



# Bristol Airport 12MPPA Extension

## Lighting Impact Assessment

*For Bristol Airport*

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Prepared by	Hannah Jane	
Checked by	Eunan Scanlon	
Approved by	Eunan Scanlon	

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# Bristol Airport 12MPPA Extension

## 1. INTRODUCTION

Hydrock Consultants has been appointed by Bristol Airport to provide planning stage advisory services in relation to the design and construction of the proposed 12MPPA extension of the airport. This document forms part of the Outline Planning Application and will inform the North Somerset Council Planning Department, Natural England, and other consultees of the lighting impact that the extension proposals will have on the area and its surroundings.

## 1.1 Purpose of Report

The following design statement is provided for planning purposes to describe the existing light levels on site and to provide an indicative lighting design and assessment of anticipated effects for the airport extension. This statement will serve as a guide to ensure the future external lighting scheme is as unobtrusive as possible, complies with guidelines for the reduction of light pollution, key statutory regulations and policy requirements with respect to lighting and biodiversity, to satisfy the local planners and the local community.

## 1.2 Development Details

Bristol Airport is the UK's 9th largest airport and the 3rd largest regional airport in England, with passenger numbers exceeding 8 million in 2017. It is expected that passenger numbers will rise to 12 million in the 2020s, and as such certain regions of the airport require development to be able to operate efficiently at this capacity.

The 12MPPA extension proposes to update 17 separate areas of the airport as shown in Figure 1. Each of these areas are discussed in more detail in section 4.

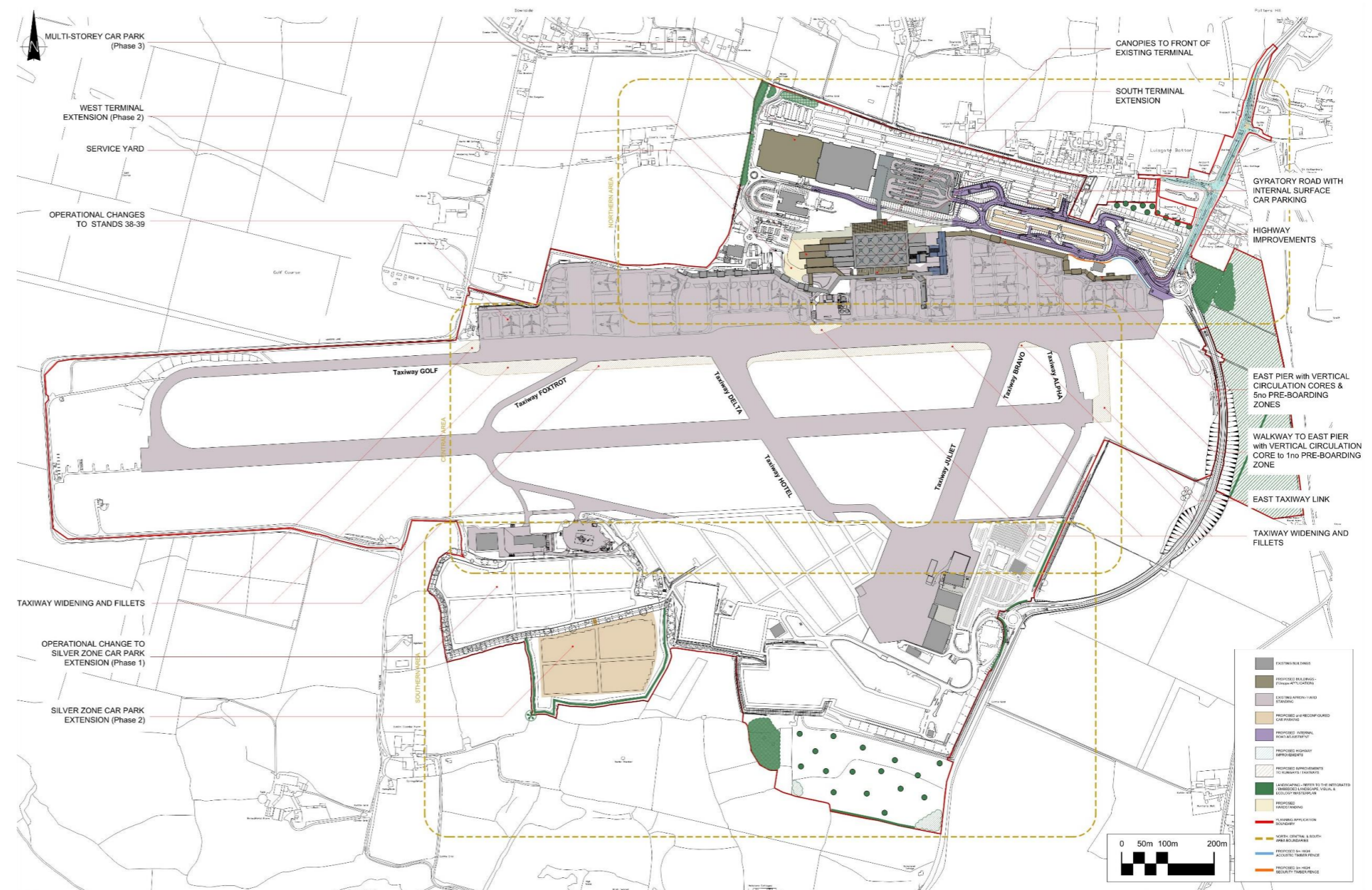


Figure 1: Bristol Airport 12MPPA extension masterplan.

## 2. LEGISLATION, POLICY AND GUIDANCE

### 2.1 National Legislation

National Legislation is given in the following documents:

- Wildlife and Countryside Act 1981;
- Environmental Protection Act 1990;
- Protection of Badgers Act 1992;
- Clean Neighbourhood and Environment Act 2005; and
- The Conservation of Habitats and Species Regulations 2017.

The statutory regime within these documents has been amended to include the light spill glare from lighting installations within different premises: 'artificial light emitted from premises so as to be prejudicial to health and nuisance'.

Under Section 79 of the Environmental Protection Act 1990, local authorities have a duty to take notice and act accordingly to investigate any complaint regarding artificial lighting of statutory nuisance. Once statutory nuisance may occur, local authorities must issue an abatement notice requiring that the nuisance cease or be abated within a set timescale.

### 2.2 National Planning Policy

The National Planning Policy Framework (NPPF) 2018 states that:

- 180: Planning policies and decisions should also ensure that new development is appropriate for its location taking in 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.

The Planning Policy Guidance (PPG) states that: "Artificial light provides valuable benefits to society, including through extending opportunities for sport and recreation, and can be essential to a new development. Equally, artificial light is not always necessary, has the potential to become what is termed 'light pollution' or 'obtrusive light' and not all modern lighting is suitable in all locations. It can be a source of annoyance to people, harmful to wildlife, undermine enjoyment of the countryside or detract from enjoyment of the night sky. For maximum benefit, the best use of artificial light is about getting the right light, in the right place and providing light at the right time.

Lighting schemes can be costly and difficult to change, so getting the design right and setting appropriate conditions at the planning stage is important. In particular, some types of premises (including prisons, **airports** and transport depots where high levels of light may be required for safety and security reasons) are exempt from the statutory nuisance regime for artificial light, so it is even more important to get the lighting design of these premises right at the outset.

### 2.3 Local Planning Policy

#### 2.3.1 *North Somerset Council Core Strategy (January 2017)*

Policy CS3 states that: "Development that, on its own or cumulatively, would result in air, water or other environmental pollution or harm to amenity, health or safety will only be permitted if the potential adverse effects would be mitigated to an acceptable level by other control regimes, or by measures included in the proposals, by the imposition of planning conditions or through a planning obligation."

Policy CS23 states that: "Proposals for the development of Bristol Airport will be required to demonstrate that satisfactory resolution of

environmental issues, including the impact of growth on surrounding communities and surface access infrastructure."

### 2.4 North Somerset and Mendip Bats Special Area of Conversation (SAC) Guidance on Development SPD (January 2018)

**1.1** The North Somerset and Mendip Bats SAC is designated under the Habitats Directive 92/43/EEC, which is transposed into UK law under the Conservation of Habitats and Species Regulations 2010. This means that the populations of bats supported by this site area of international importance and therefore afforded high levels of protection, placing significant legal duties on decision-makers to prevent damage to bat roosts, feeding areas and the routes used by bats to travel between these locations.

**1.2** The primary reason for designation of the bat SAC are two Annex II species:

- The Greater Horseshoe bat *Rhinolophus Ferrumequinum*; and
- The Lesser Horseshoe bats *Rhinolophus Hipposideros*.

**1.4** The Conservation Objectives for the SAC area: With regard to the SAC and the natural habitats and/or species for which the site has been designated, and subject to natural change, ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Quality Features, by maintaining or restoring:

- The extent and distribution of qualifying natural habitats and habitats of qualifying species;
- The structure and function (including typical species) of qualifying natural habitats;
- The structure and function of the habitats of qualifying species;

- The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
- The populations of qualifying species; and
- The distribution of qualifying species within the site.

**4.4** Loss of habitats refers not only to physical removal but also from the effects of lighting. A development proposal will be expected to demonstrate that bats will not be prevented from using features by the introduction of new lighting or a change in lighting levels. Reference to specific lux levels will be expected. Lighting refers to both external and internal light sources. Applicants will be expected to demonstrate that considerations of site design, including building orientated; and the latest techniques in lighting design have been employed in order to, ideally, avoid light spill to retained bat habitats. Applicants will similarly be expected to demonstrate use of the latest techniques to avoid or reduce light spill from within buildings.

**4.13** Horseshoe bats are known to be a very light sensitive species, and are linked to linear habitat features.

**4.14** In addition many night flying species of insect such as moths, a key prey species for horseshoe bats, are attracted to light, especially those lamps that emit an ultra-violet component and particularly if it is a single light source in a dark area. It is also considered that insects are attracted to illuminated area from further afield resulting in adjacent habitats supporting reduced numbers of insects. This is likely to further impact on the ability of the horseshoe bats to be able to feed.

**4.15** A variety of techniques will be supported to facilitate development that will avoid minimise and/or compensate for light spill:

- Use of soft white LED lights with directional baffles as required (LED light lacks a UV element and minimises insect migration from areas accessed by SAC bats);

- Use of building structure, design, location and orientation to avoid/minimise lighting impacts on retained habitats;
- Use of landscaping and planting to protect and/or create dark corridors on site;
- Use of SMART glass where appropriate;
- Use of internal lighting design solutions to minimise light spill from places such as windows; and
- Use of SMART lighting solutions.

## 2.5 Aerodrome Regulations and Standards

### 2.5.1 ICAO Annex 14 - Volume 1: Aerodrome Design and Operations (July 2016)

The International Civil Aviation Organisation (ICAO) provides guidance on the planning and design of aerodromes, and sets minimum aerodrome specifications. It does not include specifications on the overall planning of aerodromes such as [...] the impact on environment.

**5.3.23.2** Apron floodlights should be located so as to provide adequate illumination on all apron areas, with a minimum of glare to pilots of aircraft in flight and on the ground, aerodrome and apron controllers, and personnel on the apron. The arrangement and aiming of floodlights should be such that an aircraft stand receives light from two or more directions to minimise shadows.

**5.3.23.3** The spectral distribution of apron floodlights shall be such that the colours used for aircraft marking connected with routine servicing, and for surface and obstacle marking, can be correctly identified.

**5.3.23.4** The average illuminance should be at the least the following:

1. Aircraft stand:
  - a. Horizontal illuminance - 20 lux with a uniformity ratio (average to minimum) of not more than 4 to 1; and

- b. Vertical illuminance - 20 lux at a height of 2m above the apron in relevant directions.

#### 2. Other apron areas:

- a. Horizontal illuminance - 50% of the average illuminance on the aircraft stands with a uniformity ratio (average to minimum) of not more than 4 to 1.

### 2.5.2 EASA Certification Standards CS-ADR-DSN Issue 4

#### CS ADR-DSN.M.750 Apron Floodlighting

- a. The purpose of apron floodlighting is to facilitate safe operations on an apron, on a de-icing/anti-icing facility, and on a designated isolated aircraft parking position intended to be used at night.
- b. Applicability: Apron floodlighting should be provided on an apron, as necessary on a de-icing/anti-icing facility, and on a designated isolated aircraft parking position intended to be used at night. Aprons primarily used for recreational flying need not be illuminated.
- c. Location: Apron floodlights should be located so as to provide adequate illumination on all apron service areas, with a minimum of glare to pilots of aircraft in flight and on the ground, aerodrome and apron controllers, and personnel on the apron. The arrangement and aiming of floodlights should be such that an aircraft stand receives light from two or more directions to minimise shadows.
- d. The characteristics for apron floodlighting are the same as stated in 5.3.23.3 and 5.3.23.4 in section 2.4.1.

### 2.5.3 Airport Planning Manual Part 2: Land Use and Environmental Control

**3.6.7** The lighting of buildings accounts for a major part of the energy consumption at an

airport. Where artificial lighting is installed, it should be appropriately controlled and should use the most efficient, suitable light source.

3. BASELINE LIGHTING SURVEY

The baseline survey consists of a desk top survey of the site and a night-time on-site survey of the area, identifying and commenting on the existing lighting profile across the entire site and immediately adjacent areas. This is completed through:

- An assessment of the site, adjacent areas and sensitive receptors;
- On site measurements of typical existing lighting conditions in terms of lighting levels (lux), light quality and possible existing light pollution issues;
- Establishing the site and surrounding area Environmental Zone ratings as per current Institute of Lighting Professionals (ILP) and Bat Conservation Trust guidance.

The survey has been undertaken in accordance with ILP Professional Lighting Guide 04: Guidance on Undertaking Environmental Lighting Impact Assessments, current Institute of Lighting Professionals (ILP) and Bat Conservation Trust guidance.

The survey and report aim to clarify the known light pollution issues and will enable a review of the results against the criteria identified by the various lighting and environmental bodies, national and local policy and standards.

3.1 Desk Study

Guidance Notes for the Reduction of Obstructive Light GN01:2011 classifies environmental zones into five categories, shown in Table 1. The lighting limitations for each environmental zone are described in Table 2, extracted from the same document. Limits are set in terms of:

- Permissible maximum upward light %;
- Illuminance into windows;
- Source intensity; and

- 'building luminance', which sets upper values for decorative lighting of any structure, statue etc.

These limits should then be applied to any new lighting in the area.

Following the desk study and night time survey, the site has been classified as Environmental Zone E2.

Where possible, any new lighting proposed by the development should conform to the limitations provided in Table 1. The Planning Policy Guidance document produced by the UK Government does, however, state that "some types of premises (including airports [...] where high levels of light may be required for safety and security reasons) are exempt from the statutory nuisance regime for artificial light."

The North Somerset and Mendip Bats Special Area of Conversation (SAC) Guidance on Development SPD also requires any existing and proposed features used by SAC bats to not be lit above 0.5 lux; or not exceeding baseline light levels where this is not feasible.

3.2 Site Study

The survey was undertaken on Wednesday 5th September and Friday 7th September 2018 between 9.00pm and 12.30pm. On both nights, the weather was dry with little cloud cover.

Moonlight can affect illuminance measurements, with bright moonlight contributing to around 0.25 to 0.35 lux. However, during the survey the moon was in the waning crescent phase, with the new moon occurring on 9<sup>th</sup> September. Little moonlight was visible during the survey, so illuminance recordings should not be affected.

The proposal of the survey has been to review any existing artificial lighting on or near the site, the illumination of the adjacent roads and external lighting of nearby residential buildings. The data collected will serve to determine the impact of the development's eventual proposed lighting strategy. A good

Zone	Sky Glow ULR (Max %)	Light Intrusion (into windows) E <sub>v</sub> (Lux)		Luminaire intensity I (candelas)		Building Luminance L (Pre-curfew)
		Pre-curfew	Post-curfew	Pre-curfew	Post-curfew	Average L (cd/m <sup>2</sup> )
E0	0	0	0	0	0	0
E1	0	2	0(1*)	2500	0	0
E2	2.5	5	1	7500	500	5
E3	5	10	2	10000	1000	10
E4	15	25	5	25000	2500	25

Table 1: Obtrusive Light Limitations for Exterior Lighting Installations - General Observers.  
(ULR = Upward Light Ratio of the installation; E<sub>v</sub> = Vertical illuminance in lux; I = Light intensity in candelas; L = Luminance in candelas per square meter.  
\*permitted only from public road lighting installations.)

understanding of the future nature of the site, the surrounding areas and any potential sensitive areas is needed to determine the right external lighting solutions.

The measurements have been taken using a calibrated handheld lux meter. Horizontal illuminance measurements have been taken at all locations, at 0m above ground, and vertical measurements have been taken when deemed necessary, at 1.5m above ground.

Spot and line measurements have been taken through the site to record average lux levels and to assess the lux profile of the existing luminaires.

3.3 Survey Results

This section describes the principal lighting sources and lighting situations found on the site survey.

Please see Appendix B for photographic evidence taken throughout the site survey. All measurements have been captured in drawings 09194-HYD-XX-GF-DR-E-9000 to 09194-HYD-XX-GF-DR-E-9010 shown in Appendix C.

3.3.1 The A38 and Main Entrance

The northernmost section of the A38 adjacent to Downside Road is lit with 6m tall column luminaires. They have a Correlated Colour Temperature (CCT) of 4000°K. The measurements taken in this area show that the road is currently lit to current British Standards.

Zone	Surrounding	Lighting Environment	Examples
E0	Protected	Dark	UNESCO Starlight Reserves, IDA Dark Sky Parks
E1	Natural	Intrinsically	National Parks, Areas of Outstanding Natural Beauty
E2	Rural	Low District Brightness	Small Town centres or suburban locations
E3	Suburban	Medium District Brightness	Small Town centres or suburb locations
E4	Urban	High District Brightness	Town/City centres with high levels of night-time activity

Table 2: Environmental Lighting Categories

The main entrance to the airport is lit with column luminaires with a mixture of CCTs ranging from 2700°K to 4000°K. Most columns are approximately 8m tall, though 3m to 4m tall columns were found adjacent to pedestrian crossings.

The northern roundabout is lit with LED column luminaires with a CCT of 4000°K CCT. The columns are approximately 6m tall. Readings in this area show that the roundabout is lit to current British Standards. RGB feature lighting is also present in the centre of the roundabout, its main purpose to provide an entrance marker to the airport rather than provide illuminance.

The section of A38 between the two roundabouts is not lit with most measurements recorded at 0.0 lux. There are no sources of illumination along the road or pathways. The airport buildings and car parks are visible from this location.

The southern roundabout is lit with column luminaires with a 3000°K CCT. They are approximately 6m tall. Measurements made in this area show that the roundabout is lit to current British Standards.

### 3.3.2 Northern Car Parks

The northern car parks are lit with column luminaires. Most columns are approximately 6m to 8m tall, though some columns were found to be smaller at 3m to 4m. A range of CCTs and lighting technologies were found in this area. CCTs ranged from 2700°K to 4000°K and lamps were found to be a mix of LED, SON and halogen technologies.

The staff car park is lit with 5m tall column luminaires with a CCT of 2700°K.

The multi-storey car park to the west of the site is lit with surface mounted batten luminaires. These provided a higher light spill into immediately adjacent areas, with a maximum horizontal recorded measurement of 73.2 lux.

### 3.3.3 North Side Road, the Terminal and Hampton Hotel

North Side road is lit with column luminaires of varying height. Taller columns (approximately 8m) provide overall illuminance, however, smaller columns (approximately 3m to 4m) provide illuminance along the pathways and adjacent to crossings.

1m high bollards are located along main pedestrian routes leading from the car park areas to the main terminal to aid in wayfinding. High amounts of foliage (trees and bushes) separate the main terminal from the car parks.

The terminal building does not have any external lighting as the internal lighting penetrates through the glass façade, illuminating the entrance effectively. 3m to 4m 3000°K columns light the bus parking areas directly across from the terminal.

New LED bollards and wall mounted luminaires are located around the Hampton Hotel pathways. These provide a high amount of illumination, with measurements recording a maximum horizontal illuminance of 230 lux directly adjacent to the bollards.

The Hampton Hotel car park is well lit with 6m tall column luminaires with a CCT of 4000°K.

### 3.3.4 Downside Road

There are currently no luminaires present along Downside Road, with the only illumination coming from the adjacent residences.

The adjacent northern car parks are well lit, to current British Standards, but light spill is not present along Downside Road due to a tall, thick line of foliage between the two areas.

A woodland area lies directly southwest of the junction linking Downside Road to the A38. This woodland area has been identified as an important bat habitat and will be assessed further in section 4.3.4.

### 3.3.5 Stands and Apron Areas

The apron areas are lit with floodlights mounted on tall masts to provide uniform illuminance over a wide area. The floodlights were a mixture of CCTs ranging from 2,700°K to 4000°K. Each mast varied the number of floodlights mounted to its structure depending on the size of area requiring illumination.

The fuel farm was inaccessible at the time of survey; however, the area was lit with SON column luminaires with a CCT of 2700°K. Structure mounted floodlights were also present on the fuel tanks with a CCT of 4000°K.

From these areas, the Aeronautical Ground Lighting (ALG) fittings located along the runway were observable and the luminaires lighting the southern car parks were visible, particularly the intense temporary column luminaires located in the Cogloop parking area.

### 3.3.6 Area surrounding the Runway

The runway is lit solely with AGL fittings. The maximum illuminance recorded along the runway was 2.4 lux directly adjacent to the AGL fittings, with illuminance falling to approximately 0.1 lux between the fittings. These fittings have the ability to increase their illuminance in foggy weather.

The runway lighting is designed to be viewed in the east-west plane, to aid pilots in landing and take-off only. Therefore, these lights are not visible when viewed in the north-south plane.

Areas adjacent to the runway are not lit to ensure that the runway is easily visible for pilots landing in all weather conditions.



Figure 2: Image of the AGL fittings found on the runway.

### 3.3.7 Cogloop Parking

The Cogloop parking area is currently lit with temporary, extendable column luminaires. At the time of the survey, these were at a height of 6m to 8m.

These columns provided high levels of illumination when measured directly beneath the luminaires, with measurements recorded in the region of 800 lux, though this decreases to 7 lux after approximately 20m and down to 0 lux after approximately 30m.

From this location, the runway lighting was not visible due to the south to north viewing plane,

though the lighting of the airport buildings and apron areas were clearly visible. A sky glow around the airport was also observable at this location.

### 3.3.8 Southern Car Parks

The southern car parks are generally well lit with 6m to 8m tall column luminaires. Measurements in this area show that the car park areas are currently lit to current British Standards for high usage car parks.

The Silverzone overflow car park is not currently lit with measurements recorded at 0 lux for this area.

Lighting for the airport buildings and apron areas was observable in this location, with a sky glow seen around the airport.

### 3.3.9 Agricultural Land below Airport Boundary

No luminaires are present in the farmland to the south of the airport. The majority of readings taken in these locations were 0.0 lux, reaching a maximum of 1.0 lux directly adjacent to the airport boundary.

The farmland is separated from the airport site by a 2m to 3m high bund, with thick foliage planted on top. No light spill from the Cogloop or southern car parks was found in this area.

A dark corridor around the perimeter of the site is required under the 10MPPA permission and this will be required to be retained for the 12MPPA extension.

Goblin Combe Farm, located approximately 500m from the airport boundary, is the only source of light in this area as it is currently used as a car park.

The lighting from the airport buildings was easily observable in this location, with a sky glow seen around the airport.

### 3.4 Receptor Assessment

The sensitive receptors of the site have been identified as the following:

- Residences along Downside Road;
- Residences along the A38;
- The Mendip Hills Area of Outstanding Natural Beauty (AONB);
- Dark agricultural to the South and East of the site; and
- Light sensitive biodiversity surrounding the site.

The impact on these receptors shall be discussed in detail in section 4.3.

### 3.5 Baseline Survey Conclusion

The site existing lighting levels and sources have been recorded and the most important surrounding areas have been identified. The site has been classified as Environmental Zone classification CIE E2.

This information will now be used to assess each of the extension proposals and its residual effects on the surrounding areas and sensitive receptors.

## 4. INDICATIVE EXTERNAL LIGHTING STRATEGY

### 4.1 Design Guidance

The following documents should be consulted and adhered to when designing the external lighting strategy for the scheme:

- ILP Guidance Notes for the Reduction of Obtrusive Light GN01:2011;
- ILP Guidance Note 08: Bats and Artificial Lighting in the UK;
- ILP PLG04: Guidance on Undertaking Environmental Lighting Impact Assessments;
- EASA Certification Standards;
- ICAO Annex 14 - Volume 1: Aerodrome Design and Operations July 2016;
- CIBSE Lighting Guide 6 (LG6) – Outdoor Environment;
- CIBSE Lighting Guide 15 (LG15) - Transport Buildings;
- CIBSE SLL Code for Lighting 2012;
- BS 5489-1:2013 – Code of Practice for Design of Road Lighting;
- BS EN 12464-2:2014 – Lighting of Work Places – Part 2: Outdoor Work Places;
- CEN/TR 13201-1: Road Lighting – Part 1: Selection of Lighting Classes;
- CIE – Guidelines for Minimising Sky Glow;
- Royal Commission on Environmental Pollution – Artificial Light in the Environment.

The ILP Guide for the Reduction of Obtrusive Lights is the primary document used by most local councils and planning departments to categorise the provision of external lighting. Where possible, the external lighting should be compliant to Dark Sky requirements and to Lighting Environmental Zone CIE E2.

The CIBSE Lighting Guide 15: Transport Buildings provides specific requirements for the

lighting at airports and repeats the standards listed in ICAO Annex 14, shown in Table 5.

Section 2.3.4 also provides further guidance on the lighting of aircraft stand areas:

- Lighting installation for aircraft stands normally consists of high-mast floodlighting from 12m to 30m in height located in specific areas in the airfield apron. Indirect floodlight mirror systems could also be used to reduce glare from direct light sources.
- Annex 14 recommends a luminaire mounting height approximately double the highest pilot eye's position for regular aircraft. Floodlights with an asymmetric light distribution should be considered to reduce the pilot disability glare issues. In addition, [there is usually] a 0 to 5 degree limit on vertical tilt of all luminaires. Annex 14 also sets limits for spill lighting onto the adjacent taxiways of 5 lux (max.) and onto runways of 0 lux (max.) respectively.
- Car parks and approach roads should be well lit, at least to the levels required by BS 5489-1.

Figure 4 shows a typical lighting arrangement and requirements for a pier-served stand.

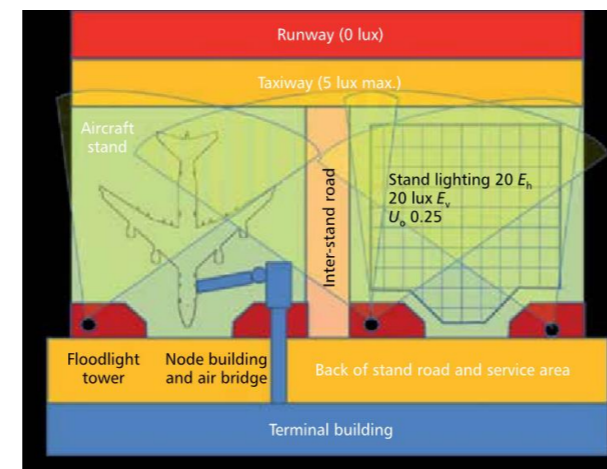


Figure 3: Typical lighting arrangement of pier-served stands (taken from CIBSE LG15).

Ref. no.	Type of area, task or activity	E <sub>m</sub> [lx]	U <sub>0</sub>	RGL	R <sub>a</sub>	Specific Requirements
General						1. Direct light in the direction of the control tower and landing aircraft shall be avoided.  2. Direct light emitted above horizontal from floodlights should be restricted to the minimum.
5.2.1	Hangar Apron	20	0.10	55	20	
5.2.2	Terminal apron	20	0.25	50	20	
5.2.3	Loading areas	20	0.25	50	40	For reading labels: E <sub>m</sub> = 50 lx
5.2.4	Fuel depot	50	0.25	50	40	
5.2.5	Aircraft maintenance stands	200	0.50	45	60	

Table 3: BS EN 12464-2:2014 Table 5.2 – Airport lighting requirements.

Ref. no.	Type of area, task or activity	E <sub>m</sub> [lx]	U <sub>0</sub>	RGL	R <sub>a</sub>	Specific Requirements
5.9.1	Light traffic, e.g. parking areas of shops, terraced and apartment houses, cycle parks	5	0.25	55	20	
5.9.2	Medium traffic, e.g. parking areas of department stores, office buildings, plants, sports and multipurpose building complexes	10	0.25	50	20	
5.9.3	Heavy traffic, e.g. parking areas of major shopping centres, major sports and multipurpose building complexes	20	0.25	50	40	

Table 4: BS EN 12464-2:2014 Table 5.9 - Parking areas.

Ref. no.	Type of area, task or activity	E <sub>m</sub> [lx]	UGR limit	U <sub>0</sub>	R <sub>a</sub>	Remarks
5.9.1	Aircraft stands*	20 (horizontal)  20 (vertical)	-  -	0.25  0.25	-  -	Horizontal illuminance at apron level. Vertical illuminance at height of 2m above apron in relevant direction
5.9.2	Other apron areas*	50% of average illuminance on aircraft stands	-	0.25	-	

Table 5: CIBSE Lighting Guide 15 - Table 2.3.1 - Airports. \*Values from ICAO Annex 14.

## 4.2 Indicative External Lighting Strategy

All sites have been assessed for their residual effects against guidance given the ILP Professional Lighting Guide 4 shown in Table 6.

Where adverse effects have been anticipated, indicative external lighting proposals have been modelled using Dialux Evo 8.0 lighting software to understand predicted light levels of the new development.

Adjacent buildings have been modelled when close enough to affect lighting calculations however, no foliage or landscape screening has been included in the model. Therefore, the light spill calculations could be viewed as a worst-case scenario.

Please see the following page for a detailed plan of all extension site areas.

### 4.2.1 South Terminal Extension

The site proposes to extend the existing terminal building to the south.

The residual effects of this development are deemed to be neutral as no additional external lighting installations will be required for this area.

### 4.2.2 West Terminal Extension

The site proposes to extend the western end of the terminal building.

The residual effects of this development are deemed to be neutral as no additional external lighting installations will be required for this area.

### 4.2.3 Service Yard

The site proposes to construct a new service yard to the west of the terminal building.

The residual effects of this development are deemed to be neutral as the site survey found lighting levels in this area to be in line with current British Standards.

Any new lighting proposals in this area will provide similar horizontal and vertical illuminance figures, and will not contribute any further upward light spill to the area.

### 4.2.4 Walkway to East Pier

The site proposes to build a new walkway with a Vertical Circulation Core (VCC) and one additional Pre-Boarding Zone (PBZ).

The residual effects of this development are deemed to be neutral as no additional external lighting installations will be required for this area.

### 4.2.5 East Pier

The site proposes to construct a new pier to the east of the site with Vertical Circulation Cores (VCCs) and five new Pre-Boarding Zones (PBZs). The existing apron area will also be extended towards the east to create 3no. new stands.

The site has been identified as an area which may contribute negative residual effects due to its location adjacent to unlit farmland to the East. Detailed lighting calculations have been undertaken to evaluate the impact of the area.

The lighting in this area has been designed to current BS EN 12464-2:2014, ICAO and CIBSE standards.

The area has been lit with 20m tall masts with each mast housing 5no. LED floodlights. Additional LED building mounted luminaires have also been modelled to provide illuminance on the service road adjacent to the pier. All floodlights have been specifically designed to not produce upward light to reduce the overall sky glow created by the airport.

Vertical illuminance calculations have also been undertaken to assess vertical light spill created by the development.

Figure 4 shows the vertical calculation points to the east of the airport. The calculation grid has been set up to calculate illuminance on a 5m by 5m grid and is located at the edge of the airport boundary. The maximum recorded measurement is 0.37 lux which is well within guidelines given in the ILP Guidance Notes for the Reduction of Obtrusive Light for a site located in an E2 environmental classification zone.

Nature	Ref.	Level	Descriptions	Remedial needs
Positive	1	Major/substantial beneficial effects	Significant improvement in night environment and/or reductions in glare, spill light and sky glow etc.	
	2	Moderate beneficial effects	Noticeable improvement in night environment and/or reductions in glare, spill light and sky glow etc.	
	3	Minor beneficial effects	Slight improvement 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	None
Negative	5	Minor adverse effects	Slight increase in visibility of site, glare, sky glow etc.	Develop appropriate levels and type of mitigation
	6	Moderate adverse effects	Noticeable increase in visibility of site, glare, sky glow etc.	
	7	Major adverse effects	Significant increase in visibility of site, glare, sky glow etc.	

Table 6: Residual effects table - ILP Professional Lighting Guide 4.

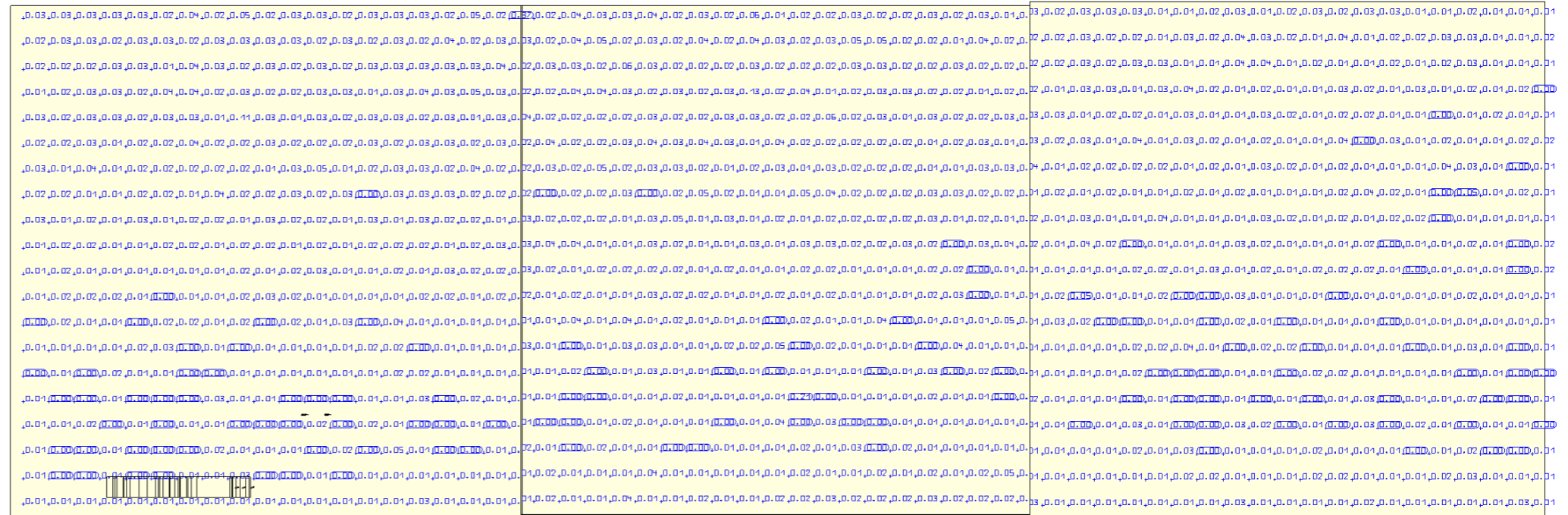


Figure 4: Vertical illuminance calculations located approximately 100m east of the East Pier..

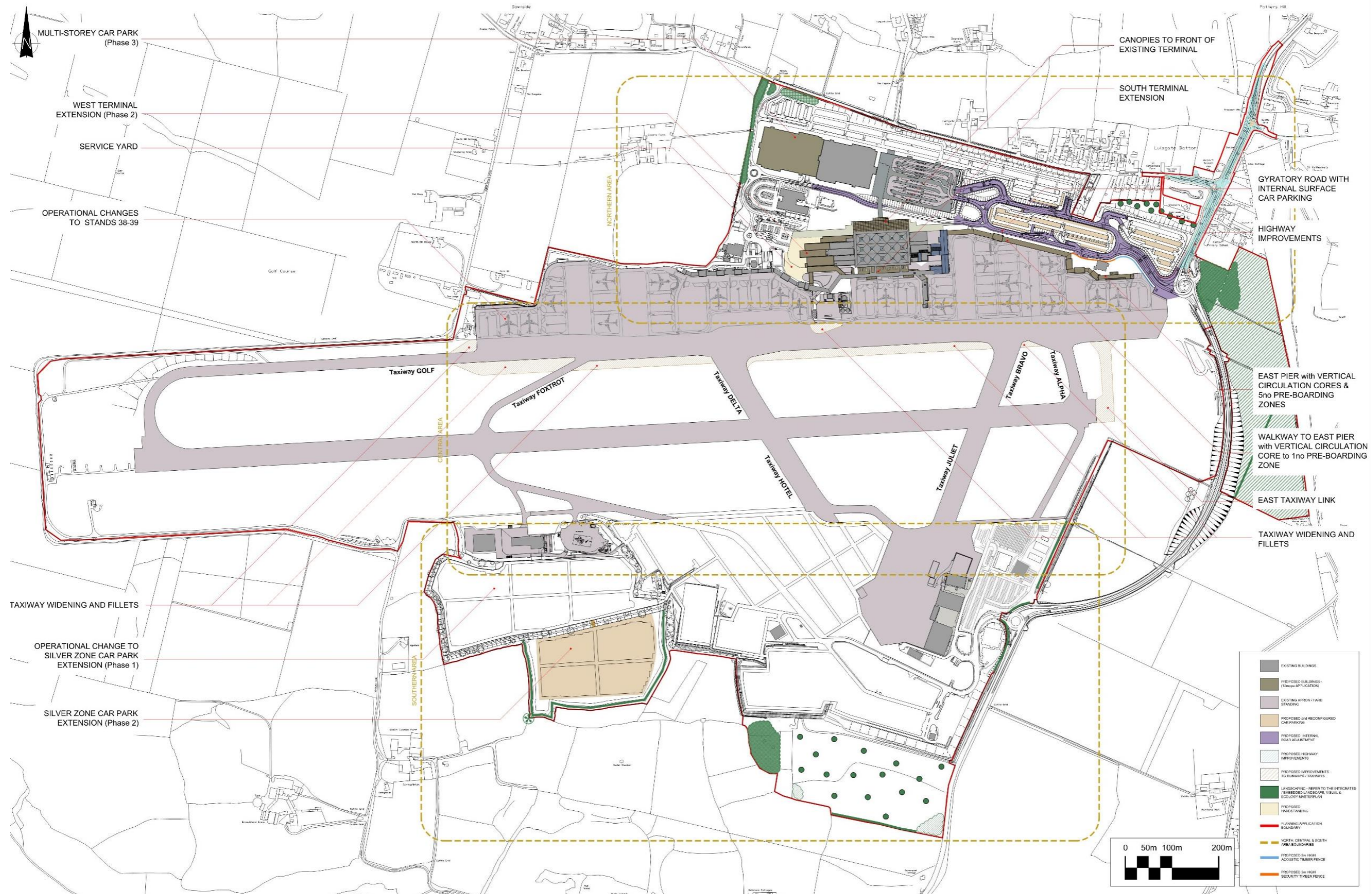


Figure 5: Bristol Airport 12MPPA extension masterplan.

Replacing the older SON or halogen floodlights in this area will provide an energy saving element, and carbon reduction. Newer LED luminaires are also highly directional, so obtrusive light spilling into unwanted areas is reduced.

A 5m tall acoustic fence separates the East Pier from the main entrance of the site. The fence will aid in reducing horizontal light spill from the area.

Following the calculations, the site has been deemed to have a Minor Adverse effect on the surrounding area. The taller height of the masts means that the airport buildings will not shield these luminaires from view. However, as the apron areas are presently lit with tall masts and floodlight luminaires, the perceived effect is only deemed minor.

Please see drawing 09194-HYD-XX-GF-DR-E-9012 in Appendix D for a detailed horizontal light spill calculation of the area.

#### 4.2.6 *Front of Existing Terminal*

The site proposes to construct new canopies to the front of the existing terminal building.

The residual effects of this development are deemed to be Minor Beneficial. The site survey indicated various forms of lighting in and around this area which will no longer be required as passengers will travel within internal circulations. Therefore, current illuminance levels due to wayfinding bollards and column luminaires at crossings will be reduced.

The canopies above the terminal entrance will also act to obstruct any upward lighting, reducing the upward light spill in this area and overall sky glow from the airport.

#### 4.2.7 *Multi-Storey Car Park*

The site proposes to construct an additional multi-storey carpark towards the North West of the site. It would house approximately an additional 2150 car parking spaces.

The site survey indicated that the current multi-storey car park does not create obtrusive light along Downside Road due to the screening from thick foliage. Due to this, it is likely that foliage will also screen light spill from the proposed multi-storey car park onto Downside Road.

Therefore, the residual effects of this development are deemed to be neutral.

#### 4.2.8 *Gyratory Road*

The site proposes to construct a new gyratory road, with internal surface car parking located in the centre.

The residual effects of this development are deemed to be neutral. The site survey found that the existing column luminaires in this area are providing illuminance at current British Standards. Whilst the layout of the luminaires may change, the horizontal and vertical illuminance in this area will be retained.

Updated lighting proposals will also use more modern technology. The existing luminaires in this area use a mixture of SON and halogen lamps. The new column luminaires will use LED technology which is more energy efficient and able to direct light more effectively. Due to this, upward light spill is likely to be reduced.

Existing foliage to the north of the site will also shield any light spill into the adjacent dwellings located along Downside Road.

#### 4.2.9 *East Taxiway Link*

The site proposes to construct a new East Taxiway towards the eastern edge of the site.

The residual effects of this development are deemed to be neutral as the only lighting requirements for this area will be additional AGL fittings and visual signage to guide pilots. These lighting installations will not be visible outside of the airport boundary.

#### 4.2.10 *Silver Zone Car Park Extension*

The site looks to increase the Silver Zone Car Parking area by approximately 2700 spaces.

This area has been identified as an area which may contribute negative residual effects due to its location adjacent to unlit farmland. Detailed indicative lighting calculations have been undertaken to evaluate the impact on the area.

The area has been lit with 8m tall column luminaires with a CCT of 3000°K. Each lamp has a tilt of 0° and has been specifically designed to produce zero upward light in order to reduce the overall sky glow from the airport.

In accordance with BS EN 12464-1:2014 standards, the area has been lit to an average of 5 lux with 0.25 uniformity, assuming that it is a light use car park.

Vertical illuminance calculations have also been undertaken to assess the vertical light spill created by the development.

In accordance with the North Somerset and Mendip Bats Special Area of Conservation Guidance on Development SPD, the hedgerows surrounding the site must not be lit over 0.5 lux. Current planning conditions also require the perimeter of this site to not be lit above 1 lux. Drawing 09194-HYD-XX-GF-DR-E-9011 in Appendix D shows a detailed light spill calculation of the area, and states the maximum vertical illuminance measurements at 1m above ground. All calculated measurements are below 0.5 lux.

Figure 6 shows the vertical calculation points to the west of the airport. The calculation grid has been set up to calculate illuminance on a 5m x 5m grid and is located approximately 50m from the airport boundary. The maximum recorded measurement is 0.024 lux which is well within guidelines given in the ILP Guidance Notes for the Reduction of Obtrusive Light for a site located in an E2 environmental classification zone.

Figure 7 shows the vertical calculation points to the south of the airport. The calculation grid has been set up to calculate illuminance on a 5m x 5m grid and is located approximately 50m from the airport boundary. The maximum recorded measurement is 0.03 lux which is well within guidelines given in the ILP Guidance Notes for the Reduction of Obtrusive Light for a site located in an E2 environmental classification zone.

It is advised that the luminaires in these areas are fitted with Passive Infrared Sensors (PIRs). Not only would this provide an element of energy saving and carbon reduction, the luminaires would only be operated when needed. These controls will vastly reduce the overall perceived effect of lighting this area as individual sections will stay unlit unless necessary.

Following the calculations, the site is deemed to have a neutral effect on the surrounding area. Despite the new installation of luminaires in a location which is currently unlit, horizontal and vertical calculations demonstrate that no light spill shall reach the site boundary. This is in accordance with the North Somerset and Mendip Bats SAC guidelines. The use of PIRs will also keep the area lit to current lux levels at most times, with luminaires only being used to facilitate safe passage when the car parks are in use.

#### 4.2.11 *Highway Improvements*

The site proposes to widen the northern section of the A38 adjacent to Downside Road and leading to the main airport entrance.

The residual effects of this development are deemed to be neutral as the site survey found lighting levels in this area to be in line with current British Standards for roadways and junctions. Whilst the layout of the luminaires may change, the horizontal and vertical illuminance in this area will be retained.

This area is discussed further in section 4.3.4 in relation to the bat sensitive woodland.

#### 4.2.12 Taxiway Widening and Fillets

The site proposes to widen the Taxiway Golf area and introduce fillets.

The residual effects of this development are deemed to be neutral as the site survey found these areas to be lit to current British Standards and will not require any additional lighting.

#### 4.2.13 Operational Changes to Stands

The site proposes to update the stands in this area to reflect stands 33 to 36.

The residual effects of this development area deemed to be neutral as the site survey found existing illuminance levels to be within current British Standards and will not require any additional lighting.

#### 4.2.14 Operational Change to Silver Zone Car Park Extension

The Silver Zone car parking area is currently lit with a temporary lighting installation. It has been identified as an area that requires more detailed lighting calculations to evaluate the impact of the area.

The area has been lit with 8m tall column luminaires with a CCT of 3000°K. Each lamp has a tilt of 0° and has been specifically designed to produce zero upward light in order to reduce overall sky glow from the airport.

In accordance with BS EN 12464-1:2014 standards, the area has been lit to an average of 5 lux with 0.25 uniformity, assuming that it is a light use car park.

Vertical illuminance calculations have also been undertaken to assess the vertical light spill created by the development.

In accordance with the North Somerset and Mendip Bats Special Area of Conservation Guidance on Development SPD, the hedgerows surrounding the site must not be lit over 0.5 lux. Current planning conditions also require the perimeter of this site to not be lit above 1

lux. Drawing 09194-HYD-XX-GF-DR-E-9011 in Appendix D shows a detailed light spill calculation of the area, and states the maximum vertical illuminance measurements at 1m above ground. All calculated measurements are below 0.5 lux.

Figure 6 shows the vertical calculation points to the west of the airport. The calculation grid has been set up to calculate illuminance on a 5m x 5m grid and is located approximately 50m from the airport boundary. The maximum recorded measurement is 0.024 lux which is well within guidelines given in the ILP Guidance Notes for the Reduction of Obtrusive Light for a site located in an E2 environmental classification zone.

Figure 7 shows the vertical calculation points to the south of the airport. The calculation grid has been set up to calculate illuminance on a 5m x 5m grid and is located approximately 50m from the airport boundary. The maximum recorded measurement is 0.03 lux which is well within guidelines given in the ILP Guidance Notes for the Reduction of Obtrusive Light for a site located in an E2 environmental classification zone.

It is advised that the luminaires in these areas are fitted with Passive Infrared Sensors (PIRs). Not only would this provide an element of energy saving and carbon reduction, the luminaires would only be operated when needed. These controls will vastly reduce the overall perceived effect of lighting this area as individual sections will stay unlit until illumination is necessary.

Following the calculations, the site is deemed to have a Moderate Beneficial effect on the surrounding area. The site survey identified the current lighting in this area to be overly bright and producing high amounts of glare.

The indicative design would reduce the lumen output of individual luminaires, reducing the perceived effect of the area.

The use of PIRs would also mean that the area remains dark until illuminance is necessary.

Please see drawing 09194-HYD-XX-GF-DR-E-9011 in Appendix D for a detailed light spill calculation of the area.

[illegible]

Figure 6: Vertical illuminance calculations located approximately 50m west of the existing and proposed Silver Zone car parks.

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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Figure 7: Vertical illuminance calculations approximately 50m south of the existing and proposed Silver Zone car parks.

4.3 Impact on Sensitive Receptors

The impact of the extension proposals on each of the sensitive receptors as identified in section 3.4 have been evaluated.

4.3.1 Residences along Downside Road

The sites most likely to affect the residences are the proposed gyratory road and the additional multi-storey carpark.

The site survey indicated that Downside Road is currently not lit. Tall, thick foliage currently screens the residences from the airport site and survey measurements indicate that this area is dark.

The new gyratory road proposes to update the existing road layout within the northern car park areas.

Lighting proposals for this area should confirm to current British Standards, namely BS EN 12464-2 and BS 5489, and ILP Guidance Notes for the Reduction of Obtrusive Light.

The additional multi-storey car park proposes to construct an additional 2150 car parking spaces in the car park to the north west of the site.

The site survey indicated that the current multi-storey car park does not create obtrusive light along Downside Road due to the screening of foliage. Lighting proposals for the new multi-storey car park should conform to current British Standards, namely BS EN 12464-2 and BS 5489, and ILP Guidance Notes for the Reduction of Obtrusive Light.

The effect of the extension proposals on the residences along Downside Road is deemed negligible.

4.3.2 Residences along the A38

The site most likely to affect the residences is the proposed roadworks on the A38.

The site survey indicated that the A38 is lit to current British Standards. As such, whilst the

luminaire layout of the area may change, the lighting levels and obtrusive light created by the development will not be increased due to the development. Any new external lighting strategies in this area should conform to current British Standards, namely BS EN 12464-2 and BS 5489, and the ILP Guidance Notes for the Reduction of Obtrusive Light. In particular, proposals should ensure that any light intrusion into windows does not exceed 5 lux (pre-curfew) and 1 lux (post curfew).

The effect of the extension proposals on the residences along the A38 is deemed negligible.

4.3.3 The Mendip Hills AONB and Dark Farmland to the South and East of the site.

The sites most likely to affect the nearby AONB are the new east pier and the installation of lighting to the current and proposed Silver Zone car parks to the south of the site.

The perception of the airport lighting will be increased due to the increased number of luminaires; however, this increase is seen as minimal and therefore acceptable.

It is recommended that PIRs are fitted to the luminaires installed in the Silver Zone car parks, and retrofitted into the other southern car park areas, to ensure that the luminaires are only in operation when necessary. This will provide a beneficial perception difference to the airport lighting when viewed from the Mendip Hills AONB and dark agricultural land to the South and East of the site.

Therefore, the effect of the extension proposals on the Mendip Hills AONB and agricultural land to the South and East of the site is deemed minor and acceptable.

4.3.4 Light Sensitive Biodiversity

The woodland area at the A38 & Downside Road junction has been identified as an important bat habitat area.

Site survey readings of the area show that the current vertical illumination readings at

approximately 1.5m above ground along the woodland boundary are in the region of 1 to 5 lux.

Detailed calculations have been undertaken in this area to assess whether the woodland will be subject to further illumination from the A38 roadway changes.

The area has been lit with 10m tall column luminaires with a CCT of 3000°K. Each lamp has a tilt of 0° and has been specifically designed to produce zero upward light. The junction has been modelled in accordance with recommendations given in BS 5489-1:2013 - Code of Practice for the Design of Road Lighting.

Vertical illuminance calculations have also been undertaken to assess the vertical light spill created by the development.

The calculation grid has been set up to calculate illuminance on a 5m x 5m grid and is located along the woodland boundary. The maximum recorded measurement is 2.94 lux which is within the baseline maximum conditions of the site.

Following the calculations, the site is deemed to have a neutral effect on the surrounding area. This is due to the calculated lux levels of predicted lighting being within the same approximate levels recorded on the site survey. In accordance with the North Somerset and Mendip Bats SAC recommendations, the predicted light levels do not exceed baseline light levels.

Please see drawing 09194-HYD-XX-GF-DR-E-9011 in Appendix D for a detailed light spill calculation of the area.

The agricultural land to the south of the site has also been identified as an important bat habitat.

As previously discussed in sections 4.2.11 and 4.2.15, detailed calculations have been undertaken in this area to predict whether the Silver Zone car park proposals will impact the

light sensitive biodiversity in this area. Calculations confirmed that the boundary of the site will not be lit over 0.5 lux, and therefore, in accordance with the North Somerset and Mendip Bats SAC recommendations, these sites will not affect any existing or future habitats.

4.4 Conclusion

All sites included in the extension proposals have been evaluated to assess the residual effects that the extension will have due to updated lighting proposals.

Table 7 below summarises the residual effects of the extension proposals.

Area	Residual Effect
South Terminal Extension	Neutral
West Terminal Extension	Neutral
Service Yard	Neutral
Walkway to East Pier	Neutral
East Pier	Minor Adverse
Front of Existing Terminal	Minor Beneficial
Multi-Storey Car Park	Neutral
Gyratory Road	Neutral
East Taxiway Link	Neutral
Silver Zone Car Park Extension	Neutral
Highway Improvements to A38	Neutral
Taxiway Widening and Fillets	Neutral
Operational Changes to Stands	Neutral
Operational Changes to Silver Zone Car Parking	Moderate Beneficial

Table 7: Summary of residual effects.

The East Pier proposals have been deemed to have a Minor Adverse effect on the surrounding area. The following mitigation methods should be adopted to ensure that the external lighting proposals in all areas reduce obtrusive lighting as much as possible.

#### 4.4.1 *Recommendations for All External Lighting Proposals*

The following principals should be adopted when designing external lighting proposals for the 12MPPA extension:

- The use of directional, LED lamps is recommended to both save energy and ensure that light is only directed to the required areas;
- Cowls, shields or hoods could be fitted to luminaires to limit light spill into unwanted areas.
- Proposed luminaires should, where possible, have a 0° tilt and be designed to have a ULR of <5%;
- Within existing car park areas to the south of the site, it is recommended that these luminaires are fitted with Passive Infrared Sensors (PIRs). This will serve to save energy, reduce carbon consumption and ensure that illuminance is only provided when necessary, reducing the perceived effect of the areas;
- A range of lamp Correlated Colour Temperatures (CCTs) were found on site, ranging from < 2,700 K to 4,000 K. It is recommended that any new fittings use a similar colour temperature to create continuity throughout the site. A warm white such as 3,000 K is recommended to create a warm, welcoming environment and reduce the emission of white and blue wavelengths of the light spectrum. In airside operational areas, a CCT of 4000°K or above may be required; and
- The site already benefits from landscape screening to the south of the airport boundary. Further woodland planting and around the edges of the site can help mask the light spill from the external lighting, and improve the ecology of the site.

## Appendix A: Glossary of Terms

### Atmospheric Conditions

The amount of particle pollution and presence of moisture and other gases in the atmosphere. Light is scattered by the particles and that coming back to an observer below causes the veiling impact of Sky Glow.

### Aura

Localised halo of light above a lit area, caused by direct upward light or reflections from the ground and other surfaces. More obvious where light units are grouped relatively close together and / or of high power.

### Ballast

Ballast is located internally within a luminaire and forms part of the lighting control gear. The ballast regulates the light output of the luminaire.

### Curfew

The time after which stricter requirements (for the control of obtrusive light) will apply. Often a condition of use of lighting applied by the local planning authority.

### Colour Rendering Index (CRI)

Ability of a light source to match colours in comparison with a full spectrum light source such as daylight or a tungsten lamp. On a scale of 0 – no colour matching, to 100 – full colour matching.

### Environmental Zone (E0 – E4)

A classification method developed by the ILP to match appropriate lighting controls to the local environment:

- An E0 Zone is UNESCO Starlight Reserve, IDA Dark Sky Parks etc.;
- E1 Zone is an intrinsically dark landscape;
- E2 Zone as low district brightness;
- E3 Zone is medium district brightness; and
- E4 Zone is a City Centre location.

### LED

Light emitting diode.

### Lighting Illuminance

The illuminance or light level is the amount of light energy reaching a given point on a defined surface area, namely the luminous flux (i.e. lumens) per square meter. Illuminance is measured in lux.

### Lux

The lux is the unit of illuminance and luminous emittance, measuring luminous flux per unit area. It is equal to one lumen per square meter. In photometry, this is used as a measure of the intensity, as perceived by the human eye, of light that hits or passes through a surface.

### Sky Glow

Wide area of night sky scattering direct and indirect upward light back to an observer. Depends on atmospheric conditions and the amount of upward light. Very typical above urban areas.

### SON

High-pressure sodium discharge lamp. Typically golden orange light or whiter light, but more modern versions available in a ‘whiter’ output. Very poor CRI of approximately 25.

### SOX

Low pressure sodium discharge lamp. Orange light, essentially monochromatic, identifying only yellow colour with all others rendered as shades of grey. CRI 0.

### ULOR

Upward light ratio output.

### Uniformity (U<sub>o</sub>)

The uniformity of illumination is the lowest calculated illuminance and the average illuminance of the working plane. Uniformity is calculated to ensure the lighting design provides a uniform illuminance in line with the required standards.

## Appendix B: Photographic survey evidence



Figure 8: View of Airport Buildings (right) and southern car parks (left) from the A38.

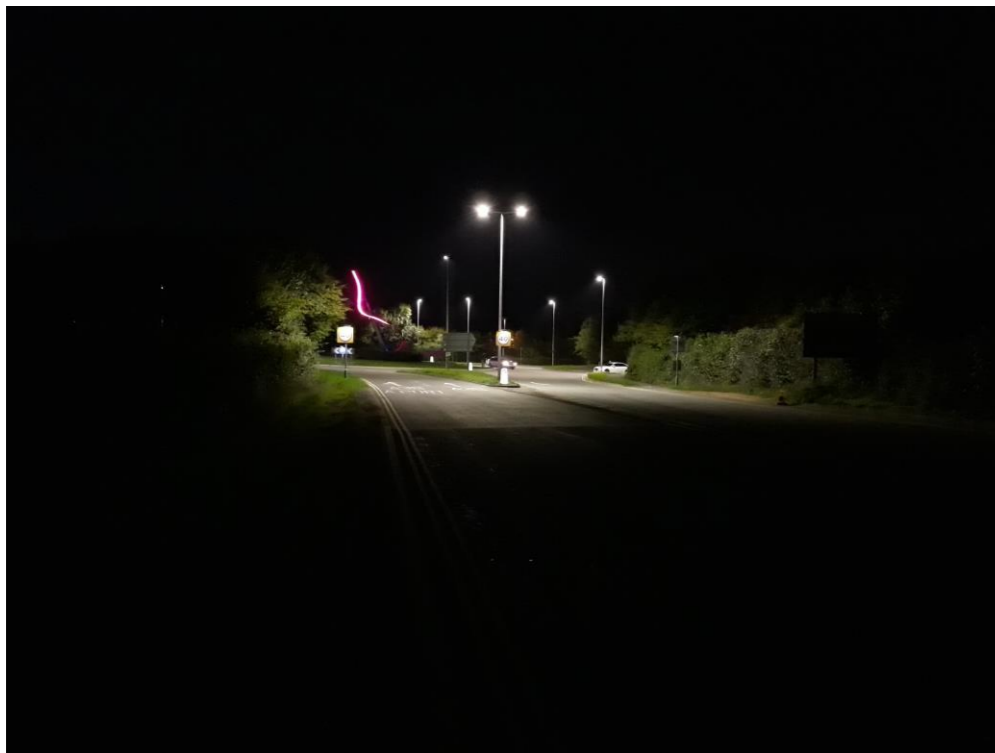


Figure 9: The northern roundabout located on the A38.



Figure 10: Northern car park showing difference in colour temperature of column luminaires.



Figure 11: Light spill from current multi-storey car park in the northern car park area.

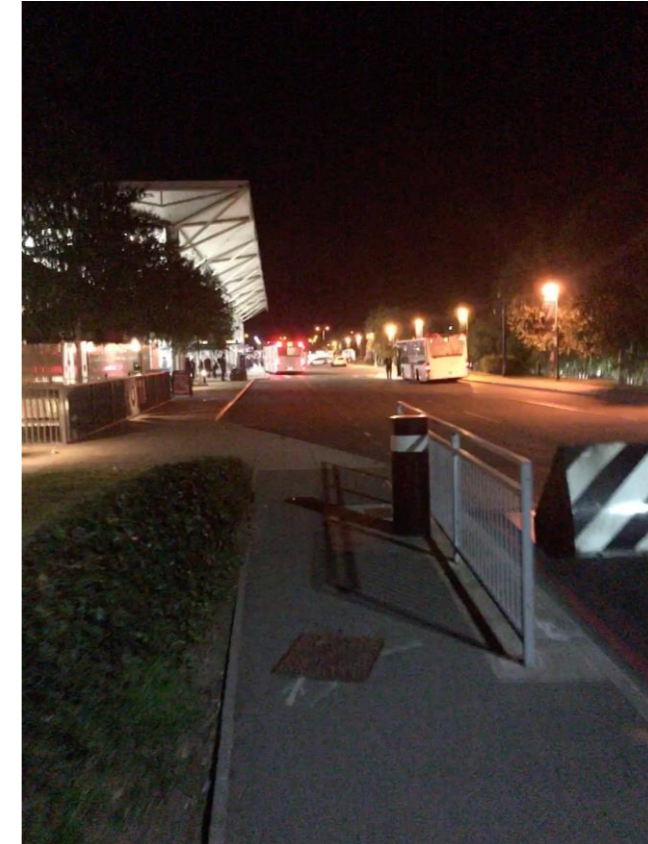


Figure 12: Entrance to terminal building.



Figure 13: Column luminaires located in northern car park.



Figure 16: High mast floodlighting in apron areas.



Figure 14: Apron area and runway.



Figure 15: View of southern car parks from runway.



Figure 17: View of Hampton Hotel car park.

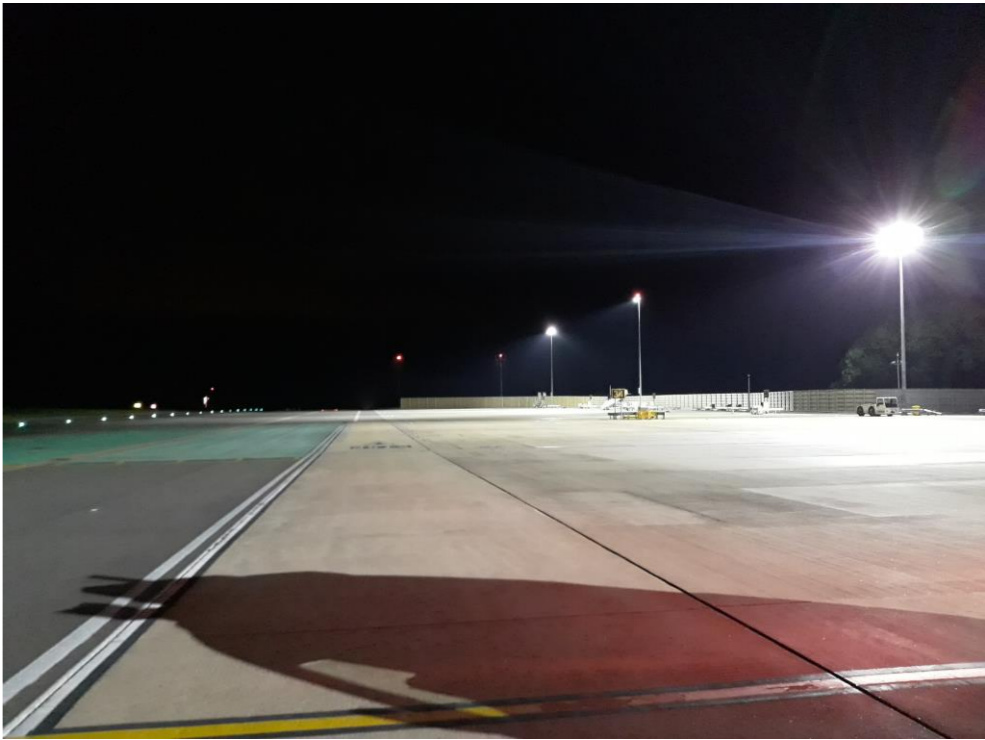


Figure 18: Stands located in apron areas - high mast floodlighting.



Figure 19: Southern car park column luminaires.



Figure 20: View of airport buildings from Bristol Flying Centre.

*Appendix C: Baseline Survey  
Measurements*



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Architect :  
**TODD ARCHITECTS**



2nd Floor  
11-12 Queens Square  
Bristol  
BS1 4NT  
0117 945 9225  
bristolcentral@hydrock.com  
hydrock.com

Client :  
**BRISTOL AIRPORT**

Project Title:  
**BRISTOL AIRPORT  
12MPPA EXTENSION  
DRAWING KEY**

Drawing Title:  
**ELECTRICAL SERVICES  
BASELINE LIGHT SURVEY  
ILLUMINANCE MEASUREMENTS**

Drawing Status:  
**PRELIMINARY**

Hydrock Job No: **C-09194**

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Architect :  
TODD ARCHITECTS

**Hydrock**

2nd Floor

11-12 Queens Square

Bristol

BS1 4NT

0117 945 9225

BristolCentral@hydrock.com

hydrock.com

Client :  
BRISTOL AIRPORT

Project Title:  
BRISTOL AIRPORT  
12MPPA EXTENSION  
SOUTH WEST OF SITE

Drawing Title:  
ELECTRICAL SERVICES  
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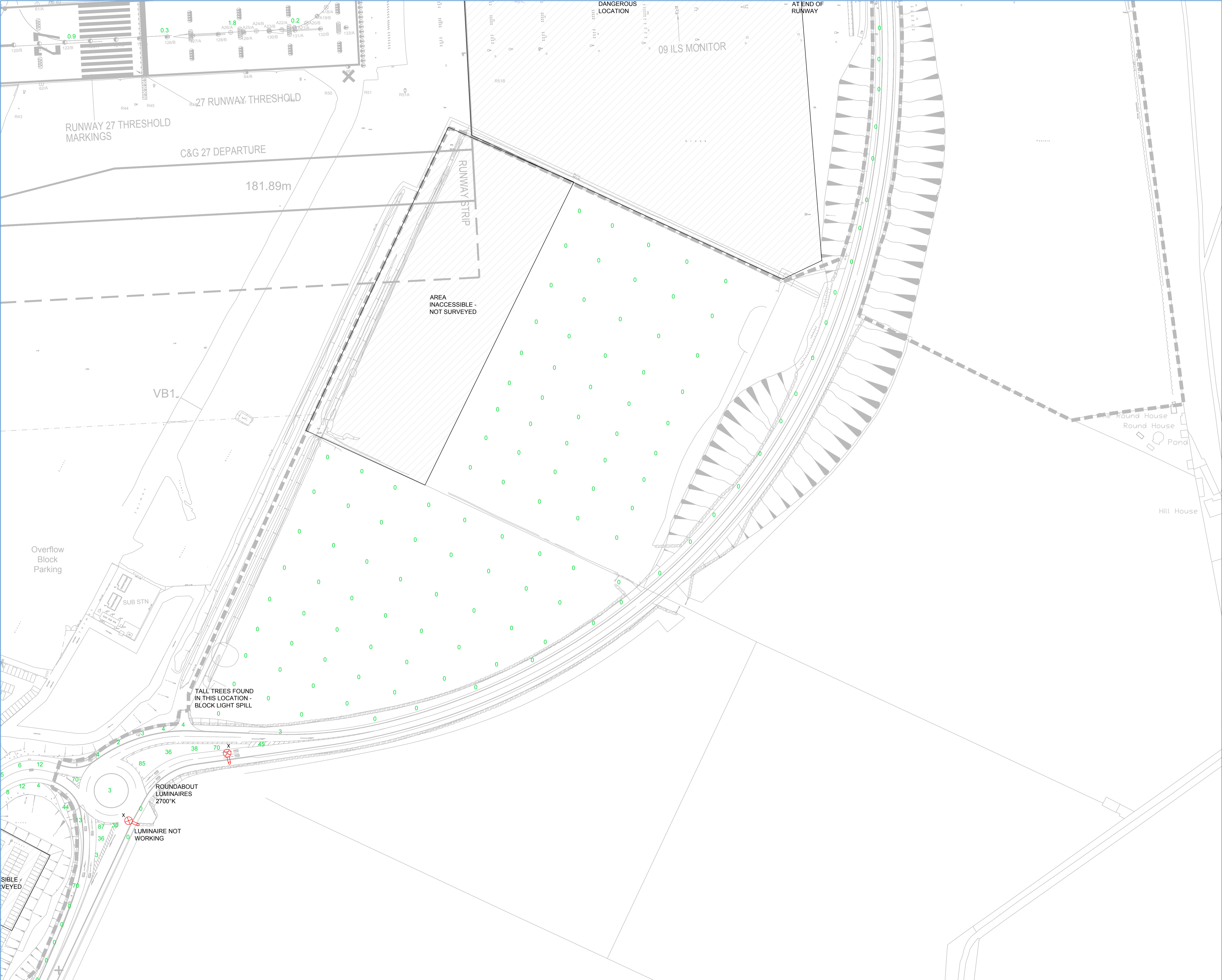
Project Title:  
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Architect :  
**TODD ARCHITECTS**



2nd Floor  
11-12 Queens Square  
Bristol  
BS1 4NT  
0117 945 9225  
bristolcentral@hydrock.com  
hydrock.com

Client :  
**BRISTOL AIRPORT**

Project Title:  
**BRISTOL AIRPORT  
12MPPA EXTENSION  
SOUTH EAST OF SITE**

Drawing Title:  
**ELECTRICAL SERVICES  
BASELINE LIGHT SURVEY  
ILLUMINANCE MEASUREMENTS**

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