provided by the government website GOV.UK, "Guidance on Artificial light nuisances: how councils deal with complaints", and states that street lighting is also excluded.

7.3.4. Local Authorities are provided with powers to serve abatement notices to premises with artificial lighting installations deemed to be causing a nuisance. There is however no definition provided on the levels of artificial lighting which could be considered as a statutory nuisance.

National polices

7.3.5. The National Planning Policy Framework (NPPF), February 2019 provides guidance on the Government's planning policies. It states that "Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of

pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation". (NPPF, Paragraph 180, 2019)

7.3.6. The Department for Communities and Local Government Planning Practice Guidance (2017) sets out planning policies and the government's expectations of how these should be applied. The guidance provides a section on Light Pollution (2019) and gives guidance on the following:

- "What light pollution considerations does planning need to address?"
- "What factors can be considered when assessing whether a development proposal might have implications for light pollution?"
- "What factors are relevant when considering where light shines?"
- "What factors are relevant when considering when light shines?"
- "What factors are relevant when considering how much the light shines?"
- "What factors are relevant when considering the possible ecological impacts of lighting?"
- "What other information is available that could inform approaches to lighting and help reduce light pollution?"

Local polices

Broadland District Council, Development Management DPD 2015

7.3.7. Broadland District Council's Development Management Development Plan 2015 in Paragraph 2.21 refers to the NPPF (2012) and states "Paragraph 109-125 of the NPPF set out the Government's view on conserving and enhancing the natural environment and the considerations that apply when assessing the potential impacts of pollution. Development will therefore not be permitted which would result in any significant unacceptable impact upon the environment, health, or amenity. In particular, the degree of overlooking, over shadowing and over massing should be taken into account in considering the impact of new development upon neighbouring properties. Also, the potential impact associated with light, noise, odour, dust and other atmospheric pollutants arising from any new development should be considered. Regard should also be had to Policies EN1 and EN4 in the Environment chapter of the DPD". (Policy EN1 relates to Biodiversity and Habitats and Policy EN4 relates to Pollution).

7.3.8. Paragraph 3.17 states "Paragraph 125 of the NPPF (2012) states that encouraging good design, planning polices, and decisions should limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation. The term nocturnal character when used in this context refers to the impact of any external lighting proposals at night when they are likely to have

most impact, particularly in the countryside. The presence of any existing lighting should be taken into account along with levels of illumination associated with proposed lighting".

Broadland District Council, Local Development Framework, Landscape Character Assessment Supplementary Planning Document (SPD), September 2013

7.3.9. Broadland District Council, Local Development Framework, Landscape Character Assessment Supplementary Planning Document (SPD), September 2013 details in paragraph 2.5.14 the key issues affecting landscape character with regards to infrastructure, transport and traffic and includes:

- "Construction of new roads, bypasses and service stations, including the introduction of new structures, lighting and earthworks into the landscape"
- "Road improvements that can have an urbanising effect, especially on rural lanes, by road widening, straightening and introduction of features such as kerbs, paving, highway lighting, visibility splays and signage"

7.3.10. Paragraph 4.2.3 summaries the key issues in relation development planning for infrastructure projects as:

- "loss of tranquillity from road and development growth/widespread lighting; increase in power lines, telecommunication masts, wind turbines and associated buildings."

Blofield Parish Neighbourhood Plan, Final Version Adopted July 2016

7.3.11. Blofield Parish Neighbourhood Plan, Final Version Adopted July 2016 states that, "The large majority of streets in the parish are not lit. With the exception of floodlights lit for short periods at Norwich United Football ground and early evening floodlights at the golf driving range, the only significant source of light pollution within the parish is the stretch of the former A47, the Yarmouth Road, which has street lighting. However, the villages experience increasingly intrusive night-time light glow from Norwich and its suburbs. There are still parts of the parish in which the Milky Way and many constellations of stars can be seen. It is intended that the Neighbourhood Plan will help sustain and preserve this experience by ensuring that light pollution and intrusion are properly considered in all future development. The Parish Council currently has a policy of no new street lighting."

7.3.12. Policy ENV5: Dark Skies "In accordance with the National Planning Policy Framework (NPPF, paragraph 125, 2012) any new developments should limit impact on dark skies. This includes restricting streetlights and lighting of commercial structures."

Acle Parish Council, Beighton Parish Council and Lingwood and Burlingham Parish Council

7.3.13. Acle Neighbourhood Plan Adopted; February 2015 does not contain planning policies relating to lighting that are relevant to the Proposed Scheme.

7.3.14. Beighton Parish Council and Lingwood and Burlingham Parish Council do not have a neighbourhood plan and therefore no planning policies relating to lighting.

Guidance

- International Commission on Illumination, Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, 2nd Edition, CIE 150:2017
- International Commission on Illumination, Guidelines for Minimizing Sky Glow, CIE 126:1997
- Institution of Lighting Professionals Guidance Notes for the Reduction of Obtrusive Light, GN01:2020 (included in annex A)
- Institution of Lighting Professionals Professional Lighting Guide 04, Guidance on Undertaking Environmental Lighting Impact Assessments (2013)
- Institution of Lighting Professionals / Bat Conservation Trust, Bats and artificial lighting in the UK, GN08/18 (2018)
- Bat Conservation Trust, Artificial Lighting and Wildlife, Interim Guidance: Recommendations to Help Minimise the Impact of artificial Lighting (2014)
- Bats and Lighting Research Project, University of Bristol, Bats and Lighting, Overview of current evidence and mitigation (2014)

7.4. Methodology

7.4.1. This section outlines the methodology adopted in undertaking the Lighting Assessment.

7.4.2. The lighting assessment has been undertaken based on Road Lighting Layout drawings HE551490-MMSJV-HLG-000-DR-EO-00007, HE551490-MMSJV-HLG-000-DR-EO-00008, HE551490-MMSJV-HLG-000-DR-EO-00009 and HE551490-MMSJV-HLG-000-DR-EO-00010 (revisions P03.2).

Scope of assessment

7.4.3. The lighting assessment evaluates the impacts of the proposed lighting installation and:

- identifies and describes the artificial light currently affecting the land within the redline boundary (referred to as 'the Site') and surrounding identified receptors
- provides the limitations of obtrusive light for the environmental zone in accordance with the guidance provided by the Institution of Lighting Professionals (ILP) in GN01:2020 - Guidance Notes for the Reduction of Obtrusive Light (included in Annex A)
- identifies design interventions and provide guidance on mitigation measures, with a view to reducing potential impacts to a negligible magnitude
- identifies predicted residual impacts of obtrusive light.

7.4.4. The guidance provided in the ILP Professional Lighting Guide 04, Guidance on undertaking Environmental Lighting Impact Assessments (2013) has been used to undertake the lighting assessment.

Baseline assessment methodology

7.4.5. Receptors near the Proposed Scheme were identified through an initial desk study of the area.

7.4.6. The location of each receptor was agreed with Broadland District Council on 21 June 2018. Receptor sites where chosen to allow the identification of baseline conditions, and an assessment of potential impacts on people and the environment in which they live, and on the location of potential ecological receptors.

7.4.7. An assessment of each receptor location was undertaken during the day and night and evaluated in terms of their direct and intermittent views towards the Proposed Scheme, and whether existing screening is likely to prevent light spill, views of luminaire intensity or sky glow. Day-time and night-time photographs were taken from each location at a height of 1.7m which is representative of adult eye height.

7.4.8. At each receptor location, 4 readings of vertical illuminance were taken with the sensor of the light meter pointed north, south, east and west at a height of 1.5m. One reading of horizontal illuminance was taken at ground level. This provides information on the levels of ambient light in each area.

Summary of receptor locations

7.4.9. A summary of the viewpoint locations and a description of each receptor are shown in Table 7-1 and Table 7-2.

Table 7-1: Summary of key lighting related survey viewpoint locations

Survey viewpoint location number	Drawing reference number	Description of location	Receptor(s)
1	HE551490-MMSJV-HLG-000-DR-EO-00011	Residential property 115a Yarmouth Road, Blofield	Residents of property
2	HE551490-MMSJV-HLG-000-DR-EO-00011	Residential property 117 Yarmouth Road, Blofield	Residents of property
3	HE551490-MMSJV-HLG-000-DR-EO-00011	Residential property 119 Yarmouth Road, Blofield	Residents of property
4	HE551490-MMSJV-HLG-000-DR-EO-00011	Owls Barn, Lingwood Road, Blofield	Grade II listed building (Assessment is documented in ES Chapter 6 – Cultural Heritage)
5	HE551490-MMSJV-HLG-000-DR-EO-00011	Residential property Sunny Acres, High Noon Lane, Blofield	Residents of property
6	HE551490-MMSJV-HLG-000-DR-EO-00011	Brienz, Waterloo, Blofield, NR13 4LJ	Distant views (Assessment is documented in ES Chapter 7 – Landscape and Visual Effects)
7	HE551490-MMSJV-HLG-000-DR-EO-00011	Fairview, Lingwood Road, Blofield	Distant views (Assessment is documented in ES Chapter 7 – Landscape and Visual Effects)
8	HE551490-MMSJV-HLG-000-DR-EO-00011	High Noon Lane, Blofield	Users of road (Assessment is documented in ES Chapter 7 – Landscape and Visual Effects)
9	HE551490-MMSJV-HLG-000-DR-EO-00012	Main Road, North Burlingham	Users of road
10	HE551490-MMSJV-HLG-000-DR-EO-00012	Residential property Mustard House, Coxhill Road, North Burlingham	Distant views from residential property
11	HE551490-MMSJV-HLG-000-DR-EO-00012	Residential property The White House, Acle Road, North Burlingham	Residents of property
12	HE551490-MMSJV-HLG-000-DR-EO-00012	Agricultural field, South Walsham Road	Users of field
13	HE551490-MMSJV-HLG-000-DR-EO-00012	Lingwood Lane (at junction with Acle Road)	Users of road (Assessment is documented Chapter 7 – Landscape and Visual Effects)
14	HE551490-MMSJV-HLG-000-DR-EO-00012	Lingwood Lane	Users of road (Assessment is documented in Chapter 7 – Landscape and Visual Effects)
15	HE551490-MMSJV-HLG-000-DR-EO-00012	The Windle	Users of road (Assessment is documented in Chapter 7 – Landscape and Visual Effects)
16	HE551490-MMSJV-HLG-000-DR-EO-00011	Residential property 111 Yarmouth Road, Blofield	Residents of property

Source: Mott MacDonald Sweco Joint Venture (2018)

7.4.10. Areas where changes to lighting levels that may affect light sensitive flora and fauna have been identified as part of the biodiversity assessment in ES Chapter 8 (**TR010040/APP/6.1**) and are summarised in Table 7-2.

Table 7-2: Summary of key biodiversity survey receptor locations

Survey viewpoint location number	Drawing reference number	Description of location	Receptor(s)
1, 2 and 3	HE551490-MMSJV-HLG-000-DR-EO-00011	Field north of A47 eastbound at Blofield junction	Assessment is documented in ES Chapter 8 – Biodiversity
4 and 52	HE551490-MMSJV-HLG-000-DR-EO-00011	Within grounds of residential property Sunny Acres, High Noon Lane, Blofield	Assessment is documented in ES Chapter 8 – Biodiversity
5 and 8	HE551490-MMSJV-HLG-000-DR-EO-00011	Yarmouth Road	Assessment is documented in ES Chapter 8 – Biodiversity
6, 7, 9, 10, 11, 12	HE551490-MMSJV-HLG-000-DR-EO-00011	Field south of Yarmouth Road	Assessment is documented in ES Chapter 8 – Biodiversity
13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and 24	HE551490-MMSJV-HLG-000-DR-EO-00012	Field south of the A47 westbound opposite the existing North Burlingham junction	Assessment is documented in ES Chapter 8 – Biodiversity
25, 26, 27, 28, 29 and 30	HE551490-MMSJV-HLG-000-DR-EO-00012	Fields north of the A47 eastbound at North Burlingham	Assessment is documented in ES Chapter 8 – Biodiversity
31, 32, 33, 34, 35, 36, 37, 38 and 41	HE551490-MMSJV-HLG-000-DR-EO-00012	Fields next to the B1140 and Acle Road	Assessment is documented in ES Chapter 8 – Biodiversity
39 and 40	HE551490-MMSJV-HLG-000-DR-EO-00012	Land next to the A47 westbound, east of the North Burlingham junction	Assessment is documented in ES Chapter 8 – Biodiversity
42	HE551490-MMSJV-HLG-000-DR-EO-00012	Main Road, North Burlingham	Assessment is documented in ES Chapter 8 – Biodiversity
43, 44 ,45, 46, 47 ,48, 49 and 50	HE551490-MMSJV-HLG-000-DR-EO-00012	Land next to South Walsham Road	Assessment is documented in ES Chapter 8 – Biodiversity
51	HE551490-MMSJV-HLG-000-DR-EO-00011	Within garden of residential property 117 Yarmouth Road, Blofield to the south of the A47 westbound	Assessment is documented in ES Chapter 8 – Biodiversity

Source: Mott MacDonald Sweco Joint Venture (2018)

Environmental zone

7.4.11. To define the maximum permissible levels of obtrusive light an appraisal has been carried out to classify the Site in terms of its environmental zone, which equates to the district brightness of the surroundings (see Table 7-3 for environment zone information).

7.4.12. Based upon previous practical experience, the Site has been classified as an 'E2' environmental zone which equates to 'Low district brightness area – Village or

relatively dark outer suburban locations'. Further to the Site's categorisation as an 'E2' zone it is imperative that impacts to receptors identified in relation to sensitive ecology are minimised to negligible levels.

7.4.13. The environmental zone classification and curfew time of 23:00 has been agreed with Broadland District Council on 21 June 2018.

Table 7-3: Environmental zones

Environmental zone	Surrounding	Lighting Environment	Examples
E0	Protected	Dark (SQM 20.5+)	Astronomical Observable dark skies, UNESCO Starlight Reserves, IDA Dark Sky Places
E1	Natural	Dark (SQM 20 to 20.5)	Relatively uninhabited rural areas, National Parks, areas of outstanding natural beauty, IDA buffer zones etc
E2	Rural	Low district brightness (SQM ~15 to 20)	Sparsely inhabited rural areas, Village or relatively dark outer suburban locations
E3	Suburban	Medium district brightness	Well inhabited rural and urban settlements, Small town centres or suburban locations
E4	Urban	High district brightness	Town or city centres with high levels of night-time activity

Source: Guidance Notes for the Reduction of Obtrusive Light GN01:2020 (ILP/2020)

Obtrusive light limitations

7.4.14. It can be seen from Table 7-3 that a lighting installation located in an area deemed to be more sensitive will understandably equate to greater constraints with regards to obtrusive light. Table 7-4 details maximum permissible levels of obtrusive light associated with an E2 zone.

Table 7-4 Obtrusive Light Limitations

Environmental zone	Sky glow – upward light ratio (max %)	Light intrusion into windows Ev (Lux)		Building luminance pre-curfew
		Pre-curfew[a]	Post-curfew[a]	Average L (cd/m²)
E0	0	0	0	0
E1	0	2	0 (1[b])	0
E2	2.5	5	1	5
E3	5	10	2	10
E4	15	25	5	25

Notes:

(a) Curfew: The time after which more stringent requirements (for control of obtrusive light) will apply; often a condition of use of lighting by the local planning authority. If not otherwise stated, 23:00 is suggested by the ILP.

(b) Permitted only from public road lighting installations.

7.4.15. Table 7-4 Obtrusive Light Limitations been developed for reducing the potential levels of glare associated with floodlighting applications, typically sport. The receptors for this project have not been assessed for glare in terms of this table as the lighting equipment (roadway lighting) falls outside the scope of the table. Luminaires that have been selected within the design comply with luminous intensity classes up to G6, as referenced in BS EN 13201 - 2:2015 Annex A.1, which serve to reduce the potential for roadway lighting to contribute to significant levels of upward light. Incidentally, this obtrusive light control method indirectly helps to restrict glare in line with maximum limits shown in column 'Ap>0.5' in Table 7-5.

Table 7-5: Obtrusive light limitations

Light technical parameter	Application conditions	Luminaire group (projected area A_p in m^2)					
		$0<A^p \leq 0.002$	$0.002<A^p \leq 0.01$	$0.01<A^p \leq 0.03$	$0.03<A^p \leq 0.13$	$0.13<A^p \leq 0.50$	Ap>0.5
Maximum luminous intensity emitted by luminaire (*I* in cd)	**E0**						
	Pre-curfew	0	0	0	0	0	0
	Post-curfew	0	0	0	0	0	0
	E1						
	Pre-curfew	0.29 *d*	0.63 *d*	1.3 *d*	2.5 *d*	5.1 *d*	2,500
	Post-curfew	0	0	0	0	0	0
	E2						
	Pre-curfew	0.57 *d*	1.3 *d*	2.5 *d*	5.0 *d*	10 *d*	7,500
	Post-curfew	0.29 *d*	0.63 *d*	1.3 *d*	2.5 *d*	5.1 *d*	500
	E3						
	Pre-curfew	0.86 *d*	1.9 *d*	3.8 *d*	7.5 *d*	15 *d*	10,000
	Post-curfew	0.29 *d*	0.63 *d*	1.3 *d*	2.5 *d*	5.1 *d*	1,000
	E4						
	Pre-curfew	1.4 *d*	3.1 *d*	6.3 *d*	13 *d*	26 *d*	25,000
	Post-curfew	0.29 *d*	0.63 *d*	1.3 *d*	2.5 *d*	5.1 *d*	2,500
Aid to gauging A_p		2 to 5cm	5 to 10cm	10 to 20cm	20 to 40 cm	40 to 80 cm	>80cm
Geometric mean of diameter (cm)		3.2	7.1	14.1	26.3	56.6	>80
Corresponding A_p representative area (m^2)		0.0008	0.004	0.016	0.063	0.251	>0.5

Source: Guidance Notes for the Reduction of Obtrusive Light GN01:2020 (ILP/2020)

Notes: (a) Curfew: The time after which more stringent requirements (for control of obtrusive light) will apply; often a condition of use of lighting by the local planning authority. If not otherwise stated, 23:00 is suggested by the ILP.

Impact methodology

7.4.16. The lighting assessment will consider each identified receptor and the potential impacts from the lighting associated with the Proposed Scheme and will evaluate whether the limitations detailed in Table 7-4 and visualised in Figure 7-1 will be exceeded in terms of the following:

- Sky glow – The illumination of the sky at night by artificial light sources including light emitted directly upward from the light source and reflected from the ground or surface.
- Light intrusion – Light that falls beyond the boundary of the area being lit.

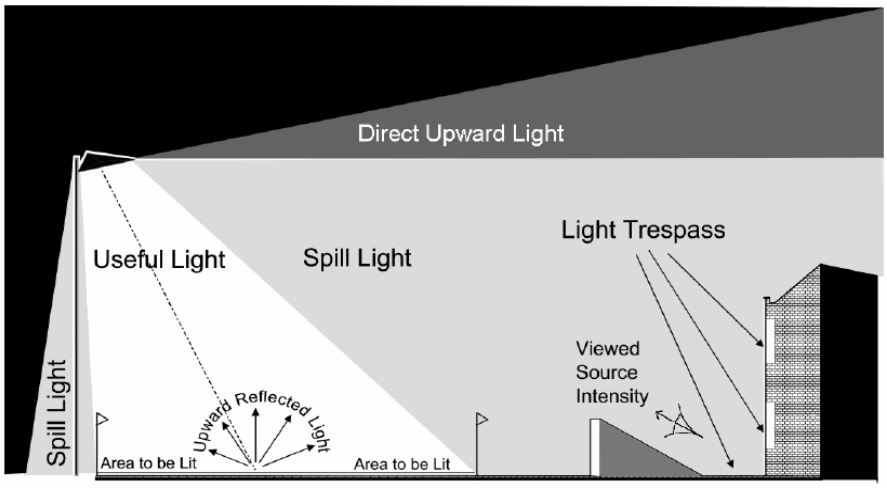

Figure 7-1: Types of obtrusive light

Source: ILP Guidance Notes for the Reduction of Obtrusive Light GN01:2020

7.4.17. The impacts of artificial lighting for the Site will have varying levels of significance and have been assessed based on the magnitude experienced by each identified receptor. The level of change is presented on a scale of minor, moderate, major or none/negligible. The resulting overall impacts can be described as positive, neutral or negative.

7.4.18. The ILP Professional Lighting Guide 04, Guidance on undertaking Environmental Lighting Impact Assessments (2013) provides no methodology for assessing the environmental value (or sensitivity) of receptors in terms of lighting and therefore the magnitude of the impact evaluated from the criteria above is assessed using the matrix as provided in the ILP Professional Lighting Guide 04, Guidance on undertaking Environmental Lighting Impact Assessments (2013) and outlined in Table 7-4 Obtrusive Light Limitations.

Table 7-6: Evaluation table

Nature	Ref	Level	Descriptions	Remedial needs
Positive	1	Major/substantial beneficial effects	Significant improvements in night environment and/or reductions in glare, spill light and sky glow etc.	No remedial/mitigation measures required.
	2	Moderate beneficial effects	Noticeable improvements in night environment and/or reductions in glare, spill light and sky glow etc.	
	3	Minor beneficial effects	Slight improvements in night environment and/or reductions in glare, spill light and sky glow etc.	
Neutral	4	None/negligible	No significant effect or overall effects balancing out.	
Negative	5	Minor adverse effects	Slight increase in visibility of site, glare, and sky glow etc.	Develop appropriate levels and type of mitigation
	6	Moderate adverse effects	Noticeable increase in visibility of site, glare and sky glow etc.	
	7	Major adverse effects	Significant problems with increase in visibility of site, glare, and sky glow etc.	

Source: ILP Professional Lighting Guide 04 (ILP, 2013)

7.4.19. Changes in levels of artificial lighting can impact on ecological receptors, for example bats and other nocturnal species. This lighting assessment evaluates baseline levels and the predicted change to levels of artificial lighting at each identified ecological receptor location. The effects of the described impacts upon ecology, have been factored into an assessment of the Proposed Scheme's overall effect on biodiversity as detailed in ES Chapter 8 (**TR010040/APP/6.1**).

Calculation methodology

7.4.20. Numerical modelling and calculations have been carried out using the lighting analysis software AGi32, version 17.5.

7.4.21. To understand the levels of obtrusive light experienced at the receptor locations identified as residential properties, obtrusive light calculation grids have been used calculating illuminance and luminaire intensity in accordance with International Commission on Illumination, Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, CIE 150:2017.

7.4.22. To understand the levels of obtrusive light experienced at identified ecological receptors locations identified, grids calculating illuminance have been created so that measurements of baseline and calculated illuminance can be compared.

7.4.23. A ground surface model used within the calculation has been created from the scheme contour plan HE551490-MMSJV-VTO-000-M3-VT-00001 using Autodesk Civil3D to represent the existing ground surface for the site. This surface was then further developed to aid calculation time by removing unnecessary surfaces and was achieved by laying points spaced 10m by 10m apart above the surface. All points were assigned the corresponding ground height from the ground surface below. It should be noted that there are no instances where the ground model provided shadow onto the calculation grids.

7.4.24. Lighting calculation grids are subject to a tolerance of + / - 1m. This tolerance is due to not knowing the exact height of the buildings where calculation grids are required. Heights of the buildings have been taken from the site contour plan and snapped to the closest contour and the height of the buildings has been assumed to be 2 storey (5m).

7.4.25. Existing residential buildings are included for the purposes of the calculation and for the light blocking effects.

7.4.26. Obtrusive light limitations are based on levels of light experienced at windows, as the locations of windows has not been surveyed, calculation grids have been placed across the residential building facades. Calculation results provided in Table 7-9 represent the light experienced at assumed window locations.

7.4.27. Obtrusive light calculation grids representing ecological receptor locations such as treelines and hedgerow have grid heights at ground level (0m), 1.5m and 5m from the highest ground level found within the model along the extent of each grid.

7.4.28. The potential blocking effect of vegetation has not been included in the calculation due to uncertainties regarding the level of screening provided by deciduous vegetation during autumn and winter months and the calculation therefore represents a worst-case scenario.

7.4.29. A maintenance factor is a luminaire and lamp specific de-rating factor applied to lighting calculations to allow for lumen depreciation of a light source over time and a predicted amount of dirt build up on the glazing of the lantern given its height and the pollution category of the area. Maintenance factors are utilised within calculations to prove that an installation will have compliant lighting levels on a worst-case basis. In these situations, worst case would be at the end of the maintenance cycle when the light source has depreciated the most and the glazing of the lantern is the dirtiest.

7.4.30. For the purpose of obtrusive light assessment, a maintenance factor of 1 (no de-rating) has been utilised as this accounts for the worst-case scenario for obtrusive light, this would show the impacts of the installation on the first day of its use or immediately after it has been maintained.

7.4.31. Back light shields detailed on the design have been assumed to be the following types and used together:

- Pudsey Diamond Luma Shield Range – Luma 2 Frame (35mm Standard Height with End Ext. Plate (65mm Standard Height) (product numbers 6130 and 6137)
- Pudsey Diamond column mounted shield 400mm high x 455mm wide (product number 6111)

7.5. Limitations

7.5.1. The assessment of the overall effects on bats and other species, landscape and cultural heritage do not form part of the lighting assessment.

7.5.2. Baseline surveys were carried out during spring where deciduous vegetation is well developed. It is anticipated where vegetation has been recorded as deciduous this will reduce during the autumn and winter months.

7.5.3. Where assessment of baseline conditions could not be established due to land access consent not being granted, alternative receptor locations have been used where appropriate, these areas are detailed further in Annex C.

7.5.4. Baseline photography has been taken at 1.7m above ground level, outside and not within the residential properties identified as receptor locations.

7.6. Baseline conditions

7.6.1. The baseline conditions presented in this section are those surveyed and documented during the day and night-time surveys. For a comprehensive overview this section of the report should be read with reference to the following:

- Annex B - Viewpoint location plans
- Annex C – Baseline survey description and results (lighting related)
- Annex D – Baseline survey photograph sheets

Baseline survey conditions

7.6.2. The baseline survey was undertaken between 22 and 24 May 2018 with times and weather conditions detailed in Table 7-7.

Table 7-7: Survey periods and weather conditions

Survey Period	Weather conditions	Visibility of night sky	Natural ambient night-time lighting levels[a]
22 May - 13:20 to 16:05 (day-time)	19°C Sunny with clear sky with some sparse cloud cover which increased during the survey period	n/a	n/a
22 May 22:30 to 23 May 01:20 (night-time)	Overcast with a thin layer of cloud with conditions turning misty during the survey period.	The moon was not visible, but some stars were visible through breaks in the cloud. The sky appeared bright towards the north.	0.02 Lux
23 May – 12:15 to 15:50 (day-time)	15°C Sunny with some cloud cover to the west. Blue sky is visible north-east to south-east with some sparse cloud. Conditions turned to mainly overcast during the survey period.	n/a	n/a
23 May 22:40 to 24 May 02:30 (night-time)	Overcast conditions to the east, west and south with blue sky with sparse cloud visible to the north.	Stars visible to north. Moon just visible behind cloud to south and appeared bright. During the survey period cloud cover cleared and the visibility of moon increased throughout survey period.	0.01 Lux - 0.02 Lux

Source: Mott MacDonald Sweco Joint Venture (2018)

Notes: (a) Natural ambient night-time lighting levels from stars and the moon were measured away from sources of artificial light.

7.6.3. The survey was undertaken during the first intermediate lunar phase between a first quarter moon and full moon (Waxing Gibbous).

Equipment used

7.6.4. A Konica Minolta T-10A illuminance meter (Serial Number 20015630) was used for all on-site light readings in lux (lumen/m²). The hand-held meter is maintained and calibrated in accordance with the manufacturers' instructions.

7.6.5. The camera utilised for the on-site photography was a Nikon D3200 digital single-lens reflex.

Summary of baseline survey

7.6.6. The lighting scheme is split into 2 distinct areas, the A47 Yarmouth Road junction in Blofield and the A47 B1140 junction in North Burlingham.

A47 Yarmouth Road junction

7.6.7. The A47 in this location runs east to north-west on the outskirts of Blofield with Yarmouth Road junction to the south of the A47 westbound carriageway. The A47 Yarmouth Road junction and surrounding areas are mainly unit.

7.6.8. To the west of the A47 Yarmouth Road junction there are a number of residential properties located on the land between Yarmouth Road and the A47 westbound carriageway. There is mainly deciduous planting to the front (approximately 10m in height) and rear (approximately 2.5m in height) of the properties providing various levels of screening.

7.6.9. The village of Blofield is located to the west and south-west of the junction and is mainly unit apart from lighting on Yarmouth Road which is the main road through the village, the lighting on Yarmouth Road ceases approximately 400m before the A47 Yarmouth Road junction. On the north-western outskirts of the village is the site of Norwich Camping and Leisure.

7.6.10. To the south of the junction there is an allotment and plant nursery which are partially screened from the junction by a row of tall deciduous trees, approximately 10m in height lining Yarmouth Road.

7.6.11. There is a line of tall deciduous trees, approximately 10m to 15m in height, to the north of the A47 eastbound carriageway partially screening views of mainly open agricultural fields.

7.6.12. The residential property Sunny Acres on High Noon Lane is north-east of the junction.

7.6.13. Norwich United football ground is located north-west of the junction.

A47 B1140 Junction

7.6.14. The A47 in this location runs east to west with the existing junction to the east of North Burlingham. The site consists of two staggered junctions with the B1140 South Walsham Road to the north of the A47 eastbound carriageway and the B1140 Acle Road to the south of the A47 westbound carriageway.

7.6.15. Street lighting is currently in operation during the hours of darkness at the two junctions along with both A47 approach roads extending approximately 650m east to the junction with Lingwood Road and approximately 240m west to the entrance to the lay-by north of the eastbound carriageway.

7.6.16. In the south-east corner of the B1140 Acle Road junction is the White House residential property. The property is located within 10m of the existing lit A47 westbound carriageway alignment. There is limited screening around the property.

7.6.17. There are open agricultural fields on all sides of the junction with only the White House residential property close enough to experience spill light and luminaire intensity from the existing lighting installation.

Principle light sources

7.6.18. Principle light sources surrounding the site are:

7.6.19. Highway lighting at the A47 B1140 junction. This lighting consists of lighting columns 12m in height with high pressure sodium luminaires. Lighting columns are positioned next to the eastbound and westbound A47 carriageways. Lighting on the A47 appeared significantly brighter than the surrounding area which is mainly unlit.

7.6.20. Football pitch lighting at the Norwich United Football Club ground at Plantation Park, Blofield, consisting of floodlighting towers positioned around the main pitch. Each tower has between two to three floodlights orientated downward towards ground and installed at an approximate height of 16m.

7.6.21. Training pitch lighting at the Norwich United Football Club ground consisting of 6 lighting columns positioned around the training pitch. Each pole is approximately 8m in height with each pole having a single floodlight orientated downward towards ground.

7.6.22. Lighting within the forecourt of Norwich Camping and Leisure consisting of floodlighting mounted on two separate poles.

7.6.23. Lighting within the compound of the North Burlingham garden room business.

Summary of baseline ecological survey descriptions

7.6.24. Recorded light measurement reading for the identified ecological receptors are provided in Annex E, Table 7-26.

7.6.25. Not every ecological receptor has been surveyed, instead where receptors are likely to have similar measured lighting levels, other viewpoint locations have been used to represent these locations.

7.6.26. The baseline conditions at the A47 Yarmouth Road junction are mainly dark with minimal light spilling onto nearby vegetation potentially used by ecological receptors.

7.6.27. The baseline conditions at the A47 B1140 junction vary depending on the proximity of the ecological receptor to the existing street lighting on the A47. The main source of lighting in this area is from the street lighting on the A47 and surrounding areas are mainly dark. Where dark corridors exist, these are interrupted by the lighting on the A47 and ecological receptors close to the A47 will experience varying levels of spill light.

7.7. Design interventions and mitigation

7.7.1. The design interventions detailed in Table 7-8 have been incorporated to reduce an identified environmental effect.

Table 7-8: Lighting design interventions

Location	Intervention	Purpose
Scheme wide	Colour temperature/appearance of light sources changed from neutral white (4000K) to warm white (3000K)	1. Warm white light sources have a lower relative attractiveness to insects reducing the impact on the insect prey of bats (Bats and Lighting, E Stone 2014) 2. Reduction in the impact of sky glow (http://darksky.org/fsa/) and Human responses to lighting based on LED lighting solutions, Public Health England / SLL / CIBSE 2016)
Scheme wide	The lumen outputs of the luminaires have been reduced from 32klm to either 20klm, 25klm or 30klm.	Reduction in night-time visual effect and energy consumption
A47 Yarmouth Road junction	The majority of lighting column heights reduced from 10m to 8m	Reduction in night-time visual effect
A47 Yarmouth Road junction	All lighting columns to have back shields installed	Reduction in night-time visual effect
A47 B1140 junction, B1140 overbridge	Lighting columns on the overbridge have been reduced in height from 10m to 8m	Reduction in night-time visual effect
A47 B1140 junction, B1140	Lighting columns located on the proposed B1140 to have back shields installed	Reduction in night-time visual effect
A47 B1140 junction, existing A47 where the proposed mainline moves away from the existing	Removal of the existing A47 street lighting	Reduce energy consumption and reduce brightness and visibility of this area

Source: Mott MacDonald Sweco Joint Venture (2018)

7.7.2. Table 7-9 proposes mitigation measures to minimise the impact of the proposed lighting installation for both the construction and operational phases of the Proposed Scheme.

Table 7-9: Mitigation measures

Category	Mitigation measures	Description
Design	Consideration to lighting levels	Lighting levels should be selected from relevant British / European standards to ensure lighting is appropriate to the work that is being undertaken and that areas are not over lit. In accordance with British Standard (BS) 5489-1:2020, lighting levels should be selected based on confirmed traffic flow figures and the detailed risk assessment process.
Design	Specification of photometric control methods	Luminaires to be specified and installed so that light spill is minimised.

Category	Mitigation measures	Description
Design	Specification of light control equipment	Designer to specify suitable equipment and methods of lighting control to enable dimming of lighting applications at times of decreased use and switching at times when lighting is not required.
Design	Specification of supplementary photometric control methods	Shields can be applied to luminaires adjacent to sensitive areas to reduce the visibility, spill light and intensity of luminaires. Shields to be specified as following types and used together: Pudsey Diamond Luma Shield Range – Luma 2 Frame (35mm Standard Height with End Ext. Plate (65mm Standard Height) (product numbers 6130 and 6137) Pudsey Diamond column mounted shield 400mm high x 455mm wide (product number 6111)
Design	Provision of planting and soft landscaping	Planting of trees at suitable heights can provide blocking effects which can potentially limit spill lighting, the amount of luminaire intensity and direct views to luminaires. Reference should be made to ES Chapter 7 Landscape and Visual Effects for mitigatory planting and soft landscaping.
Construction Management	Provision of applicable lighting levels for construction tasks	Lighting levels should be selected from relevant British / European standards to ensure lighting is appropriate to the work that is being undertaken and that areas are not over lit. Refer to BS EN 12464-2-2014 - Lighting for Work Places (Outdoor) (BSi -2013).
Construction Management	Limitation of working hours during periods the hours of darkness	Construction working hours should be limited during periods of diminishing ambient light levels and not carried out during periods and in areas that could be considered a nuisance.
Construction Management	Temporary lighting used for health and safety purposes should be set up in line with guidance in Institution of Lighting Professionals (ILP) GN01:2011	The limitations for obtrusive light, obtained from the ILP Guidance Notes for the Reduction of Obtrusive Light GN01:2020 (ILP, 2020) should be adhered to during the construction phase.
Construction Management	Reduction of temporary lighting mounting angles.	Temporary floodlighting should ideally be mounted at a tilt of 0° and utilise a double asymmetrical photometric configuration. The ILP advises in GN01:2020 (ILP – 2020) that a maximum main beam angle of 70° should be utilised to minimise the effects of glare along with spill and upward light.
Construction Management	Consideration of placements for temporary lighting	Temporary lighting will be located and directed away from residential properties.
Construction Management	Provision of solid site hoarding	The use of solid site hoarding to contain and limit light spill and improve security, should be considered by the appointed Contractor.
Construction Management	Consideration of alternatives to lighting for security purposes	Where security lighting is considered as a form of deterrent for vandalism and theft, the appointed contractor will consider alternative forms of security to limit the burden on lighting for example, the use of infrared spectrum security lighting.
Construction Management	Location of construction compound	The construction compound should be located away from sensitive areas.

Category	Mitigation measures	Description
Operational Management	Management of lighting controls	Management of lighting controls to ensure lighting is switched off when not required or dimmed in periods of reduced usage.
Operational Management	Asset manager to carry out periodic inspection and maintenance	Periodic inspection and maintenance regime in line with the recommendations of BS 5489-1:2020, to include as a minimum: light source replacement, luminaire cleaning, renewal of failed parts, checking of gaskets, optical components and screens or baffles, checking of alignment and monitoring of operation. (BSi 2012).

Source: Mott MacDonald Sweco Joint Venture (2018)

7.8. Assessment of likely significant effects

Construction

7.8.1. During the construction phase, it is likely that the study area will be affected through the use of temporary site lighting either for health and safety purposes, site security, or both. The areas where construction works will take place are likely to be dark and some construction lighting is anticipated to be in operation during the hours of darkness particularly in winter months.

7.8.2. It is anticipated that lighting will contribute to levels of sky glow and where positioned close to existing identified receptor locations, construction lighting could cause adverse impacts though spill light and luminaire intensity. The nature of construction lighting is temporary and changeable as the construction phase evolves, therefore the impact is predicted to be **minor adverse.**

Operation

7.8.3. Table 7-10 and Table 7-12 provides a comparison between the baseline lighting measurements recorded and the calculated spill light for the Proposed Scheme.

Lighting Related Survey Viewpoints

7.8.4. Predicted impacts consider the baseline ambient levels of light, whether the Institution of Lighting Professionals (ILP) obtrusive light limitations provided in Table 7-5 have been exceeded and the current levels of screening of the Proposed Scheme.

Table 7-10: Survey viewpoint – lighting results

Viewpoint number	Baseline – Light measurements			Calculated lighting levels		Predicted impact
	Ground level (lux)	Direction of sensor	1.5m above ground level (lux)	Light intrusion Lux - maximum	Luminaire Intensity Candelas - maximum	
1	No access – assumed dark			15.5	7,804	1. Existing dark landscape 2. ILP pre-curfew and post-curfew obtrusive light limits exceeded for light intrusion and luminaire intensity 3. Deciduous screening **Major adverse effect** – (significant problems with an increase in visibility of the site, spill light and luminaire intensity)
2	0.28	north	0.03	0.5	934	1. Existing dark landscape 2. ILP post-curfew obtrusive light limits exceeded for luminaire intensity 3. Mixture of deciduous and evergreen screening **Moderate adverse effect** (noticeable increase in the visibility of the site)
		east	0.39			
		south	0.49			
		west	0.06			
3	No access – assumed dark			0.3	1,248	1. Existing dark landscape 2. ILP post-curfew obtrusive light limits exceeded for luminaire intensity 3. Deciduous screening **Moderate adverse effect** (noticeable increase in the visibility of the site)
4 (within field north of barn)	0	north	0	No direct impact from proposed lighting		1. Existing dark landscape 2. Within ILP obtrusive light limits 3. Deciduous screening **Assessment is documented within ES Chapter 6 – Cultural Heritage**
		east	0			
		south	0			
		west	0			
5	0	north	0	0.1	293	1. Existing dark landscape 2. Within ILP obtrusive light limits 3. Deciduous screening **Minor adverse effect** (slight increase in the visibility of the site)
		east	0			
		south	0			
		west	0			
6	0	north	0	No direct impact from proposed lighting		1. Existing dark landscape 2. Within ILP obtrusive light limits 3. Deciduous screening
		east	0			
		south	0			
		west	0			

Viewpoint number	Baseline – Light measurements			Calculated lighting levels		Predicted impact
	Ground level (lux)	Direction of sensor	1.5m above ground level (lux)	Light intrusion Lux - maximum	Luminaire Intensity Candelas - maximum	
						Assessment is documented within ES Chapter 7 – Landscape and Visual Effects
7	0	north	0	No direct impact from proposed lighting		1. Existing dark landscape 2. Within ILP obtrusive light limits 3. Deciduous screening **Assessment is documented within ES Chapter 7 – Landscape and Visual Effects**
		east	0			
		south	0			
		west	0			
8	Not surveyed – assumed dark			No direct impact from proposed lighting		1. Existing dark landscape 2. Within ILP obtrusive light limits 3. Deciduous screening **Assessment is documented within ES Chapter 7 – Landscape and Visual Effects**
9	0.15	north	0.01	No direct impact from proposed lighting		1. Existing lit landscape 2. Within ILP obtrusive light limits 3. Deciduous screening **Moderate beneficial effect** (Noticeable improvement in night environment)
		east	0.05			
		south	0.26			
		west	0.3			
10	0	north	0	0	89	1. Existing immediate views of dark landscape with distant views of A47 street lighting 2. Within ILP obtrusive light limits 3. Minimal screening - intermittent deciduous trees **Minor adverse effect** (slight increase in the visibility of the site)
		east	0			
		south	0			
		west	0.01			
11	7.18	north	5.54	4.4	4,962	1. Existing lit landscape 2. ILP post-curfew obtrusive light limits exceeded for light intrusion and luminaire intensity 3. No screening **None / negligible**
		east	2.92			
		south	1.89			
		west	7.08			
12	0.01	north	0	No direct impact from proposed lighting		1. Existing lit landscape 2. Within ILP obtrusive light limits 3. No screening
		east	0.03			
		south	0.05			

Viewpoint number	Baseline – Light measurements			Calculated lighting levels		Predicted impact
	Ground level (lux)	Direction of sensor	1.5m above ground level (lux)	Light intrusion Lux - maximum	Luminaire Intensity Candelas - maximum	
		west	0			**None / negligible effect**
13	0	north	0	No direct impact from proposed lighting		1. Existing immediate views of dark landscape with distant views of A47 street lighting 2. Within ILP obtrusive light limits 3. Minimal screening - intermittent deciduous trees **Assessment is documented within ES Chapter 7 – Landscape and Visual Effects**
		east	0			
		south	0			
		west	0			
14	0.02	north	0	No direct impact from proposed lighting		1. Existing immediate views of dark landscape with distant views of A47 street lighting 2. Within ILP obtrusive light limits 3. Minimal screening - intermittent deciduous trees **Assessment is documented within ES Chapter 7 – Landscape and Visual Effects**
		east	0.01			
		south	0.5			
		west	0.38			
15	0	north	0	No direct impact from proposed lighting		1. Existing immediate views of dark landscape with distant views of A47 street lighting 2. Within ILP obtrusive light limits 3. Minimal screening - intermittent deciduous trees **Assessment is documented within ES Chapter 7 – Landscape and Visual Effects**
		east	0			
		south	0			
		west	0			
16	No access – assumed dark			0.7	1,220	1. Existing dark landscape 2. ILP post-curfew obtrusive light limits exceeded for light intrusion and luminaire intensity 3. Deciduous screening **Moderate adverse effect** (noticeable increase in the visibility of the site)

Source: Mott MacDonald Sweco Joint Venture (2018)

7.8.5. Dimming and switch off regimes have not been specified at this stage, this means the level of light produced will not change after the curfew time therefore calculated light spill for each receptor will not change after the ILP suggested curfew of 23:00

hours. In practise this means one light spill level should be compared to both pre- and post-curfew limitations.

Sky glow

7.8.6. The cause of sky glow is attributed to a combination of badly directed luminaires and reflected light from the ground or surfaces. An example of upward light is illustrated in Figure 7-1.

Upward light ratio (ULR)

7.8.7. Light emitted directly into the sky from badly directed luminaires is referred to as ULR and is considered the most significant contribution to sky glow. To reduce this impact the ILP limitations for obtrusive light as detailed in Table 7-4 provides constraints on the ULR of the installation. ULR is not subject to differing limits dependant on time and hence there are no pre- or post-curfew readings.

7.8.8. An example of the distribution of light from the luminaires specified for the Proposed Scheme is shown in the Figure 7-2. The coloured segments on the figure illustrates the percentage of light being emitted in a given direction. The figure shows that no light is being emitted above the 90° horizon of the luminaire which indicates that no light is being emitted directly into the sky from the proposed luminaires. The ULR of the proposed installation is detailed in Table 7-11: ILP limitation for sky glow (ULR) and proposed installations achieved ULR.

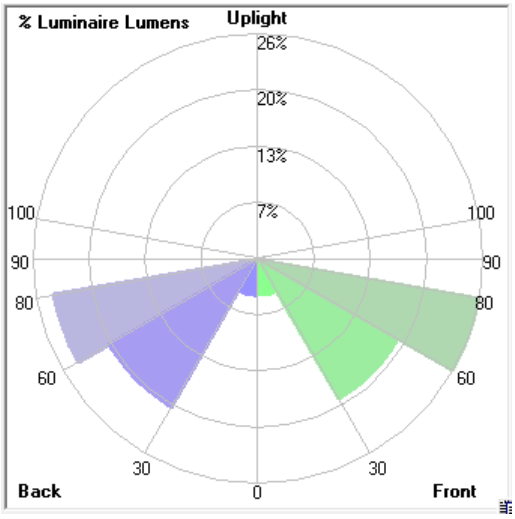

Figure 7-2: Luminaire light distribution

Source: AGI32 / Philips Lighting - Philips Luma 2 BGP625_DS50_25000_120LED

Table 7-11: ILP limitation for sky glow (ULR) and proposed installations achieved ULR

Environmental zone	Maximum permissible ULR	Achieved ULR	Predicted impact
E2 - Rural	2.5%	0.00%	Within ILP obtrusive light limits

Source: ILP GN01:2020

Reflected light

7.8.9. Along with direct upward light, a contributing cause of sky glow is reflected light. There are no set limits regarding reflected light and it is difficult to quantify changes to sky glow caused by reflected light except in the extreme.

7.8.10. The levels of reflected light are affected by the reflective properties of the materials used and the levels of lighting provided. The higher the reflective properties and lighting levels the greater the impact on sky glow.

7.8.11. While it is difficult to quantify changes to sky glow, it is predicted that the:

- A47 Yarmouth Road junction is currently unlit and an increase in lighting levels will contribute to a perceived increase in sky glow causing a **moderate adverse effect**.
- A47 B1140 junction is currently lit to a high level of lighting and minor changes to lighting levels will contribute to a **negligible** change in sky glow.

Ecological Related Survey Viewpoints

7.8.12. The effects of lighting impacts on sensitive ecology are assessed in ES Chapter 8 Biodiversity. The baseline and calculated lighting levels in Figure 7-11 are provided to assist in this assessment.

Table 7-12: Survey viewpoint – lighting results

Viewpoint number	Baseline – Light measurements			Calculated lighting levels		
	Ground level (lux)	Direction of sensor	1.5m above ground level (lux)	Ground level (lux)	1.5m above ground (lux)	5m above ground (lux)
1	0	north	0	1.7	3.7	0.4
		east	0			
		south	0			
		west	0			
2	Not surveyed – refer to viewpoint 1			1.9	4.3	0.6
3	0	north	0	1.9	4.9	0.7

Viewpoint number	Baseline – Light measurements			Calculated lighting levels		
	Ground level (lux)	Direction of sensor	1.5m above ground level (lux)	Ground level (lux)	1.5m above ground (lux)	5m above ground (lux)
		east	0			
		south	0			
		west	0.01			
4	0	north	0	0.7	1.5	0.2
		east	0			
		south	0			
		west	0			
5	0.02	north	0.02	39.6	27.6	199.9
		east	0			
		south	0			
		west	0.03			
6	0.01	north	0	16.3	31.9	37.6
		east	0			
		south	0.02			
		west	0.13			
7	0	north	0	17.7	33.6	23.1
		east	0			
		south	0			
		west	0			
8	0	north	0	14.2	4.4	0.7
		east	0			
		south	0			
		west	0.01			
9	Not surveyed - Refer to view point 7			12.8	21.9	11.3
10	0	north	0	0.1	0.1	0.0
		east	0			
		south	0			
		west	0			
11	Not surveyed – refer to viewpoint 10			16.41	3.6	0.2
12	0	north	0	0.0	0.0	0.0
		east	0			
		south	0			
		west	0			
13	2.77	north	3.88	0.0	0.3	0.1
		east	1.0			
		south	0.17			
		west	0.34			

Viewpoint number	Baseline – Light measurements			Calculated lighting levels		
	Ground level (lux)	Direction of sensor	1.5m above ground level (lux)	Ground level (lux)	1.5m above ground (lux)	5m above ground (lux)
14	0.03	north	0.23	11.5	20.7	12.9
		east	0.11			
		south	0			
		west	0.17			
15 & 16	Not surveyed – refer to viewpoint 14 (worst case)			0.0	0.0	0.0
17, 18 & 19	Not surveyed - refer to viewpoint 21			0.0	0.0	0.0
20	Not surveyed - refer to viewpoint 21			0.0	0.1	0.0
21	0.03	north	0.12	11.8	21.6	9.2
		east	0.07			
		south	0.02			
		west	0.07			
22	Not surveyed – refer to viewpoint 21			9.8	20.6	8.2
23	2.8	north	4.31	4.7	7.4	0.9
		east	2.47			
		south	0.15			
		west	1.17			
24	Not surveyed – refer to viewpoint 23			9.8	16.4	22.8
25	Not surveyed – refer to viewpoint 26			0.3	0.0	0.2
26	2.7	north	0.07	0.0	0.2	0.0
		east	1.98			
		south	4.07			
		west	0.17			
27 to 30	Not surveyed – refer to lighting related view point 12 (Figure 7-9)			0.0	0.0	0.0
31	Not surveyed – refer to viewpoints 35 & 41			0.0	0.0	0.0
32	Not surveyed – refer to viewpoints 35 & 41			0.0	0.1	0.0
33	Not surveyed – refer to viewpoints 35 & 41			0.1	0.2	0.0
34	Not surveyed – refer to viewpoints 35 & 41			0.2	0.1	0.0
35	0	north	0.02	7.0	8.4	4.7
		east	0			
		south	0			

Viewpoint number	Baseline – Light measurements			Calculated lighting levels		
	Ground level (lux)	Direction of sensor	1.5m above ground level (lux)	Ground level (lux)	1.5m above ground (lux)	5m above ground (lux)
		west	0.02			
36	Not surveyed – refer to viewpoints 35 & 41			0.0	0.1	0.0
37	Not surveyed – refer to viewpoints 35 & 41			0.0	0.0	0.0
38	0	north	0.32	0.0	0.1	0.0
		east	0.04			
		south	0.01			
		west	0.12			
39	0	north	0	1.9	6.1	0.8
		east	0			
		south	0			
		west	0			
40	0.19	north	0.57	0.4	1.3	0.2
		east	0.45			
		south	0.02			
		west	0.24			
41	0	north	0	0.1	0.3	0.1
		east	0			
		south	0			
		west	0.01			
42	4.8	north	0.16	0.0	0.0	0.0
		east	3.87			
		south	6.27			
		west	5.67			
43	0.05	north	0	14.5	11.6	16.7
		east	0.1			
		south	0.32			
		west	0.08			
44	0.02	north	0	6.7	14.9	11.4
		east	0.06			
		south	0.18			
		west	0.05			
45	Not surveyed – refer to viewpoint 47			24.5	8.8	6.7
46	Not surveyed – refer to viewpoint 47			7.9	12.7	2.9
47	0	north	0	9.6	16.5	19.4
		east	0			
		south	0.03			
		west	0.02			

Viewpoint number	Baseline – Light measurements			Calculated lighting levels		
	Ground level (lux)	Direction of sensor	1.5m above ground level (lux)	Ground level (lux)	1.5m above ground (lux)	5m above ground (lux)
48	Not surveyed – refer to viewpoint 47			15.6	16.1	0.4
49	Not surveyed – refer to viewpoint 50			0.2	0.2	0.0
50	0	north	0	0.2	0.1	0.0
		east	0			
		south	0.02			
		west	0			
51	0.02	north	0	25.3	17.5	62.8
		east	0			
		south	0.03			
		west	0			
52	Not surveyed – refer to viewpoints 1 to 4			0.0	0.0	0.0

Source: Mott MacDonald Sweco Joint Venture (2018)

7.9. Monitoring

Construction

7.9.1. For the construction phase of works the Environmental Management Plan (EMP) (**TR010040/APP/7.7**) will establish monitoring requirements and procedures to reduce or eliminate impacts on the environment. An Environmental Clerk of Works or Site Environmental Manager would be appointed to ensure that objectives of the CEMP are upheld. The Environmental Clerk of Work or Site Environmental Manager would be required to monitor construction activities that would cause likely significant effects to identified sensitive receptors.

Operation

7.9.2. To verify the effectiveness of the proposed mitigation and accuracy of the modelled calculations, a survey of the installed lighting scheme will be undertaken within 1 year of the Proposed Scheme commissioning date to measure lighting levels following the baseline assessment methodology detailed in Table 7-4. Due to their proximity to the Proposed Scheme, measurements should be carried out at viewpoint locations 1, 2, 3, 11 and 16 as detailed further in Table 7-1. The measurement of lighting levels should be undertaken during the winter months when the foliage of trees and bushes provides the least amount of screening. The measured lighting levels will therefore represent a worse-case scenario and these measurements should be compared against the assessment detailed in Table 7-10.

7.9.3. The monitoring of sensitive ecological receptors will be assessed in Chapter 8 – Biodiversity.

7.10. Conclusion

Construction

7.10.1. Following the implementation and incorporation in the EMP (**TR010040/APP/7.7**) of the suggested mitigation detailed in Table 7-9, impacts associated with spill light, luminaire intensity and sky glow are predicted to be temporary **minor adverse**.

Operation

7.10.2. The lighting scheme is split into 2 distinct areas, the A47 Yarmouth Road junction in Blofield and the A47 B1140 junction in North Burlingham.

7.10.3. Most of the existing and proposed screening consists of deciduous vegetation in the form of trees and hedgerows. The potential blocking effect of vegetation has not been included in the assessment due to uncertainties regarding the level of screening provided by deciduous vegetation during autumn and winter months, the assessment therefore represents a worst-case scenario.

7.10.4. The A47 Yarmouth Road junction is currently unlit and the baseline ambient lighting levels in the immediate area of the junction are very low. The Proposed Scheme will provide a significant increase in lighting levels increasing the sites visibility, sky glow and spill light onto identified ecological receptor locations near to the proposed lighting.

7.10.5. Blofield Parish Neighbourhood Plan, Final Version Adopted July 2016 has a policy of no new street lighting.

7.10.6. The A47 B1140 junction is currently lit to a high standard of lighting and receptor locations currently experience levels of obtrusive light in the form of light intrusion and likely luminaire intensity. The Proposed Scheme is likely to provide a similar level of lighting to that of the existing scheme for receptor locations near to the existing A47 B1140 junction such as The White House. It is however anticipated that there will be a minor increase in the site's visibility to the north and south of the Proposed Scheme due to the proposed lighting on the B1140 in both directions including the elevated lighting on the B1140 overbridge. There will be an increase in lighting levels onto identified ecological receptor locations near to the proposed lighting.

7.10.7. The existing A47 street lighting to the south of North Burlingham (circa 1.5km) will be removed (subject to confirmation) providing a moderate beneficial effect

adjacent to the existing A47 between the A47 Lingwood Road junction and the A47 Main Road eastern junction.

7.10.8. The potential effects upon the identified lighting related sensitive receptor locations are detailed in Table 7-13.

Table 7-13: Summary of lighting effects during operation (spill light and luminaire intensity)

Viewpoint	Viewpoint description	Predicted impact
1	Residential property 115a Yarmouth Road, Blofield	Major adverse effect
2	Residential property 117 Yarmouth Road, Blofield	Moderate adverse effect
3	Residential property 119 Yarmouth Road, Blofield	Moderate adverse effect
4	Owls Barn, Lingwood Road, Blofield	Assessment is documented within ES Chapter 6 – Cultural Heritage
5	Residential property Sunny Acres, High Noon Lane, Blofield	Minor adverse effect
6	Brienz, Waterloo, Blofield	Assessment to be documented within ES Chapter 7 – Landscape and Visual Effects
7	Fairview, Lingwood Road, Blofield	Assessment to be documented within ES Chapter 7 – Landscape and Visual Effects
8	High Noon Lane, Blofield	Assessment to be documented within ES Chapter 7 – Landscape and Visual Effects
9	Main Road, North Burlingham	Moderate beneficial effect
10	Residential property Mustard House, Coxhill Road, North Burlingham	Minor adverse effect
11	Residential property The White House, Acle Road, North Burlingham	None / negligible effect
12	Agricultural field, South Walsham Road, North Burlingham	None / negligible effect
13	Lingwood Lane (at junction with Acle Road)	Assessment to be documented within ES Chapter 7 – Landscape and Visual Effects
14	Lingwood Lane	Assessment to be documented within ES Chapter 7 – Landscape and Visual Effects
15	The Windle	Assessment to be documented within ES Chapter 7 – Landscape and Visual Effects
16	Residential property 111 Yarmouth Road, Blofield	Moderate adverse effect

Source: Mott MacDonald Sweco Joint Venture (2018)

7.10.9. The predicted impacts of sky glow on the wider study area:

- A47 Yarmouth Road junction is currently unlit and an increase in lighting levels will contribute to a perceived increase in sky glow causing a **moderate adverse effect**.
- A47 B1140 junction is currently lit to a high level of lighting and minor changes to lighting levels will contribute to **none / negligible** change in sky glow.

7.10.10. The Proposed Scheme is subject to further design development including the implementation of mitigation measures detailed in Table 7-9, the levels of effect should be reassessed once these measures have been incorporated within the Proposed Scheme.

7.11. Summary

7.11.1. Street Lighting is proposed at the A47 Yarmouth Road and A47 B1140 junctions.

7.11.2. The 2 study areas were categorised as having a low district brightness in line with the Institution of Lighting Professionals (ILP) environmental zone E2 classification. An environmental zone is assigned to set appropriate limitations for obtrusive light, relative to the areas existing levels of light and characterisation. The environmental zone was agreed with the Broadland District Council.

7.11.3. A survey was carried out during both daylight hours and during the hours of darkness to establish a baseline of lighting conditions and identified that the Site and views towards the Site and surrounding study area appeared generally dark. The most visible sources of artificial lighting included:

- Highway lighting at the A47 North Burlingham junctions with the B1140. This lighting consists of lighting columns 12m in height with high pressure sodium luminaires. Lighting columns are positioned next to the eastbound and westbound A47 carriageways. Lighting on the A47 appeared significantly brighter than the surrounding area which is mainly unlit.
- Football and training pitch lighting at the Norwich United Football Club ground at Plantation Park, Blofield.
- Lighting within the forecourt of Norwich Camping and Leisure consisting of floodlighting mounted on 2 separate poles.
- Lighting within the compound of the North Burlingham garden room business.

7.11.4. To the west of the A47 Yarmouth Road junction there are a number of residential properties located on the land between Yarmouth Road and the A47 westbound carriageway. There is deciduous planting to the front and rear of the properties providing various levels of screening.

7.11.5. At the A47 B1140 junction street lighting is currently in operation during the hours of darkness and in the south-eastern corner of the B1140 Acle Road junction is the White House residential property. There is limited screening around the property. There are open agricultural fields on all sides of the junction with only the White

House residential property close enough to be experiencing obtrusive light from the existing lighting installation.

7.11.6. Most of the existing screening consists of deciduous vegetation in the form of trees and hedgerows. The potential blocking effect of vegetation has not been included in the assessment due to uncertainties regarding the level of screening provided by deciduous vegetation during autumn and winter months, the assessment therefore represents a worst-case scenario.

7.11.7. The A47 Yarmouth Road junction is currently unlit and the baseline ambient lighting levels in the immediate area of the junction are very low. The Proposed Scheme will provide a significant increase in lighting levels increasing the sites visibility, sky glow and spill light onto identified ecological receptor locations near to the proposed lighting. It is noted that *Blofield Parish Neighbourhood Plan, Final Version Adopted July 2016* has a policy of no new street lighting.

7.11.8. The A47 B1140 junction is currently lit to a high standard of lighting and receptor locations currently experience levels of obtrusive light in the form of light intrusion and likely luminaire intensity. The Proposed Scheme is likely to provide a similar level of lighting to that of the existing scheme for receptor locations near to the existing A47 B1140 junction such as The White House. It is however anticipated that there will be a minor increase in the site's visibility to the north and south of the Proposed Scheme due to the proposed lighting on the B1140 in both directions including the elevated lighting on the B1140 overbridge. There will be an increase in lighting levels onto identified ecological receptor locations near to the proposed lighting.

7.11.9. During early stages of construction, impacts are predicted to be temporary minor adverse impacts where construction work is carried out during hours of darkness in proximity to sensitive receptors. As construction of each area of the Proposed Scheme is completed and lighting installations become operational, increased lighting levels for the various applications are predicted to evolve into:

- **major adverse effect** on the residential property 115a Yarmouth Road, Blofield due to significant problems with an increase in visibility of the site, spill light and luminaire intensity
- **moderate adverse effect** on the residential properties 111, 117 and 119 Yarmouth Road, Blofield due to noticeable increase in the visibility of the site
- **minor adverse effect** to the residential properties Sunny Acres, High Noon Lane, Blofield and Mustard House, North Burlingham due to slight increase in the visibility of the site
- **none / negligible effect** on the residential property The White House, North Burlingham due to baseline data indicating existing levels of obtrusive light
- **moderate beneficial effect** to the area south of North Burlingham with the removal of existing street lighting

7.11.10. The effects of lighting impacts on sensitive ecology are assessed in ES Chapter 8 Biodiversity (**TR010040/APP/6.1**), it is predicted that the lighting receptor locations identified to support the ecological assessment will experience increased levels of artificial light.

7.12. References

BS 5489-1:2020 Code of practice for the design of road lighting Part 1: Lighting of roads and public amenity areas

BS EN 12464-2:2014 Light and lighting – Lighting of work places Part 2: Outdoor work places

Institution of Lighting Professionals Guidance Notes for the Reduction of Obtrusive Light, GN01:2020

Institution of Lighting Professionals Professional Lighting Guide 04, Guidance on Undertaking Environmental Lighting Impact Assessments (2013)

Clean Neighbourhoods and Environmental Act 2005

https://www.gov.uk/guidance/artificial-light-nuisances-how-councils-deal-with-complaints

Ministry of Housing, Communities and Local Government, National Planning Policy Framework (2019)

The Department for Communities and Local Government Nation Planning Policy Framework (2012)

The Department for Communities and Local Government Planning Practice Guidance (2017), Light Pollution (2019)

Broadland District Council, Development Management DPD 2015

Broadland District Council, Local Development Framework, Landscape Character Assessment Supplementary Planning Document (SPD), September 2013

Blofield Parish Neighbourhood Plan, Final Version Adopted July 2016

Acle Neighbourhood Plan Adopted; February 2015

CIE 150:2003 Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting (2017)

CIE 126:1997 Guidelines for Minimizing Sky Glow

Institution of Lighting Professionals / Bat Conservation Trust, Bats and artificial lighting in the UK, GN08/18. (2018)

Bat Conservation Trust, Artificial Lighting and Wildlife, Interim Guidance: Recommendations to Help Minimise the Impact of artificial Lighting (2014)

Bats and Lighting Research Project, University of Bristol, Bats and Lighting, Overview of current evidence and mitigation (2014)

Human responses to lighting based on LED lighting solutions, Public Health England / SLL / CIBSE 2016

7.13. Glossary

Acronym	Description
BS	British Standard
BSi	British Standards Institute
CEMP	Construction Environmental Mitigation Plan
CIBSE	Chartered Institution of Building Services Engineers
CIE	International Commission on Illumination
CNEA	Clean Neighbourhoods and Environmental Act 2005
DCO	Development Consent Order
DPD	Development Plan Document
ILP	Institution of Lighting Professionals
LED	Light Emitting Diode
LVIA	Landscape and Visual Impact Assessment
m	metre
NPPF	National Planning Policy Framework
SLL	Society of Light and Lighting
SPD	Supplementary Planning Document
ULR	Upward Light Ratio

Term	Definition
Artificial Light Source	Manmade lighting such as floodlights, illuminated bollards and street lighting.
Candela	International System of Units (SI) for Luminous Intensity, a common candle emits light with a luminous intensity of approximately 1 candela.
Eav	The average illuminance on a vertical plane across a calculated area, measured in lux.
Illuminance	Measurement of Luminous Flux at a point on a surface.
Light Distribution	See photometric.
Light Intrusion	Light that falls beyond the boundary of the area being lit.
Light Spill	See Light Intrusion.
Lumens	SI unit for Luminous Flux, a measure of the total amount of visible light emitted by a given source.
Luminaire	Complete light fitting housing the lamp, control gear and optical distribution control.
Luminaire Intensity	Measured in Candelas, this is a measure of the amount of light that a source radiates in a given direction. This can be considered as the power of light in 1 specific angle (or given direction) often to an observer.
Luminance	Luminance is an indicator of how bright a surface will appear.
Luminous Flux	Measurement (in Lumens) of visible light produced by a light source.
Lux	SI unit for Illuminance, 1 lumen per square metre.
Maintenance Factor	Ratio applied to the average Illuminance levels in the calculation model which accounts for both the depreciation of lumens emitted from the light source over time and the dirt accumulated on the luminaire.

Term	Definition
Obtrusive Light	Light that falls, or can be viewed beyond the boundary of the area being lit which causes annoyance, discomfort or distraction.
Photometric	The distribution of luminous intensity, in candelas for the transvers and axial planes, in layman's terms this is the "footprint" of the light distribution for a given luminaire.
Proposed Scheme, the	The concept or design proposed i.e. the road layout and associated earthworks, drainage, structures, lighting, etc
Sky Glow	The illumination of the sky at night by artificial light sources including light emitted directly upward from the light source and also reflected from the ground or a surface.
Site, the	The Proposed Scheme boundary i.e. the existing geographic space the design is proposed to be located within.
Upward Light Ratio (ULR)	Percentage of Flux emitted from a luminaire and / or whole installation at and above the horizontal position of the luminaire.

Annex A – ILP Guidance Notes for the Reduction of Obtrusive Light GN01:2020

Guidance Note 01/20

Guidance note for the reduction of obtrusive light

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This guidance note has been revised to reflect the changes in international guidance regarding obtrusive light as detailed in CIE 150:2017 *Guide on the limitation of the effects of obtrusive light from outdoor lighting installations*.[1] It also considers industry comment regarding the assessment and definition of obtrusive lighting.

Good lighting practice is the provision of the right light, at the right time, in the right place, controlled by the right system.

Humanity's invention of artificial light and its application in the external environment has done much to safeguard and enhance our night-time environment but, if not properly controlled, *obtrusive light* (sometimes referred to as light pollution) can present serious physiological and ecological problems.

Obtrusive light – whether it keeps you awake through a bedroom window, impedes your view of the night sky or advisedly affects the performance of an adjacent lighting installation – is a form of pollution, which may also be a nuisance in law and which can be substantially mitigated without detriment to the lighting requirements of the task.

Sky glow, the brightening of the night sky, *glare* the uncomfortable brightness of a light source when viewed against a darker background, *light spill* the spilling of light beyond the boundary of the area being lit and *light intrusion* ("nuisance")[2] are all forms of obtrusive light which may cause nuisance to others, or adversely affect fauna and flora as well as waste money and energy.

Considerations to be made

Think before you light. Is it necessary? What effect could it have on others? Has it the potential to cause a nuisance? How can you mitigate and manage any potential adverse effects from your lighting installation?

There are published standards and guidance for most lighting tasks, adherence to which will help mitigate obtrusive lighting aspects. Organisations from which full details of these standards can be obtained are given later in this Guidance Note.

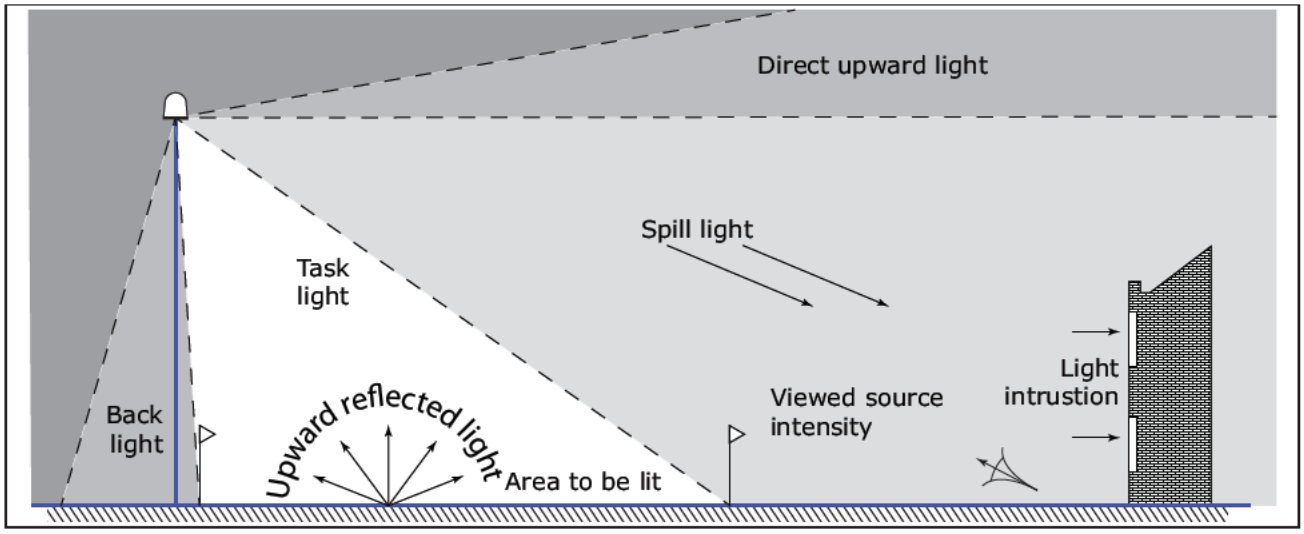


Figure 1: Types of intrusive light

1 The copyright of the data detai ed within this guide be ongs to CIE, emai ciecb@cie.co.at
This document shou d be used in conjunction with CIE 150:2017 and CIE 126:1997 and not as a rep acement for the procedures contained therein.
These documents can be obtained from https://www.techstreet.com/cie/pages/home and members of a Nationa Committee of the CIE can purchase them with a discount of 66.7%.

2 The term ight trespass is sometimes used, but trespass is to physica y encroach on and and ight can't do that, so the term nuisance shou d a ways be used.

For the purpose of this Guidance Note the following two Commission Internationale De L'Eclairage (CIE) documents are specifically referenced; they provide guidance to the mitigation of obtrusive light from exterior lighting installations:

- CIE 150:2017 Guide on the limitation of the effects of obtrusive light from outdoor lighting installations;
- CIE 126-1997 Guidelines for minimizing sky glow

When considering any lighting installation these two documents should be referenced.

Whilst this Guidance Note specifically considers the effects from external lighting installations, the considerations within it can be relevant when considering modern office blocks and shop fronts where the main external facing structure is transparent and light from within the buildings could become a source of illumination to the exterior environment.

"Good Design Equals Good Lighting"

It cannot be stressed sufficiently that employing a competent lighting designer with proven experience in the lighting application being considered will provide a suitable lighting installation where all obtrusive lighting aspects are mitigated[3].

Any lighting scheme consists of three basic elements: a light source, a luminaire (incorporating the optical control system) and a method of installation/mounting.

Light sources (lamps/LEDs)

Remember that the light source output in lumens is not the same as the wattage and that it is the former that is important in combating the problems of obtrusive light.

Most night-time visual tasks are only dependent on light radiated within the visual spectrum. It is therefore not necessary for light sources to emit either ultra-violet or infra-red radiation unless specifically required to do so. The majority of light sources used in external lighting do not contain these wavelengths or where they are present their spectral power is very low.

Research indicates that light from the blue end of the spectrum could have important adverse effects on fauna and flora. The lighting designer should consider the blue light spectral power of the light source and try to balance the needs of the task to be lit with any impact on fauna and flora within the environment.

Luminaires

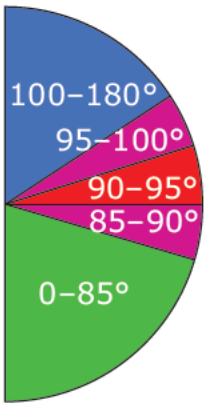
The choice of luminaire with the right optical distribution at the right mounting height is critical to minimising light spill and obtrusive light effects while providing the right lighting performance on the task area.

Sky glow is the general diffuse sheen that is visible in the direction of large cities, airports, and industrial complexes. It occurs from both natural and artificial light sources and does not depend exclusively on the lighting design. It also depends on the atmospheric conditions (humidity, aerosols, clouds, haze, atmospheric pollution, etc). Light propagating into the atmosphere either directly from upward directed or incompletely shielded sources, or after reflection from the ground or other surfaces, is partially scattered back towards observers on the ground; the impact being shown in Table 1.

It is therefore important to consider the luminaire, its light distribution, how it is installed, and how it is set up.

For most general sports and area lighting installations the use of luminaires with asymmetric optics designed so that the front glazing is kept at or near parallel to

3 Competency can be determined through membership of a professiona ighting body supported by the appropriate qua ifications and experience in the app ication of ighting required.



Indicative diagram

Table 1: The effect on the ability to view the night sky at various angles

Angle of light emitted (degrees)	Sky glow effect	Glare effect
100 – 180	Local	Little
95 – 100	Significant	Some
90 – 95	High	High
85 – 90	Significant	High
0 – 85	Minimal	Some

the surface being lit should, if correctly aimed, ensure minimum obtrusive light.

Appendices 1 and 2 in this Guidance Note give more details of how to choose luminaires, and if necessary modify them through the use of louvres and shields.

Installation

In most cases it will be beneficial to use as high a mounting height as possible, giving due regard to the daytime appearance of the installation.

It should be noted that a lower mounting height is perhaps not better as can be seen from Figures 2a and 2b from CIE 150. A lower mounting height can create a higher level of light spill and require additional lighting points.

Keep glare to a minimum by ensuring that the main beam angle of all luminaires directed towards any potential observer is no greater than 70°. Higher mounting

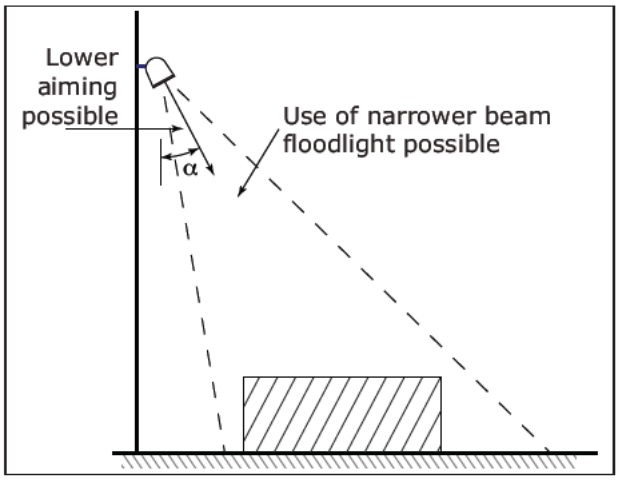


Figure 2a: Higher mounting height – less spill light and glare

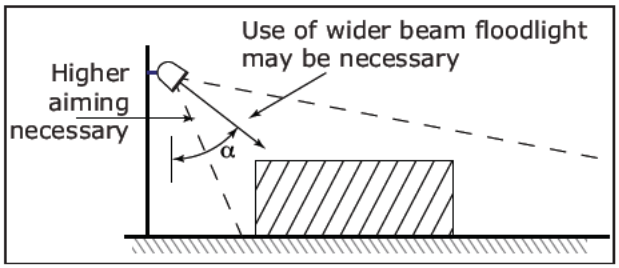


Figure 2b: Lower mounting height – more spill light and glare

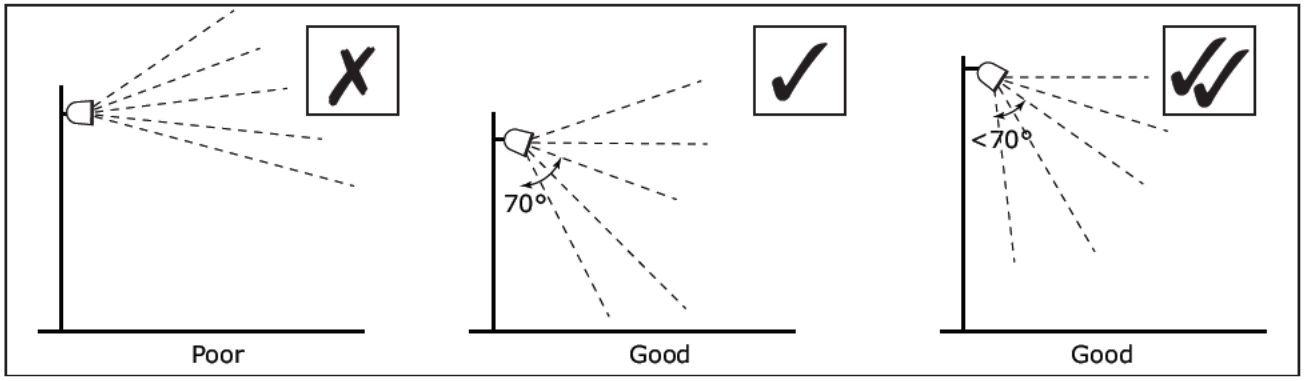


Figure 3 Luminaire aiming angles

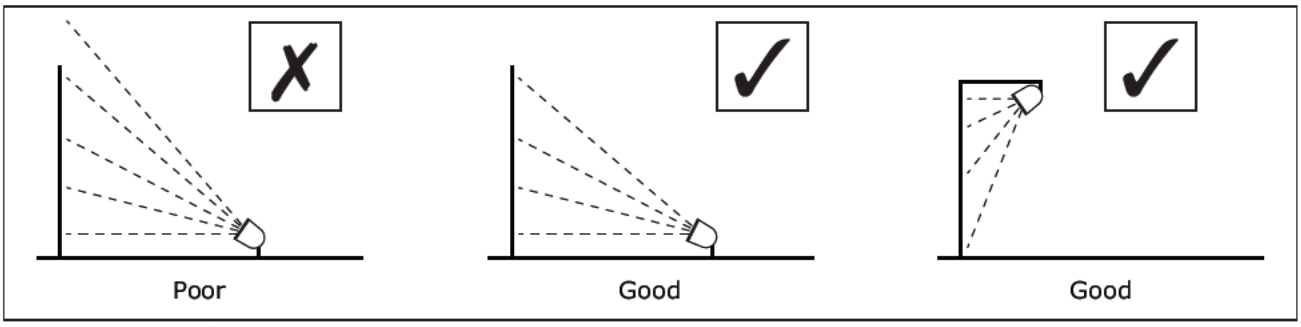


Figure 4 Façade illumination

heights allow lower main beam angles, which can assist in reducing glare.

In areas with low ambient light levels, glare can be very obtrusive, and extra care should be taken when positioning and aiming lighting equipment. With regard to domestic security lighting, the ILP produces an information leaflet GN09:2018 *Domestic exterior lighting: getting it right!* which is freely available from its website.

When lighting vertical structures such as advertising signs, direct light downwards wherever possible. If there is no alternative to up-lighting, as with much decorative lighting of buildings, then the use of luminaires with the correct optical distribution, coupled where required with shields, baffles and louvres, will help minimise spill light around and over the structure.

For road and amenity lighting installations, light near to and above the horizontal should normally be minimised to reduce glare and sky glow (Note the Upward Lighting Ratios (ULR's) advised in Tables 5 and 6). In rural areas the use of full horizontal cut off luminaires installed at 0° uplift will, in addition to reducing sky glow, help to minimise visual intrusion within the open landscape. However, in some urban locations, luminaires fitted with a more decorative bowl and good optical control of light should be acceptable and may be more appropriate.

Clean Neighbourhoods and Environment Act 2005 (CNEA)

The Clean Neighbourhoods and Environment Act 2005 (CNEA) gives local authorities and the Environment Agency additional powers to deal with a wide range of issues by classifying artificial light emitted from defined premises as a statutory nuisance.

The CNEA 2005 amended paragraph 79(1)(fb) of the Environmental Protection Act 1990 to extend the statutory nuisance regime to include light nuisance stating the following:

'artificial light emitted from premises so as to be prejudicial to health or a nuisance'.

Guidance produced on Sections 101 to 103 of the CNEA 2005 by DEFRA (DEFRA, April 2006) extends the duty on local authorities to ensure their areas are checked periodically for existing and potential sources of statutory nuisances including nuisances arising from artificial lighting. Local authorities must take reasonable steps to investigate complaints of such nuisances from artificial light. Once satisfied that a statutory nuisance exists or may occur or recur, local authorities must issue an abatement notice (in accordance with section 80(2) of the Environmental Protection Act 1990), requiring that the nuisance cease or be abated within a set timescale.

National Planning Policy Framework (NPPF)

The NPPF was introduced as a more concise and useable planning document to aid developers and designers in the design and construction of developments within the UK.

The National Planning Policy Framework 2019 makes little reference to lighting with regard to the control of obtrusive light with section being the only reference, which states:
c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.

With regard to the planning aspect, many local planning authorities (LPAs) have already produced, or are producing, policies that within the planning system will become part of their local development framework. For new developments there is an opportunity for LPAs to impose planning conditions related to external lighting, including curfew hours.

National planning policy

The national on-line planning guidance resource looks at when lighting pollution concerns should be considered.

The guidance provides a high-level overview for planners, with links to appropriate documents looking at the subject through seven discussion points:

- What light pollution considerations does planning need to address?
- What factors can be considered when assessing whether a development proposal might have implications for light pollution?
- What factors are relevant when considering where light shines?
- What factors are relevant when considering when light shines?
- What factors are relevant when considering how much the light shines?
- What factors are relevant when considering possible ecological impacts of lighting?
- What other information is available that could inform approaches to lighting and help reduce light pollution?

It is to be hoped that whilst the guide does not specifically require it planners will consider the application of artificial light and consult with lighting designers. The planners can then be advised on the planning conditions that might be applicable for each project and review any submissions to determine if the planning conditions have been met.

The Scottish Executive has published a design methodology document (March 2007) entitled "*Controlling Light Pollution and Reducing Lighting Energy Consumption*" to further assist in mitigating obtrusive light elements at the design stage.

Environmental zones

It is recommended that local planning authorities specify the environmental zones given in Table 2 for exterior lighting control within their development plans.

Design guidance

The following limitations based upon CIE150 may be supplemented or replaced by an LPA's own planning guidance for exterior lighting installations. As lighting design is not as simple as it may seem, you are advised to consult and/or work with a competent professional lighting designer when considering any exterior lighting.

Table 2: Environmental zones

Zone	Surrounding	Lighting environment	Examples
E0	Protected	Dark (SQM 20.5+)	Astronomical Observable dark skies, UNESCO starlight reserves, IDA dark sky places
E1	Natural	Dark (SQM 20 to 20.5)	Relatively uninhabited rural areas, National Parks, Areas of Outstanding Natural Beauty, IDA buffer zones etc.
E2	Rural	Low district brightness (SQM ~15 to 20)	Sparsely inhabited rural areas, village or relatively dark outer suburban locations
E3	Suburban	Medium district brightness	Well inhabited rural and urban settlements, small town centres of suburban locations
E4	Urban	High district brightness	Town/city centres with high levels of night-time activity

Notes:

1. Where an area to be lit lies on the boundary of two zones the obtrusive light limitation values used should be those applicable to the most rigorous zone.
2. Rural zones under protected designations should use a higher standard of policy.
3. Zone E0 must always be surrounded by an E1 Zone.
4. Zoning should be agreed with the local planning authority and due to local requirements a more stringent zone classification may be applied to protect special/specific areas.
5. SQM (Sky Quality Measurements) referenced by the International Dark-Sky Association (IDA), the criteria for E0 being revised in mid 2019 but not retrospective.
6. Astronomical observable dark skies will offer clearer views of the Milky Way and of other objects such as the Andromeda galaxy and the Orion Nebula.
7. Although values of SQM 20 to 20.5 may not offer clear views of astronomical dark sky objects such as the Milky Way, these skies will have their own relative intrinsic value in the UK.

Table 3 (CIE 150 table 2): Maximum values of vertical illuminance on properties.

Light technical parameter	Application conditions	Environmental zone				
		E0	E1	E2	E3	E4
Illuminance in the vertical plane (E_V)	Pre-curfew	n/a	2 lx	5 lx	10 lx	25 lx
	Post-curfew	n/a	<0.1 lx*	1 lx	2 lx	5 lx

Note:

* If the installation is for public (road) lighting then this may be up to 1 lx.

Recommended maximum values of light parameters for the control of obtrusive light

Limitation of illumination on surrounding properties

Light intrusion/nuisance

Limits apply to nearby dwellings/premises or potential dwellings/premises and specifically windows; the values are the summation of all lighting installations.

Spill light

Table 3 can also be considered for the management of spill light; however, designers must consider the task performance requirements of any adjacent lit areas and ensure that any spill light does not adversely affect these performance parameters as this could affect their safe use. This may result in a need to minimise spill and intrusive lighting values to less that might be expected for the environmental zone within which the installation lies.

Limitation of bright luminaires in the field of view.

The limits for the luminous intensity of bright luminaires are dependent on the viewing distance *d*, (between the observer and the bright luminaire(s)) and the projected area A_p, of the bright part of the luminaire in the direction of the observer.

Table 4 shows the maximum values for the luminous intensity of luminaires in designated directions where views of bright surfaces of luminaires are likely to be a nuisance to occupants of premises or from positions where such views are likely to be maintained, that is, not momentary or short-term.

Considerations to aid the application of Table 4 and the assessment process.

a) The assessment of A_p for observers can prove difficult and will vary for all observer positions and distances. To aid this assessment values of A_p corresponding to the geometric mean diameter of each luminaire group have been extracted from CIE 150 Annex C and included within Table 4. These areas can be considered for an assessment of likely A_p in the observer direction to calculate a maximum luminous intensity value.
b) The above information is applicable for the consideration of a single luminaire but where two or more luminaires are located in close proximity to each other that to the observer they appear as a single light source then the assessment shall be undertaken based upon the combined bright surfaces of luminaires (A_p) in the direction of the observer or, from positions where such views are likely to be maintained.
c) In installations that involve mast lighting the luminaires will often be viewed against the night sky. The contrast between the background sky and the bright surface areas of the luminaires can be considerable. In such installations the curfew levels set for each environmental zone shall be applied with the exception that such installations within an E4 zone will be designed to suit the curfew requirements of an E3 zone.

Limitation of the effects on transport systems

Limits apply where users of road networks are subject to a reduction in the ability to see essential information. CIE 150 2017; Table 5 gives values that are for relevant positions and for viewing directions in the path of travel.

This assessment does not just apply to road lighting installations but to any installation where luminaires positioning falls under the above definition.

Limitation of sky glow

See Tables 6 and 7

Table 4 (CIE 150 table 3 (amended)): Limits for the luminous intensity of bright luminaires[4].

Light technical parameter	Application conditions	Luminaire group (projected area A_P in m^2)					
		$0<A_P \leq 0.002$	$0.002<A_P \leq 0.01$	$0.01<A_P \leq 0.03$	$0.03<A_P \leq 0.13$	$0.13<A_P \leq 0.50$	$A_p>0.5$
Maximum luminous intensity emitted by luminaire (I in cd)	E0						
	Pre-curfew	0	0	0	0	0	0
	Post-curfew	0	0	0	0	0	0
	E1						
	Pre-curfew	0.29 *d*	0.63 *d*	1.3 *d*	2.5 *d*	5.1 *d*	2,500
	Post-curfew	0	0	0	0	0	0
	E2						
	Pre-curfew	0.57 *d*	1.3 *d*	2.5 *d*	5.0 *d*	10 *d*	7,500
	Post-curfew	0.29 *d*	0.63 *d*	1.3 *d*	2.5 *d*	5.1 *d*	500
	E3						
	Pre-curfew	0.86 *d*	1.9 *d*	3.8 *d*	7.5 *d*	15 *d*	10,000
	Post-curfew	0.29 *d*	0.63 *d*	1.3 *d*	2.5 *d*	5.1 *d*	1,000
	E4						
	Pre-curfew	1.4 *d*	3.1 *d*	6.3 *d*	13 *d*	26 *d*	25,000
	Post-curfew	0.29 *d*	0.63 *d*	1.3 *d*	2.5 *d*	5.1 *d*	2,500
Aid to gauging A_p		2 to 5cm	5 to 10cm	10 to 20cm	20 to 40cm	40 to 80cm	>80cm
Geometric mean of diameter (cm)		3.2	7.1	14.1	26.3	56.6	>80
Corresponding A_p representative area (m^2)		0.0008	0.004	0.016	0.063	0.251	>0.5

Notes:

1. d is the distance between the observer and the glare source in metres;
2. A luminous intensity of 0 cd can only be realised by a luminaire with a complete cut-off in the designated directions;
3. A_p is the apparent surface of the light source seen from the observer position
4. For further information refer to Annex C of CIE 150
5. Upper limits for each zone shall be taken as those with column $A_p>0.5$

Limitations of the effect of over-lit building façades and signs

Table 8 provides recommendations regarding luminance values that provide visibility in order that a balanced urban lighting master plan can be considered and such lighting does not cause negative impacts such as a continuous increase in the lighting levels (ratcheting) between buildings and within areas and light pollution.

Illuminated advertising signage should be assessed as advised in the ILP's Professional Lighting Guide *The brightness of illuminated advertisements*, (PLG 05)

4 Amended based upon the approach taken by NSVV Neder andse Stichting Voor Ver ichtingskunde (Dutch: Dutch Foundation for I umination; The Nether ands) and to consider CIE 150 Annex C Tab e C.2

Table 5 (CIE 150 table 4): Maximum values of threshold increment and viewing direction in the path of travel.

Light technical parameter	Road classification*			
	No road lighting	M6/M5	M4/M3	M2/M1
Veiling luminance (L_V)	0.037 cd/m^2	0.23 cd/m^2	0.40 cd/m^2	0.84 cd/m^2
Threshold increment	15% based on adaption luminance of 0.1 cd/m^2	15% based on adaption luminance of 1.0 cd/m^2	15% based on adaption luminance of 2.0 cd/m^2	15% based on adaption luminance of 5 cd/m^2

Notes:

* Road classifications as given in CIE 115:2010

† The veiling luminance values specified in this table are based upon on a permissible TI value of 15%

Definitions:

TI The measure of disability glare (the reduction in visibility caused by intense light sources in the field of view) expressed as the percentage increase in contrast required between an object and its background for it to be seen equally well with a source of glare present. Note: Higher values of TI correspond to greater disability glare.

L_V The luminance that would need to be superimposed on a scene in object space to reduce the scene's contrast by an amount equal to the added retinal illuminance from scattered light on the scene's retinal image. It is most commonly used to describe the contrast-reducing effect of a glare source in the field of view.

Table 6 (CIE 150 table 5): Maximum values of upward light ratio (ULR) of luminaires.

Light technical parameter	Environmental zones				
	E0	E1	E2	E3	E4
Upward light ratio (ULR)/%	0	0	2.5	5	15

Note:

This does not take into account the effect of light reflected upwards from ground that also contributes to sky glow. This is the traditional method to limit sky glow and is suitable to compare different single luminaires.

For illuminated advertising signs the aim should be to achieve the limits advised in PLG05.

Table 7 (CIE 150 table 6): Maximum values of upward flux ratio of installation (of four or more luminaires).

Light technical parameter	Type of installation	Environmental zones				
		E0	E1	E2	E3	E4
Upward flux ratio (UFR)/%	Road	n/a	2	5	8	12
	Amenity	n/a	n/a	6	12	35
	Sports	n/a	n/a	2	6	15

Notes:

Table 7 allows the effect of both direct and reflected upward components of a whole installation to be taken into account. The factor being the upward flux ratio (UFR) and CIE 150 suggests that table 7 is used for all installations consisting of four or more luminaires.

Clauses 6.4.2 and 6.4.3 of CIE 150:2017 describe the calculation methods for both ULP and UFR.

Light emitted just above the horizontal in a zone between 90o and 110o is extra critical for sky glow in large open areas around observatories. An additional measure in these areas limits the luminous intensities ($I_{90} - I_{110}$) as follows:

- between 90° and 100° < 0.5 cd/1000lm;
- between 100° and 110° 0 cd.

Table 8 (CIE 150 table 7): Maximum permitted values of average surface luminance (cd/m^2).

Light technical parameter	Application conditions	Environmental zones				
		E0	E1	E2	E3	E4
Building façade luminance (L_b)	Taken as the product of the design average illuminance and reflectance divided by π	< 0.1	< 0.1	5	10	25
Sign luminance (L_s)	Taken as the product of the design average illuminance and reflectance divided by π, or for self-luminous signs, its average luminance.	< 0.1	50	400	800	1.000

Note:
The values apply to both pre- and post-curfew, except that in zones 0 and 1 the values shall be zero post curfew. The values for signs do not apply to signs for traffic control purposes.

Relevant publications and standards

British Standards

- BS 5489-1:2013 *Code of practice for the design of road lighting – Part 1 Lighting of roads and public amenity areas*;
- BS EN 13201-2:2015 *Road lighting. Part 2: Performance requirements*;
- BS EN 13201-3:2015 *Road lighting. Part 3: Calculation of performance*;
- BS EN 13201-4:2015 *Road lighting. Part 4: Methods of measuring lighting performance*;
- BS EN 12193:2018 *Light and lighting. Sports lighting*;
- BS EN 12464-2:2014 *Lighting of work places. Outdoor work places*;
- PD CEN TR 13201-1:2014 *Road lighting. Guidelines on selection of lighting classes*.

CIE publications

- CIE 001 *Guidelines for minimizing urban sky glow near astronomical observatories*;
- CIE 094-1993 *Guide for floodlighting*;
- CIE 112-1994 *Glare evaluation system for use within outdoor sport and area lighting*;
- CIE 115:2010 *Lighting of roads for motor and pedestrian traffic*;
- CIE 126:1997 *Guidelines for minimizing sky glow*;
- CIE 129:1998 *Guide for lighting exterior work areas*;
- CIE 136:2000 *Guide to the lighting of urban areas*;
- CIE 150:2017 *Guide on the limitation of the effects of obtrusive light from outdoor lighting installations*;
- CIE 169:2005 *Practical design guidelines for the lighting of sport events for colour*.

ILP publications

- PLG04 *Guidance on undertaking environmental lighting impact assessments*;
- PLG05 *The brightness of illuminated advertisements*;
- PLG06 *Guidance on installation and maintenance of seasonal decorations and lighting column attachments*
- GN09 *Domestic exterior lighting: getting it right!*

SLL/CIBSE Publications

- LG01 *The industrial environment* (2018);
- LG04 *Sports lighting*;
- LG06/16 *The exterior environment*;
- LGLOL *Guide to limiting obtrusive light*.

NB: These notes are intended as guidance only and the application of the values given in the various tables should be given due consideration along with all other factors in the lighting design. Lighting is a complex subject with both objective and subjective criteria to be considered. The notes are therefore no substitute for professionally assessed and designed lighting, where the various and maybe conflicting visual requirements need to be balanced.

Acknowledgements

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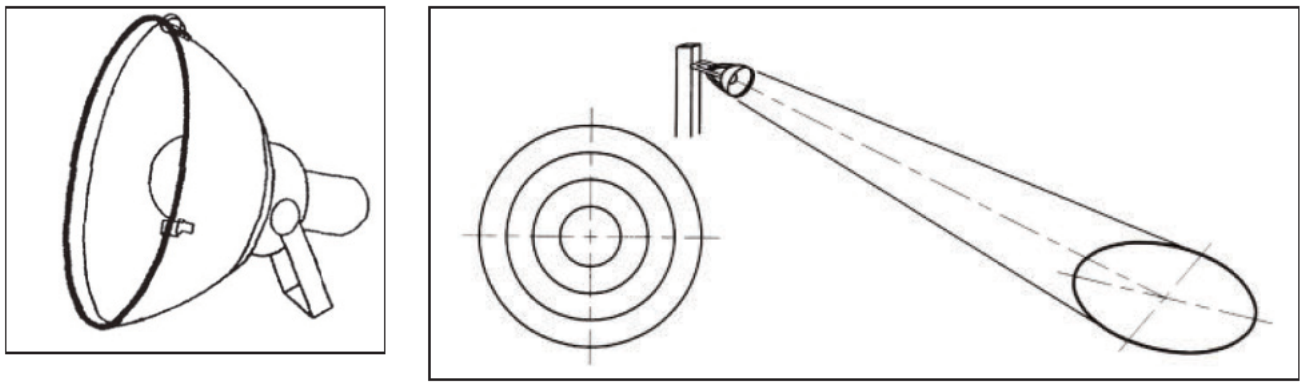
Dan Oakley – South Downs National Park

Appendix 2 images – acdc

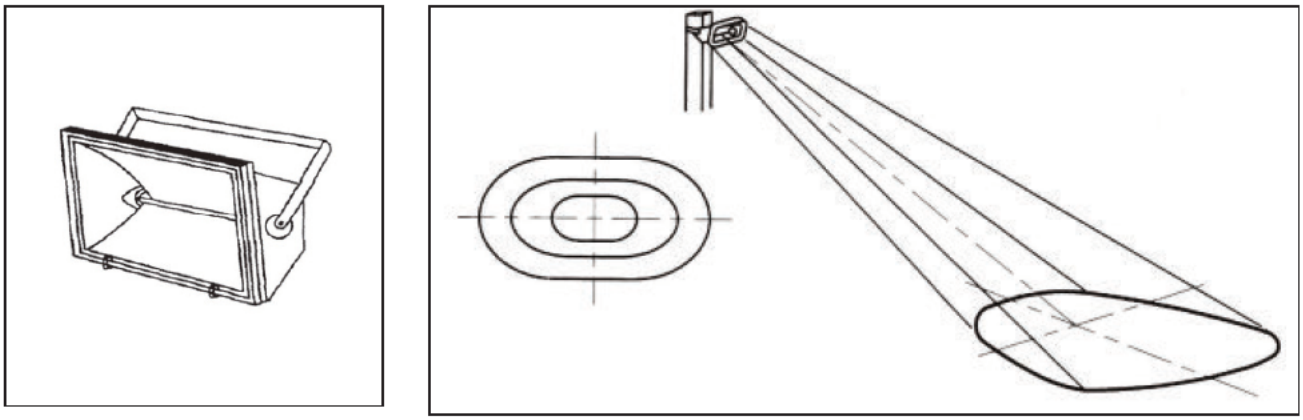
Appendix 1

Outdoor luminaire classification system

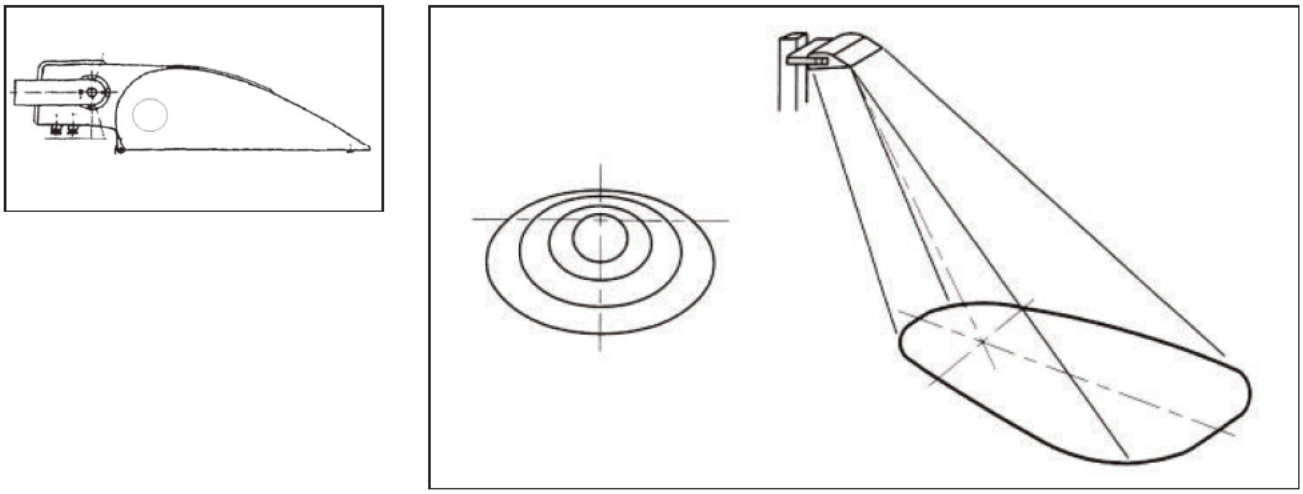
Based upon CIE 150:2017 and for the purpose of this and associated documents the following figures illustrate the luminaire classification (CIE 150:2017)



Type A: Floodlight/projector producing a symmetrical beam



Type B: Floodlight/projector producing a fan-shaped beam



Type C: Floodlight/projector producing a double asymmetric distribution in the vertical plane

Appendix 2

Illustrations of luminaire accessories for limiting obtrusive light

Luminaire with cowl, hood and shield

With louvre

With cowl

Annex B – Viewpoint location plans

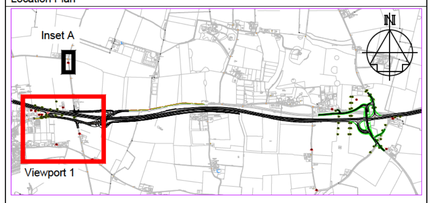
Viewport 1

Inset A

Notes

1. Do not scale from this drawing
2. Survey viewpoints may be added/subtracted subject to on site conditions and observations.
2. All dimensions are in metres unless otherwise shown. All levels are in metres above Ordnance Datum (AOD). All dimensions & levels should be checked on site.
3. Any drawing errors or discrepancies should be brought to the attention of Mott MacDonald Sweco JV.

Location Plan



Key to symbols

1 Proposed lighting survey viewpoint

1 Proposed ecology related lighting survey viewpoint

Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P01.1	27/04/18	FIRST ISSUE	CM	DH	JM

Mott MacDonald Sweco

Client: highways england

Drawing Status	Suitability
FOR REVIEW & COMMENT	S3

Project Title: A47 BLOFIELD TO NORTH BURLINGHAM

Drawing Title: LIGHTING SURVEY
VIEWPOINT LOCATION PLAN
SHEET 1 OF 2

Scale	Designed	Drawn	Checked	Approved
1:1250	OConnell, Christopher	Main, Cameron	Hawkins, Dean	McKay, Jamie
Original Size: A1	Date: 27/04/18	Date: 27/04/18	Date: 27/04/18	Date: 27/04/18

Drawing Number: HE PIN | Originator | Volume
HE551490 - MMSJV - HLG -
000 - DR - EO - 00011
Location | Type | Role | Number

Project Ref. No.: HE551490

Revision: P01.1

pw:\\CSPWInt.grontmij.net:PW_UK Production\Documents\Projects\Transportation\HEBLOFLD - A47 BLOFIELD TO NORTH BURLINGHAM\Highways\Road Lighting\Drgs & Models - 2D drawing\HEBLOFLD-MMSJV-HLG-000-DR-EO-00002

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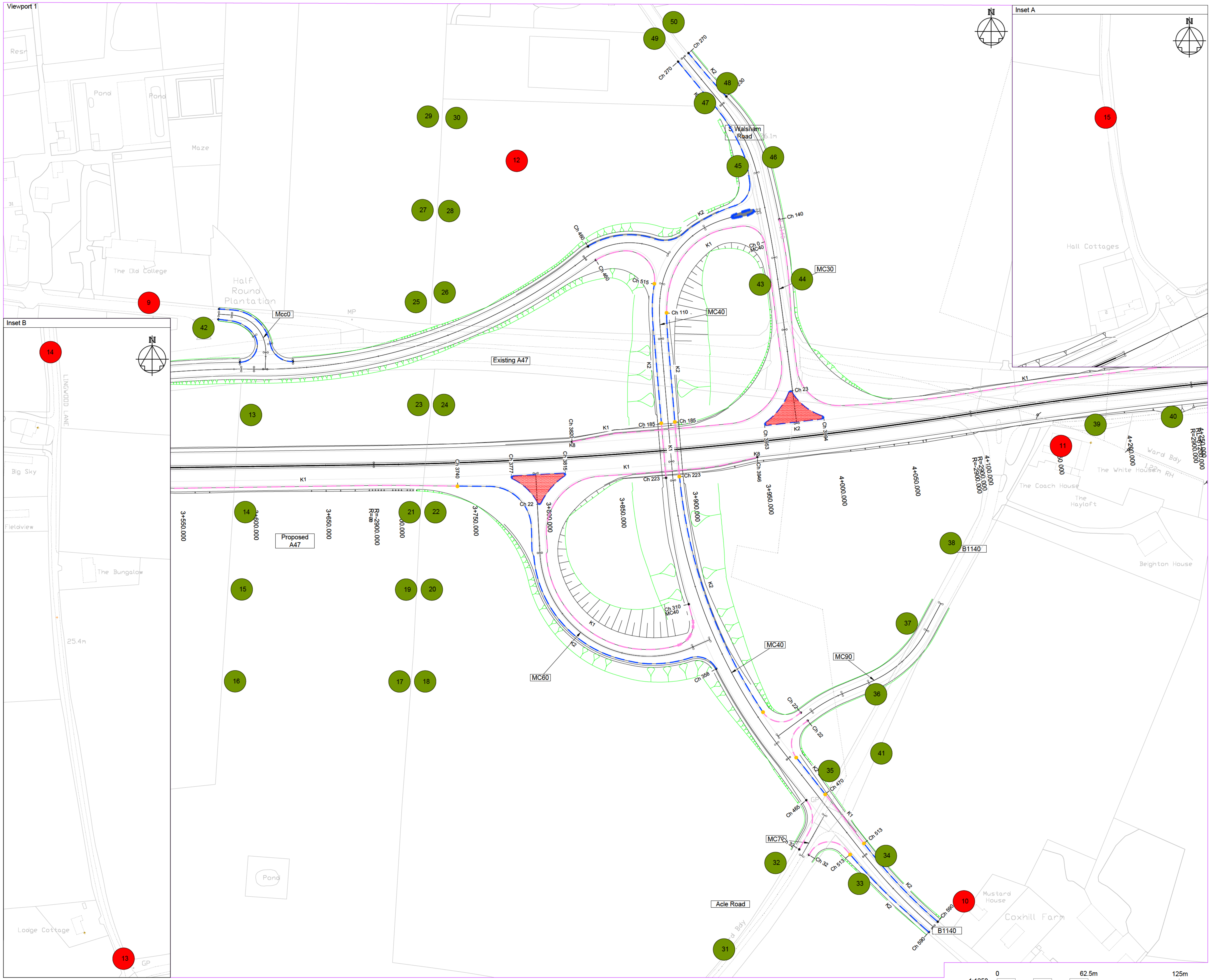
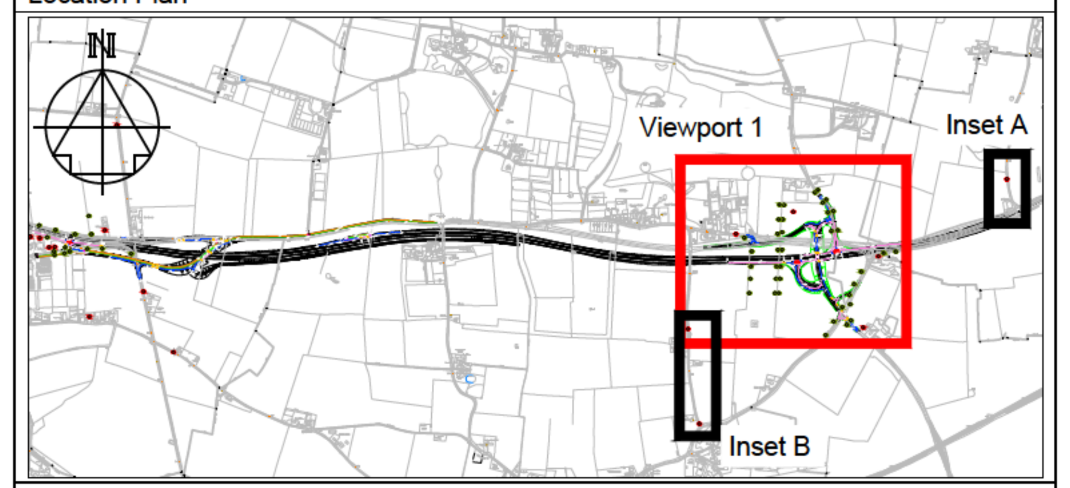


Notes

1. Do not scale from this drawing
2. Survey viewpoints may be added/subtracted subject to on site conditions and observations.
2. All dimensions are in metres unless otherwise shown. All levels are in metres above Ordnance Datum (AOD). All dimensions & levels should be checked on site.
3. Any drawing errors or discrepancies should be brought to the attention of Mott MacDonald Sweco JV.

Location Plan



Key to symbols

- (red circle) 1 Proposed lighting survey viewpoint
- (green circle) 1 Proposed ecology related lighting survey viewpoint

Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P01.1	27/04/18	FIRST ISSUE	CM	DH	JM

Mott MacDonald Sweco

Client: highways england

Drawing Status: FOR REVIEW & COMMENT

Suitability: S3

Project Title: A47 BLOFIELD TO NORTH BURLINGHAM

Drawing Title: LIGHTING SURVEY VIEWPOINT LOCATION PLAN SHEET 1 OF 2

Scale	Designed	Drawn	Checked	Approved
1:1250	Hawkins, Dean	Main, Cameron	Hawkins, Dean	McKay, Jamie
Original Size: A1	Date: 27/04/18	Date: 27/04/18	Date: 27/04/18	Date: 27/04/18

Drawing Number: HE551490 - MMSJV - HLG - 000 - DR - EO - 00012 (HE PIN | Originator | Volume | Location | Type | Role | Number)

Project Ref. No.: HE551490

Revision: P01.1

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Annex C – Baseline survey description and results (lighting related)

Viewpoint location 1, 2, 3 and 16 - Residential properties on Yarmouth Road, Blofield

7.13.1. Viewpoint locations 1, 2, 3 and 16 are in the gardens of residential properties 111, 115a, 117 and 119 on Yarmouth Road and were located to understand existing conditions at the properties.

7.13.2. Access to properties 111, 115a and 119 could not be obtained at the time of the survey and therefore the recording of baseline conditions could not be undertaken within the gardens. The baseline conditions at the front of properties 117 and 119 were recorded next to Yarmouth Road.

7.13.3. Within the rear garden of property 117 (viewpoint 2), there is a mixture of vegetation consisting of tall mature hedges and trees approximately 10m in height, mainly evergreen screening views of the A47 which is located north of the property behind the rear garden boundary. Although the screening appears dense, vehicles travelling along the A47 are just visible through the vegetation. In the north-west corner of the garden the vegetation becomes deciduous and the first-floor windows of 115a are visible. A wooden fence approximately 1.5m high bounds the garden to the east and west and a mixture of mature vegetation at the rear of the garden of property 119 can be seen over the fence which appeared approximately 10m in height, dense, and deciduous.

7.13.4. The two-storey property at 117 is located to the south of the viewpoint and there are first floor windows on all sides of the property.

7.13.5. At the entrance to properties 117 and 119 on Yarmouth Road there is a mainly continuous line of deciduous hedge approximately 2.5m in height running east to west which bounds the properties to the south with small break at the entrance of the property driveways. The hedge line stops at the western property boundary of 119 where Yarmouth Road bends 90° to join onto the A47 mainline, and a row of recently trimmed trees is visible beyond which the conservatory of 119 can be seen. On the bend of Yarmouth Road, the vegetation becomes denser and there are intermittent views of the property through the deciduous vegetation. While the ground floor windows of both properties are screened, the first-floor windows are visible from Yarmouth Road above the hedge. Views from the first-floor windows looking south are of the tall deciduous trees which are approximately 10m in height, lining Yarmouth Road with intermittent views of the plant nursery through the vegetation.

7.13.6. During the night-time survey at the rear of property 117, light spilling through the property windows was visible on the ground and extended to the rear of the garden.

Light from the internal first-floor windows of property 115a was visible through the vegetation to the north-west and headlights of vehicles travelling on the A47 were visible through the vegetation in the north-east corner of the garden.

7.13.7. At the front of the properties, a security light attached to property 117 was temporarily in operation lighting the property and driveway along with the row of trees lining Yarmouth Road to the south of the property. Approximately 100m west, lighting within the camping and leisure centre compound is visible in the form of light spilling onto Yarmouth Road and nearby vegetation. At the western boundary of 119 on the corner of Yarmouth Road, the occasional headlight from vehicles travelling on the A47 are visible towards the north-east.

7.13.8. Sky glow, orange in appearance was visible to the west towards the village of Blofield.

7.13.9. Overall, the area appeared generally dark and the only visible light sources were from the camping and leisure centre and from light either spilling through the property windows or from the residential security lighting. Although the baseline conditions could not be recorded from properties 111 and 115a along with the rear garden viewpoint of 119, it is assumed that the conditions at each of these viewpoints will appear dark. The screening to the rear of the properties consists of vegetation with varying levels of height (screening first floor windows) and density with a mix of evergreen and deciduous species and it is anticipated that during the winter the vegetation will provide substantially less screening as the leaves die back. To the front of the properties, vegetation is lower only screening the ground floor windows.

7.13.10. Table 7-14 details the light measurements recorded during the survey in the rear garden of property 117 (viewpoint 2). To illustrate the baseline lighting levels to the front of properties 117 and 119 (viewpoint 3) additional light measurements have been provided.

Table 7-14: Survey viewpoint 2 – light measurement results

Viewpoint number	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)
2	0.28	north	0.03
		east	0.39
		south	0.49
		west	0.06
2 & 3 (Additional viewpoint – property driveway Yarmouth Road)	0.02	north	0.02
		east	0
		south	0
		west	0.03

Viewpoint number	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)
3 (Additional viewpoint - corner of Yarmouth Road)	0	north	0
		east	0
		south	0
		west	0.01

Source: Mott MacDonald Sweco Joint Venture (2018)

Viewpoint location 4 – Owls Barn, Lingwood Road, Blofield

7.13.11. Viewpoint location 4 is located within the grounds of Owls Barn and is approximately 340m south to south-east of the A47 Yarmouth Road junction. The viewpoint was surveyed to assess the existing lighting conditions in relation to the Cultural Heritage assessment.

7.13.12. At the time of the survey, access to the grounds of the barn was restricted. To provide an understanding of the existing views from the barn the assessment was undertaken at the southern edge of the agricultural field north of the viewpoint location.

7.13.13. At the rear of the barn there is a line of deciduous trees located at the southern edge of the field partially screening views from the barn towards the north. Even though the foliage on the trees was fully developed the barn and associated house was partially visible. It is anticipated that during the winter the tree line will provide substantially less screening as the leaves dies back.

7.13.14. Beyond the tree line there are views across the agricultural field to the north which inclines towards the A47 Yarmouth Road junction, at the northern boundary of the field there is a line of tall deciduous trees which increases in density in the north-eastern corner of the field towards the junction. The Blofield allotments are located to the west of the field and there is a line of deciduous hedgerow, approximately 2m in height, separating the allotments from the field. The open field is visible towards the east which is bounded by a thick line of deciduous hedgerow approximately 2m in height, beyond the hedgerow the first and second floor windows of the properties on Hemblington Road can be seen.

7.13.15. During the day-time survey sources of artificial lighting were not visible.

7.13.16. During the night-time survey the field appeared generally dark with only intermittent views of artificial lighting. While screening is present to the north of the barn, light emanating from the internal building windows of the barn was visible through vegetation in the field to the south. Distant views of the spill light emanating from the previously mentioned floodlighting from within the forecourt of Norwich Camping and Leisure is visible to the north-west.

7.13.17. Sky glow was visible to the:

- North-east visible through the tree line at the northern boundary of the field and appeared intense and possibly from a nearby floodlighting installation although the location of the lighting was not identified.
- West and north-west towards the village of Blofield and appeared orange in colour.
- East and appeared orange in colour potentially from the highway lighting at the A47 B1140 junction.

7.13.18. Overall, the area appeared dark with only intermittent views of light sources as indicated by the light measurement results shown in Table 7-15. Views towards the A47 Yarmouth Road junction are screened by the deciduous trees at the northern property boundary and the tree line along the northern boundary of the field. It is anticipated that this screening will reduce in density during the winter months as the vegetation dies back. Sky glow was present towards the north, east and west.

Table 7-15: Survey viewpoint 4 – light measurement results

Viewpoint number	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)
4 (within field north of barn)	0	north	0
		east	0
		south	0
		west	0

Source: Mott MacDonald Sweco Joint Venture (2018)

Viewpoint location 5 – Residential property Sunny Acres, High Noon Lane, Blofield

7.13.19. The residential property Sunny Acres is located approximately 160m north-east of the A47 Yarmouth Road junction on High Noon Lane which runs parallel to the A47 mainline eastbound carriageway and was surveyed to understand the baseline views from the residential property.

7.13.20. The viewpoint is located on the driveway to the property, the single storey property along with associated barn and garage is to the north. A single luminaire is attached to the garage behind the house at an approximate height of 4m assumed to be used for security and lighting of the driveway. To the south, the driveway is lined either side by a mixture of deciduous trees and bushes of varying heights. At the end of the driveway looking south is a large evergreen conifer to the west and a group of deciduous trees approximately 4m in height to the east beyond which a deciduous hedgerow approximately 2m in height can be seen screening the A47 mainline from High Noon Lane. As the trees at the end of the driveway are taller

than the hedgerow separating the A47 from High Noon Lane, views above the hedgerow are partially screened although the deciduous trees lining Yarmouth Road are clearly visible.

7.13.21. Adjacent to the driveway a large grassed garden can be seen to the west which is bounded to the south and west by a 2m to 3m high deciduous hedgerow above which the floodlighting of the football club is visible directly to the west along with a tall row of deciduous trees to the south-west which may provide partial screening of the A47 Yarmouth Road junction. Towards the east a 1.5m to 2m high deciduous hedgerow is visible bounding the garden from an open agricultural field. The roof top of Sparrow Hall Bungalow is visible above the hedgerow.

7.13.22. During the night-time survey, the viewpoint appeared generally dark. Lighting assumed to be from the football ground was visible towards the west causing intense sky glow which was orange in appearance. Sky glow was also visible to the south-west in the direction of Blofield. Towards the east, building mounted lighting on Sparrow Hall Farm was visible and apart from the internal property lights being visible, views to the north were dark.

7.13.23. Headlights from vehicles travelling on the A47 were visible through the hedgerow separating the A47 from High Noon Lane to the east and south. The headlights illuminated the vegetation lining the A47.

7.13.24. Overall, the immediate area appeared dark as indicated by the light measurement results in Table 7-16, with only significant views of lighting towards the west associated with the football club. The majority of screening towards the A47 to the south and south-west is approximately 2m high and deciduous and likely to be less effective during the winter months when the foliage dies back.

Table 7-16: Survey viewpoint 5 – light measurement results

Viewpoint number	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)
5	0	north	0
		east	0
		south	0
		west	0

Source: Mott MacDonald Sweco Joint Venture (2018)

Viewpoint locations 6 – Residential property Brienz, Blofield

7.13.25. The residential property Brienz is located south of the mainline A47 on the road north of Hemblington Road. The property is approximately 380m south-east of the A47 Yarmouth Road junction and corresponds with a representative viewpoint assessed within the Landscape and Visual Assessment (LVIA).

7.13.26. The two-story chalet bungalow is located to the east of the viewpoint and to the west Hemblington Road is visible which runs north to south. On the far side of the road is a line of deciduous hedgerow, approximately 3m in height which separates the road from the agricultural field previously documented as part of viewpoint 4. The hedgerow continues to the north where the road bends 90° to the west to join Yarmouth Road and a row of tall deciduous trees are visible bounding Yarmouth Road from the agricultural field. The hedgerow and tree line provide significant levels of screening from onward views to the north-west. There is a large evergreen hedge screening views towards the north and north-east from the property. The road continues to the south and is lined with hedgerow approximately 3m in height on both sides of the road. On the eastern side of the road when viewed to the south the hedgerow is evergreen and deciduous which screens the neighbouring properties. On the western side of the road the hedgerow remains deciduous.

7.13.27. From the viewpoint location the ground height inclines approximately 8m in height north towards the existing location of the A47.

7.13.28. During the night-time survey, direct views of light sources were not visible however sky glow was visible:

- To the north and appeared white in colour. The intensity of the light appeared high suggesting that the light sources were relatively close and could be emanating from one of the farm buildings north of the A47 mainline.
- To the west above the hedgerow lining the field, orange in appearance and again the light sources appeared intense and assumed to be emanating from the camping and leisure centre.

7.13.29. Overall, the immediate area appeared dark as indicated by the recorded light measurements in Table 7-17 with instances of sky glow visible to the north and west. The viewpoint appeared well screened from onward views by deciduous hedgerow and trees to the north and west.

Table 7-17: Survey viewpoint 6 – light measurement results

Viewpoint number	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)
6	0	north	0
		east	0
		south	0
		west	0

Source: Mott MacDonald Sweco Joint Venture (2018)

Viewpoint location 7 – Lingwood Road, Blofield

7.13.30. Viewpoint 7 is located on Lingwood Road on the eastern outskirts of Blofield, approximately 670m south-east of the A47 Yarmouth Road junction and represents a viewpoint to be used in the LVIA.

7.13.31. To the north the land undulates, initially falling and then rising towards the A47. The ground height in the location of the viewpoint is higher than that of the A47 and there are unrestricted views to the north and north-east of which travelling vehicles are clearly visible. The properties previously described for viewpoint 6 are located to the north-west and sit lower in the valley and are heavily screened from the viewpoint by dense deciduous vegetation. Beyond these properties the previously described trees, which are approximately 10m in height, lining Yarmouth Road are visible providing screening of the A47.

7.13.32. There is a single story residential building to the east of the viewpoint, the tops of the property windows are visible above a deciduous hedge line which bounds the property in this location. To the south there are views of open agricultural fields with onward views interrupted by several trees bounding the fields. To the west and north-west, the land appears to drop and the previously described field to the south of Yarmouth Road (as described for viewpoint 4) and the plant nursery can be seen in the distance.

7.13.33. During the night-time survey, the headlights from vehicles travelling along the A47 were clearly visible to the north. To the north-west and beyond the A47, a small floodlighting installation is visible from the viewpoint location, appearing to consist of 2 floodlights which were prominent against the otherwise dark landscape, possibly associated with Sparrow Hall Farm. To the east the house appeared generally dark with a small amount of light visible through the property windows. A single light source is visible to the west along Lingwood Road and appeared to be lighting nearby vegetation. A number of distant single light sources were visible to the west and north-west.

7.13.34. Sky glow appeared prominent towards the west in the direction of Blofield and to a lesser degree to the south and south-east.

7.13.35. In summary the viewpoint location appeared dark as indicated from the light measurements recorded in Table 7-18 with only distant views to the north and north-west of floodlighting and vehicle headlights and sky glow to the west. The A47 Yarmouth Road junction appeared well screened by the deciduous trees lining Yarmouth Road.

Table 7-18: Survey viewpoint 7 – light measurement results

Viewpoint number	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)
7	0	north	0
		east	0
		south	0
		west	0

Source: Mott MacDonald Sweco Joint Venture (2018)

Viewpoint location 8 – High Noon Lane, Blofield

7.13.36. Viewpoint location 8 is located on High Noon Lane, north of the A47 eastbound carriageway, approximately 550m north-east of the A47 Yarmouth Road junction and represents the baseline conditions to be used in the LVIA.

7.13.37. Baseline data was not obtained as part of the survey and therefore the following details have been provided from a desktop review of the viewpoint location.

7.13.38. High Noon Lane runs south of the viewpoint location and agricultural fields are present to the south-east and south-west of the viewpoint location. The Sunny Acres residential property (viewpoint 5) is visible to the south beyond which the previously described deciduous vegetation screening the A47 from the property is visible.

7.13.39. Floodlighting associated with the Norwich United Football Club will be visible to the south-west and it is anticipated that this will be prominent in the night-sky when in operation.

7.13.40. It is anticipated that the viewpoint location will appear dark with distant views of the football pitch floodlighting and sky glow emanating from Blofield to the south-west being visible.

Viewpoint location 9 – Main Road, North Burlingham

7.13.41. Viewpoint 9 is located on Main Road on the eastern outskirts of North Burlingham and was surveyed to understand the baseline views from Main Road.

7.13.42. The mainline A47 is to the south of Main Road and a small junction with the A47 eastbound carriageway is located to the east of the viewpoint location.

7.13.43. To the north of the viewpoint, a row of dense deciduous hedges line Main Road which runs east to west. There is a property behind the hedges however this is not visible from the viewpoint location. To the east a mixture of deciduous and evergreen vegetation is visible initially screening views of the A47 which becomes visible at the end of Main Road where it joins the A47 eastbound carriageway.

Street lighting located at the A47 B1140 junction is visible at the end of Main Road beyond which the White House residential property can be seen. To the south of the viewpoint a small compound associated with a business selling garden rooms and sheds is located between Main Road and the A47 and is bounded by a wire mesh fence. Through and above the fence several deciduous trees lining the eastbound A47 are visible and street lighting adjacent to the A47 can be seen. To the south of the A47 open fields with intermittent tree lines are visible. Views of the A47 to the west are screened from the viewpoint by a cluster of commercial buildings.

7.13.44. During the night-time survey lighting concentrated to the south-west of the garden room compound was visible, although this lighting was not evident during the day-time survey. The compound lighting consisted of security and feature lighting of the garden rooms, white in colour and appeared obtrusive in terms of spilling light onto Main Road and the adjacent vegetation. Recorded light measurements of the spill light are shown in Table 7-19.

7.13.45. Further distant views towards the west along Main Road appeared dark. Above and behind the buildings within the compound, the street lighting on the A47 was visible and appeared yellow in colour. To the south of the viewpoint the A47 is visible and the associated street lighting appeared very bright against the dark landscape. To the east spill light from the compound is visible but to a lesser extent, a dark patch on the road initially exists where the vegetation to the south of Main Road screens the A47 street lighting however further along Main Road the vegetation ceases and Main Road becomes well-lit by the spill light from the A47 street lighting which is clearly visible at the end of Main Road.

7.13.46. Sky glow was visible to the east and west of the viewpoint and was more intense to the east above the street lighting on the A47 B1140 junction.

7.13.47. To summarise, although there are some dark refuges, with a combination of the street lighting on the A47 and the garden room compound there are a number of views of existing lighting some of which appear very bright against the dark landscape and there is evidence of extensive spill lighting onto vegetation as indicated in by the recorded lighting measured for viewpoint 42 in Table 7-26.

Table 7-19: Survey viewpoint 9 – light measurement results

(Source: Mott MacDonald Sweco Joint Venture (2018))

Viewpoint number	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)
9	0.15	north	0.01
		east	0.05
		south	0.26
		west	0.30

Viewpoint location 10 – Mustard House, B1140

7.13.48. Viewpoint 10 is located on the B1140 south of the A47 B1140 junction and was surveyed to understand the existing conditions at the property.

7.13.49. Mustard House is located to the east of the viewpoint and on the western boundary of the property a wooden fence approximately 2m high obstructs views of the ground floor windows; a single window is visible above the fence. Initial views to the north are of an open agricultural field which is bounded by several tall deciduous trees and then the A47 B1140 junction is visible. Although the trees provide some partial screening of the A47, vehicles using the A47 and the associated street lighting are visible. East of the junction is a small group of residential properties, the majority of which are well screened from the viewpoint location by a concentration of deciduous trees. Views to the south and west are of agricultural fields and intermittent tree lines.

7.13.50. During the night-time survey, views to the north-west and north are dominated by the street lighting installed on the A47 which appeared bright against the generally dark landscape. The street lighting appeared to be spilling onto nearby vegetation although the luminaires are orientated directly downwards and did not appear to provide much direct upward light.

7.13.51. Sky glow is visible to the south-west in the direction of the village of Lingwood.

7.13.52. Overall, the viewpoint appeared dark as indicated by the recorded light measurements in Table 7-20. Street lighting is a prominent feature to the north and north-west, due to the distance of the viewpoint from the A47 lighting installation the viewpoint does not experience any direct spill light.

Table 7-20: Survey viewpoint 10 – light measurement results

Viewpoint number	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)
10	0	north	0
		east	0
		south	0
		west	0.01

Source: Mott MacDonald Sweco Joint Venture (2018)

Viewpoint location 11 – The White House, Acle Road, North Burlingham

7.13.53. The White House is a two-storey residential property located in the south-east corner of the A47 B1140 junction and was surveyed to understand the existing conditions at the property.

7.13.54. The property is bounded by a small hedge which sits at the bottom of a small embankment at the side of the A47 westbound carriageway. The A47 sits higher than the viewpoint location and the hedge is not at a sufficient height to screen views of the A47 from the ground and first-floor windows to the north and north-west. There are initial views of the A47 to the north-east which quickly becomes screened by taller deciduous bushes and trees. In this location the street lighting on the A47 is positioned in the verges and in some instances is less than 10m from the viewpoint location and encompasses views to the north, east and west.

7.13.55. During the night-time survey the street lighting on the A47 was in operation and most of the area was bathed in yellow light and lit to a high level. Due to the close proximity of the street lighting to the mainly unscreened property there is a significant level of spill light noted on the small row of bushes surrounding the property along with the walls and windows of the property as noted by the light measurement results recorded in Table 7-21. The spill lighting encompassed the whole of the northern and western exteriors of the property and additional light measurement readings were recorded outside of the ground floor windows of the property as detailed separately in Table 7-22.

7.13.56. Due to the close proximity of the street lighting and general brightness of the area sky glow wasn't overly noticeable however some sky glow was noted in the distance towards the north.

7.13.57. Overall, the street lighting provided the area with a high level of lighting and the area appeared very bright. Spill light from the lighting installation was visible on vegetation adjacent to the A47 and a significant level of spill light was observed and recorded on the northern and western exteriors of the property.

Table 7-21: Survey viewpoint 11 – light measurement results

Viewpoint number	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)
11	7.18	north	5.54
		east	2.92
		south	1.89
		west	7.08

Source: Mott MacDonald Sweco Joint Venture (2018)

Table 7-22: Survey Viewpoint 11 – additional light measurement results

Viewpoint number	Direction of sensor	Measured at 1.5m above ground level (lux)
11	north extrusion – Ground floor window 1	6.58
	north extrusion – Ground floor window 2	4.48
	west extrusion – Ground floor window 1	6.70
	west extrusion – Ground floor window 2	3.98

Source: Mott MacDonald Sweco Joint Venture (2018)

Viewpoint location 12 – Agricultural field, South Walsham Road

7.13.58. Viewpoint 12 is in the north-western corner of the agricultural field near the A47 B1140 junction with the A47 to the south of the field and the B1140 to the east and was surveyed to understand the baseline views from the field.

7.13.59. The field is bounded to the north by a line of evergreen conifer trees, dense in nature blocking onwards views to the north. The western edge of the field is bounded by a line of deciduous trees, approximately 10m to 15m in height, with the neighbouring field visible through the vegetation. The eastern boundary of the field is initially lined with deciduous trees and bushes partly blocking onward views and the vegetation reduces towards the south-east where vehicles using the A47 B1140 junction along with the associated street lighting are visible. Beyond the junction the windows on the western elevation of the White House residential property are visible to the south-east; the windows to the northern elevation are blocked by some bushes located in the south-east corner of the field next to the A47. Views towards the A47 to the south are generally unrestricted and the vehicles along with associated street lighting is visible.

7.13.60. Night-time views towards the north and west appear dark. Views towards the east initially appear dark however the street lighting located on the A47 to the east of the A47 B1140 junction is clearly visible and the lighting and brightness intensifies near the junction towards the south-east. The previously described spill light effecting the White House is visible beyond the junction. Views of the street lighting continue south from the viewpoint location and spill light onto nearby vegetation and into adjacent fields can be seen. As an indication of the level of spill light in the field immediately next to the A47 additional light measurement results have been provided in Table 7-26 for Viewpoint 26.

7.13.61. Sky glow is visible to the east and west through the vegetation bounding the field.

7.13.62. Overall, the viewpoint appears dark as indicated by the recorded light measurements in Table 7-23. The street lighting located around the A47 is visible to the south and south-east, the lighting appears bright in relation to the relatively dark landscape and light can be seen spilling onto nearby vegetation and the field. A high level of light can be seen spilling onto the residential property (The White House) previously described for viewpoint 11 to the south-east.

Table 7-23: Survey viewpoint 12 – light measurement results

Viewpoint number	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)
12	0.01	north	0
		east	0.03
		south	0.05
		west	0

Source: Mott MacDonald Sweco Joint Venture (2018)

Viewpoint location 13 and 14 – Lingwood Lane

7.13.63. Viewpoints 13 and 14 are on Lingwood lane which is located to the west of the A47 B1140 junction and south of North Burlingham. The A47 westbound carriageway is north of the viewpoint locations. The baseline conditions at the viewpoint locations have been used to inform the LVIA.

7.13.64. Viewpoint 13 is located in the agricultural field at the southern end of Lingwood Lane at the junction with Acle Road, approximately 770m south of the existing A47. There is a row of mature deciduous trees which line Lingwood Road to the north of the viewpoint which provide only partial screening due to the spacing between the trees. To the north-east of the viewpoint location open agricultural fields are visible with some intermittent tree planting between fields, beyond the trees vehicles travelling on the A47 and the A47 street lighting can be seen to the north and north east. Directly north of the viewpoint location a two-storey house is visible, the ground floor windows are concealed by a thick deciduous hedge, but the first-floor windows are visible. To the west of the viewpoint there is an another two-storey house, views towards the A47 are partially screened by vegetation lining Lingwood Road. To the south of the viewpoint deciduous hedgerow bounding the agricultural field obscuring views of Lingwood Hall which is located south of the Lingwood Road junction with Acle Road.

7.13.65. Viewpoint 14 is located approximately 420m north of viewpoint 13 on Lingwood Lane. To the north and south the row of trees lining the eastern edge of Lingwood Road continue again only providing partial screening as vehicles on the A47 and the street lighting can be seen to the north and north-east. To the east and west of the viewpoint open agricultural fields can be seen with sparse lines of trees

bounding the fields. To the south a small cluster of single storey residential buildings and a farm shop are visible with the trees lining Lingwood Road providing sparse screening in this location. It was noted that a small number of floodlights were visible from within the farm shop compound. The previously described house to the north of viewpoint 13 is visible to the south of the viewpoint and is surrounded by tall deciduous vegetation obscuring views of any potential windows.

7.13.66. During the night-time survey, the street lighting in operation on the A47 is a prominent feature to the north and north-east at both viewpoint 13 and 14. The area appeared bright and although the lit road surface isn't visible, light spilling onto the nearby trees lining the A47 to the north can be seen, direct upward light from the luminaires seemed well controlled. To the north of viewpoint 13 light from the first-floor windows of the previously described house was visible but no light from the ground floor windows was visible.

7.13.67. At viewpoint 14, floodlighting from the farm shop compound were in operation during the survey and light from the installation was observed spilling onto Lingwood Road and into the adjacent field as illustrated by the recorded light measurements in Table 7-24.

7.13.68. At both viewpoints sky glow is visible to the west, orange in appearance and potentially emanating from the villages of Blofield and Lingwood.

7.13.69. To summarise, both viewpoints appeared generally dark albeit for a small lighting installation at the farm shop compound on Lingwood Road which appeared to be spilling a small amount of light outside of the boundary of the compound. The street lighting located at the A47 B1140 junction and associated approaches is clearly visible in the distance to the north.

Table 7-24: Survey viewpoints 13 and 14 – light measurement results

Viewpoint number	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)
13	0	north	0
		east	0
		south	0
		west	0
14	0.02	north	0
		east	0.01
		south	0.5
		west	0.38

Source: Mott MacDonald Sweco Joint Venture (2018)

Viewpoint location 15 – The Windle

7.13.70. Viewpoint 15 is located on The Windle which is a single track rural road located between 2 agricultural fields, approximately 660m east of the A47 B1140 junction and sits north of the A47 eastbound carriageway. The baseline conditions at the viewpoint location have been used to inform the LVIA.

7.13.71. The junction with the A47 is to the south of the viewpoint location next to which are 2 residential properties partially screened from the viewpoint by a thin row of deciduous trees. To the south to south-west of the viewpoint the A47 is initially screened by a row of dense deciduous vegetation separating the existing A47 layby from the mainline carriageway. To the west of the layby screening becomes intermittent consisting of small clusters of deciduous trees and vehicles travelling on the A47 along with the A47 B1140 junction, street lighting and the White House residential property are visible in the distance. The street lighting does not extend to the A47 Windle junction and ceases at the entrance near the existing A47 layby.

7.13.72. Views to the east and south-east are initially of agricultural fields which are bounded by the occasional deciduous tree, beyond the fields, vehicles travelling on the A47 are clearly visible. The A47 in this direction is not lit.

7.13.73. There are views to the north and west of open agricultural fields bounded with intermittent deciduous tree lines. Towards the north the first-floor windows of a residential building can be see above a row of deciduous hedges screening views of the ground floor. A large wooden building is clearly visible to the north-east.

7.13.74. During the night-time survey the viewpoint location appeared dark however the existing street lighting at the A47 B1140 junction is clearly visible in the distance to the south-west and appeared bright against the otherwise dark landscape. Light sources were not visible towards the south which appeared dark. Towards the north lighting associated with a farm building, not observed during the day-time survey, was in operation. This lighting was visible above a row of vegetation screening the building and appeared to be used for security and consisted of a mixture of white and orange floodlighting contributing to a small amount of sky glow above the premises. To the north-east the frontage of the wooden building noted during the day-time survey was visible during the night and lit by what appeared to be in-ground lighting. There are distant views towards the east of intermittent treelines silhouetted against lighting, orange in appearance. This lighting is assumed to be street lighting associated with the A47 Norwich Road junction in Acle.

7.13.75. Distant views of sky glow towards the east in the direction of the village of Acle and west in the direction of the village of Blofield were present.

7.13.76. Overall, the viewpoint appeared dark as indicated by the recorded light measurements in Table 7-25. The street lighting located around the A47 B1140 junction is visible to the south-west, the lighting appears bright in relation to the relatively dark landscape and light can be seen spilling onto nearby vegetation and the White House residential property previously described for viewpoint 11.

Table 7-25: Survey viewpoint 15 – light measurement results

Viewpoint number	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)
15	0	north	0
		east	0
		south	0
		west	0

Source: Mott MacDonald Sweco Joint Venture (2018)

Annex D – Baseline survey photograph sheets

Lighting related baseline survey photographs

Survey viewpoint 1

7.13.77. Access to viewpoint location 1 could not be obtained at the time of the survey and therefore the recording of baseline conditions could not be undertaken.

Survey viewpoint 2

Figure 7-3: Survey viewpoint 2 – day-time looking north

Figure 7-4: Survey viewpoint 2 – night-time looking north

Figure 7-5: Survey viewpoint 2 – day-time looking east

Figure 7-6: Survey viewpoint 2 – night-time looking east

Survey viewpoint 2 – day-time and night-time looking south

7.13.78. Views towards the south are of the residential property at the viewpoint location. As the photograph would contain views directly through the properties windows is deemed intrusive and therefore photographs were not taken.

Figure 7-7: Survey viewpoint 2 – day-time looking west

Figure 7-8: Survey viewpoint 2 – night-time looking west

Survey viewpoint 3

7.13.79. Access to viewpoint location 3 could not be obtained at the time of the survey and therefore the recording of baseline conditions could not be undertaken.

Survey viewpoint 4

Figure 7-9: Survey viewpoint 4 – day-time looking north

Figure 7-10: Survey viewpoint 4 – night-time looking north

Figure 7-11: Survey viewpoint 4 – day-time looking east

Figure 7-12: Survey viewpoint 4 – night-time looking east

Figure 7-13: Survey viewpoint 4 – day-time looking south

Figure 7-14: Survey viewpoint 4 – night-time looking south

Figure 7-15: Survey viewpoint 4 – day-time looking west

Figure 7-16: Survey viewpoint 4 – night-time looking west

Survey viewpoint 5

Figure 7-17: Survey viewpoint 5 – day-time looking north

Figure 7-18: Survey viewpoint 5 – night-time looking north

Figure 7-19: Survey viewpoint 5 – day-time looking east

Figure 7-20: Survey viewpoint 5 – night-time looking east

Figure 7-21: Survey viewpoint 5 – day-time looking south

Figure 7-22: Survey viewpoint 5 – night-time looking south

Figure 7-23: Survey viewpoint 5 – day-time looking west

Figure 7-24: Survey viewpoint 5 – night-time looking west

Survey viewpoint 6

Figure 7-25: Survey viewpoint 6 – day-time looking north

Figure 7-26: Survey viewpoint 6 – night-time looking north

Figure 7-27: Survey viewpoint 6 – day-time looking east

Figure 7-28: Survey viewpoint 6 – night-time looking east

Figure 7-29: Survey viewpoint 6 – day-time looking south

Figure 7-30: Survey viewpoint 6 – night-time looking south

Figure 7-31: Survey viewpoint 6 – day-time looking west

Figure 7-32: Survey viewpoint 6 – night-time looking west

Survey viewpoint 7

Figure 7-33: Survey viewpoint 7 – day-time looking north

Figure 7-34: Survey viewpoint 7 – night-time looking north

Figure 7-35: Survey viewpoint 7 – day-time looking east

Figure 7-36: Survey viewpoint 7 – night-time looking east

Figure 7-37: Survey viewpoint 7 – day-time looking south

Figure 7-38: Survey viewpoint 7 – night-time looking south

Figure 7-39: Survey viewpoint 7 – day-time looking west

Figure 7-40: Survey viewpoint 7 – night-time looking west

Survey viewpoint 8

7.13.80. Baseline data was not obtained as part of the survey therefore no photography is available.

Survey viewpoint 9

Figure 7-41: Survey viewpoint 9 – day-time looking north

Figure 7-42: Survey viewpoint 9 – night-time looking north

Figure 7-43: Survey viewpoint 9 – day-time looking east

Figure 7-44: Survey viewpoint 9 – night-time looking east

Figure 7-45: Survey viewpoint 9 – day-time looking south

Figure 7-46: Survey viewpoint 9 – night-time looking south

Figure 7-47: Survey viewpoint 9 – day-time looking west

Figure 7-48: Survey viewpoint 9 – night-time looking west

Survey viewpoint 10

Figure 7-49: Survey viewpoint 10 – day-time looking north

Figure 7-50: Survey viewpoint 10 – night-time looking north

Figure 7-51: Survey viewpoint 10 – day-time looking east

Figure 7-52: Survey viewpoint 10 – night-time looking east

Figure 7-53: Survey viewpoint 10 – day-time looking south

Figure 7-54: Survey viewpoint 10 – night-time looking south

Figure 7-55: Survey viewpoint 10 – day-time looking west

Figure 7-56: Survey viewpoint 10 – night-time looking west

Survey viewpoint 11

Figure 7-57: Survey viewpoint 11 – day-time looking north

Figure 7-58: Survey viewpoint 11 – night-time looking north

Figure 7-59: Survey viewpoint 11 – day-time looking east

Figure 7-60: Survey viewpoint 11 – night-time looking east

Figure 7-61: Survey viewpoint 11 – day-time looking south

Figure 7-62: Survey viewpoint 11 – night-time looking south

Figure 7-63: Survey viewpoint 11 – day-time looking west

Figure 7-64: Survey viewpoint 11 – night-time looking west

Survey viewpoint 12

Figure 7-65: Survey viewpoint 12 – day-time looking north

Figure 7-66: Survey viewpoint 12 – night-time looking north

Figure 7-67: Survey viewpoint 12 – day-time looking east

Figure 7-68: Survey viewpoint 12 – night-time looking east

Figure 7-69: Survey viewpoint 12 – day-time looking south

Figure 7-70: Survey viewpoint 12 – night-time looking south

Figure 7-71: Survey viewpoint 12 – day-time looking west

Figure 7-72: Survey viewpoint 12 – night-time looking west

Survey viewpoint 13

Figure 7-73: Survey viewpoint 13 – day-time looking north

Figure 7-74: Survey viewpoint 13 – night-time looking north

Figure 7-75: Survey viewpoint 13 – day-time looking east

Figure 7-76: Survey viewpoint 13 – night-time looking east

Figure 7-77: Survey viewpoint 13 – day-time looking south

Survey viewpoint 13 – night-time looking south

7.13.81. Photograph unavailable.

Figure 7-78: Survey viewpoint 13 – day-time looking west

Figure 7-79: Survey viewpoint 13 – night-time looking west

Survey viewpoint 14

Figure 7-80: Survey viewpoint 14 – day-time looking north

Figure 7-81: Survey viewpoint 14 – night-time looking north

Figure 7-82: Survey viewpoint 14 – day-time looking east

Figure 7-83: Survey viewpoint 14 – night-time looking east

Figure 7-84: Survey viewpoint 14 – day-time looking south

Figure 7-85: Survey viewpoint 14 – night-time looking south

Figure 7-86: Survey viewpoint 14 – day-time looking west

Figure 7-87: Survey viewpoint 14 – night-time looking west

Survey viewpoint 15

Figure 7-88: Survey viewpoint 15 – day-time looking north

Figure 7-89: Survey viewpoint 15 – night-time looking north

Figure 7-90: Survey viewpoint 15 – day-time looking east

Figure 7-91: Survey viewpoint 15 – night-time looking east

Figure 7-92: Survey viewpoint 15 – day-time looking south

Figure 7-93: Survey viewpoint 15 – night-time looking south

Figure 7-94: Survey viewpoint 15 – day-time looking west

Figure 7-95: Survey viewpoint 15 – night-time looking west

Survey viewpoint 16

7.13.82. Access to viewpoint location 16 could not be obtained at the time of the survey and therefore the recording of baseline conditions could not be undertaken.

Annex E – Baseline ecological survey results

Table 7-26: Ecological survey viewpoints – light measurement results

Viewpoint number	Description of area	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)	Comments
1, 3 and 4 (viewpoints 2 and 52 not surveyed)	A47 Yarmouth Road junction – North of A47 eastbound carriageway	0	north	0	Area appeared dark
			east	0	
			south	0	
			west	0 – 0.01	
5, 6, 7, 8, 10 and 12 (viewpoints 9 and 11 not surveyed)	A47 Yarmouth Road junction – Yarmouth Road	0 – 0.02	north	0 – 0.02	Area appeared dark
			east	0	
			south	0 – 0.02	
			west	0 – 0.13	
13	A47 B1140 junction – south of A47 westbound	2.77	north	3.88	Spill light from existing A47 street lighting
			east	1.0	
			south	0.17	
			west	0.34	
14 (viewpoints 15 and 16 not surveyed)	A47 B1140 junction – south of A47 westbound	0.03	north	0.23	Spill light from existing A47 street lighting
			east	0.11	
			south	0	
			west	0.17	
21 (viewpoints 17, 18, 19, 20 and 22 not surveyed)	A47 B1140 junction – south of A47 westbound	0.03	north	0.12	Spill light from existing A47 street lighting
			east	0.07	
			south	0.02	
			west	0.07	
23 (viewpoint 24 not surveyed)	A47 B1140 junction – south of A47 westbound	2.8	north	4.31	Spill light from existing A47 street lighting
			east	2.47	
			south	0.15	
			west	1.17	
26 (viewpoint 25 not surveyed)	A47 B1140 junction – north of A47 eastbound	2.7	north	0.07	Spill light from existing A47 street lighting
			east	1.98	
			south	4.07	
			west	0.17	
27, 28, 29 and 30 (viewpoints not surveyed – refer to viewpoint 12 Table 7-23: Survey viewpoint 12 – light measurement results	A47 B1140 junction – north of A47 eastbound	0.01	north	0	Area appeared dark
			east	0.03	
			south	0.05	
			west	0	

Viewpoint number	Description of area	Measure at ground level (lux)	Direction of sensor	Measured at 1.5m above ground level (lux)	Comments
35 and 41 (viewpoints 31, 32, 33, 34, 36 and 37 not surveyed)	A47 B1140 junction – B1140 (south of A47)	0	north	0 – 0.02	Area appeared dark
			east	0	
			south	0	
			west	0.01 – 0.02	
38	A47 B1140 junction – B1140 (south of A47)	0	north	0.32	Spill light from existing A47 street lighting
			east	0.04	
			south	0.01	
			west	0.12	
39	A47 B1140 junction – south of A47 westbound	0	north	0	Area appeared dark
			east	0	
			south	0	
			west	0	
40	A47 B1140 junction – south of A47 westbound	0.19	north	0.57	Spill light from existing A47 street lighting
			east	0.45	
			south	0.02	
			west	0.24	
42	A47 B1140 junction – Main Road	4.8	north	0.16	Spill light from existing A47 street lighting
			east	3.87	
			south	6.27	
			west	5.67	
43 and 44	A47 B1140 junction – B1140 (north of A47)	0.02 – 0.05	north	0	Spill light from existing A47 street lighting
			east	0.06 – 0.1	
			south	0.18 – 0.32	
			west	0.05 – 0.08	
47, 50 and 51 (viewpoint 45, 46, 48 and 49 not surveyed)	A47 B1140 junction – B1140 (north of A47)	0 – 0.02	north	0	Area appeared dark
			east	0	
			south	0.02 – 0.03	
			west	0 – 0.02	

Source: Mott MacDonald Sweco Joint Venture (2018)