Net Zero Teesside Project

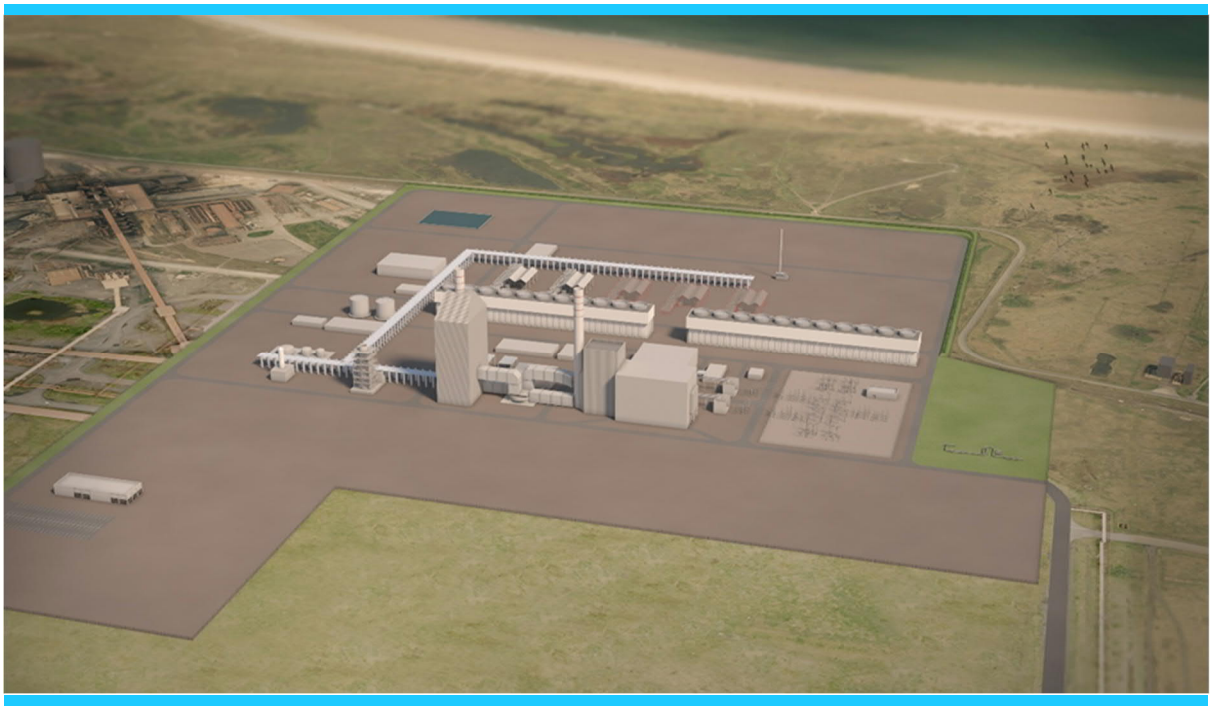
Planning Inspectorate Reference: EN010103

Land at and in the vicinity of the former Redcar Steel Works site, Redcar and in Stockton-on-Tees, Teesside

The Net Zero Teesside Order

Document Reference: 5.11 Indicative Lighting Strategy

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 – Regulation 5(2)(q)



Applicants: Net Zero Teesside Power Limited (NZT Power Ltd) & Net Zero North Sea Storage Limited (NZNS Storage Ltd)

Date: October 2021

DOCUMENT HISTORY

Document Ref	5.11 Indicative Lighting Strategy		
Revision	2.0		
Author	AECOM Various		
Signed		Date	October 2021
Approved By	R. Lowe		
Signed		Date	October 2021
Document Owner	AECOM Ltd		

GLOSSARY

Abbreviation	Description
AGI	Above Ground Installation
ANO	Air Navigation Order
BS	British Standard
CAA	Civil Aviation Authority
CEMP	Construction Environmental Management Plan – a plan to outline how a construction project will avoid, minimise or mitigate effects on the environment and surrounding area.
CIBSE	The Chartered Institute of Building Services Engineers
CIE	Commission Internationale de L'Eclairage
curfew	The time after which stricter requirements (for the control of obtrusive light) will apply; often a condition of use of lighting applied by a government controlling authority, usually the local government
DCLG	Department for Communities and Local Government
DCO	Development Consent Order
E	Illuminance – The quantity of light, or luminous flux falling on a unit area of a surface in Lux (lx). One Lux is equivalent to one lumen per square metre
Eh	Horizontal Illuminance in Lux (lx)
EIA	Environmental Protection Act
Em	Minimum average illuminance in Lux
EN	European
EPA	Environmental Protection Act
EPC	Engineering, procurement and construction

Abbreviation	Description
ES	Environmental Statement – A report in which the process and results of an Environment Impact Assessment are documented.
Ev	Ev = Average Vertical Illuminance in Lux (lx)
Glare	A sensation that is produced by bright areas within the field of vision and may be experienced either as discomfort glare or disability glare. Glare caused by reflections in specular surfaces is usually known as veiling reflections or reflected glare
HGV	Heavy goods vehicle
I	Light Intensity in Candelas (cd)
ILP	The Institute of Lighting Professionals
L	Luminance in Candelas per square metre (cdm-2)
lx	the SI unit of illuminance, equal to one lumen per square meter.
LG	Lighting Guide
Lv	Veiling Luminance – A measure of the loss of visibility caused by the disability glare from the obtrusive light installation
NPPF	National Planning Policy Framework
NSIP	Nationally Significant Infrastructure Project – defined by the Planning Act 2008 and cover projects relating to energy (including generating stations, electric lines and pipelines); transport (including trunk roads and motorways, airports, harbour facilities, railways and rail freight interchanges); water (dams and reservoirs, and the transfer of water resources); waste water treatment plants and hazardous waste facilities. These projects are only defined as nationally significant if they satisfy a statutory threshold in terms of their scale or effect.
NZT	Net Zero Teesside
Photocell	A light sensing device used for switching/controlling luminaires
PINS	Planning Inspectorate
Ra	Colour rendering measures the light source's ability to render colours correctly and is graded from 0-100. 8 colours act as controls against a pre-defined light source
RGL	Glare Rating Limit – A metric used for the assessment of glare
SLL	Society of Light and Lighting

Abbreviation	Description
TI	Threshold Increment
ULR	Upward Lighting Ratio of the installation – the maximum permitted percentage of luminaire flux that goes directly into the sky. This metric is often used as a measure of 'sky-glow'
U°	Uniformity In order to perform visual tasks in illuminated areas, there should not be any great differences in brightness so that uniformity should not fall below U° = Emin/Ē
Veiling Luminance	(Lv) A measure of disability glare, superimposed over the eye's retinal image that is produced by stray light within the eye

TABLES

FIGURES

1.0 EXECUTIVE SUMMARY

1.1.1 This Indicative Lighting Strategy document discusses the type and level of lighting requirements for the construction and operational phases of the proposed Net Zero Teesside Project ('NZT') (herein referred to as ('The Proposed Development'). An overview of the Proposed Development and site location is included in Section 2.0.

1.1.2 Section 3.0 provides a review of the relevant lighting standards and guidance. It discusses the legislative background on light pollution, the planning policy context in national policy statements and the National Planning Policy Framework, before discussing international and national guidance available on limiting light pollution, with reference to the Institute of Lighting Professionals' lighting limits.

1.1.3 Section 4.0 discusses the lighting standards and guidance on limiting light levels, with reference to the lighting requirements outlined in British Standards Institute BS EN 12464-2:2014. A summary of other guidance and reference documents is also discussed.

1.1.4 Section 5.0 outlines the sensitive receptors to light at the Site and surrounding area, including residential, road, rail and ecological – these are presented on Figure 1 for ease of reference.

1.1.5 Section 6.0 provides an overview of the obtrusive light level limits that will be followed to minimise light spill to each of the receptor categories outlined in Section 5.0. Sections 7.0 and 8.0 then discusses the Site lighting requirements for the construction and operational phases of the Proposed Development, respectively. A number of indicative impact avoidance measures are outlined in Section 9.0, which are to be adopted as good lighting design practice. Details will be confirmed at the detailed design stage.

1.1.6 In summary it is concluded that the Indicative Lighting Strategy provides an appropriate outline of the lighting requirements for the Proposed Development as part of the Application, and identifies measures which will be employed as required and which will adequately control obtrusive light through detailed design of the lighting scheme. The controls are secured through a requirement in the Draft DCO (Document Ref. 2.1).

2.0 INTRODUCTION

2.1 Overview

2.1.1 This Indicative Lighting Strategy (Document Ref. 5.11) has been prepared on behalf of Net Zero Teesside Power Limited and Net Zero North Sea Storage Limited (the 'Applicants'). It forms part of the application (the 'Application') for a Development Consent Order (a 'DCO'), that has been submitted to the Secretary of State (the 'SoS') for Business, Energy and Industrial Strategy ('BEIS'), under Section 37 of 'The Planning Act 2008' (the 'PA 2008').

2.1.2 The Applicants are seeking development consent for the construction, operation and maintenance of the Net Zero Teesside Project ('NZT'), including associated development (together the 'Proposed Development') on land at and in the vicinity of the former Redcar Steel Works site, Redcar and in Stockton-on-Tees, on Teesside (the 'Site'). The former Steel Works site, along with other land required for the Proposed Development, lies within the boundary of the land controlled by the South Tees Development Corporation ('STDC'), which is now known as 'Teesworks'.

2.1.3 A DCO is required for the Proposed Development as it falls within the definition and thresholds for a 'Nationally Significant Infrastructure Project' (a 'NSIP') under Sections 14(1)(a) and 15 of the PA 2008, associated development under Section 115(1)(b) and by direction under Sections 35(1) and 35ZA of the same Act. The DCO, if made by the SoS, would be known as the 'Net Zero Teesside Order' (the 'Order').

2.1.4 The Proposed Development will be the UK's first commercial scale, full chain Carbon Capture, Usage and Storage project and will initially capture up to 4 million tonnes (Mt) of carbon dioxide (CO_2) emissions per annum. It will comprise a number of elements, including a new gas-fired Electricity Generating Station with post-combustion carbon capture plant; gas, water and electricity connections (for the generating station); a CO_2 pipeline network (a 'gathering network') for collecting CO_2 from a cluster of local industries on Teesside; a CO_2 compressor station (for the compression of the CO_2) and a CO_2 export pipeline.

2.1.5 The CO_2 captured from the Electricity Generating Station and local industries will be compressed and then transported (via the export pipeline) for secure storage within the Endurance saline aquifer located 145 kilometres offshore from Teesside under the North Sea. The export pipeline has the capacity to carry up to 10Mt of CO_2 per annum. The Proposed Development will therefore make a significant contribution toward the UK reaching its greenhouse gas emissions target by 2050.

2.2 The Applicants

2.2.1 NZT encompasses proposals to both decarbonise electricity generation and a cluster of carbon intensive industries on Teesside. In line with the CCUS business models published by BEIS in December 2020, there will be separate entities who will be responsible for:

- electricity generation with post-combustion carbon capture (including the gas, water and electricity connections);

- CO_2 gathering (from industrial emitters), CO_2 compression and CO_2 export and storage; and
- industrial (including hydrogen production) carbon capture and connections to the CO_2 gathering network.

2.2.2 The entities are set out in Table 2-1 below:

Table 2-1: NZT Entities

Onshore works scope	Partnership	NZT Entity	Within the scope of the DCO Application?
Electricity Generating Station with post-combustion carbon capture (including the gas, water and electricity connections)	bp*, Eni, Equinor and Total	Net Zero Teesside Power Limited	Yes
CO_2 gathering network, CO_2 compression and the onshore section of CO_2 export pipeline	bp*, Eni, Equinor, National Grid, Shell and Total	Net Zero North Sea Storage Limited	Yes
Industrial and hydrogen production carbon capture and connection to the CO_2 gathering network	Individual industrial emitters	N/A	No

*Operator on behalf of the relevant Partnership

2.2.3 NZT is being promoted by Net Zero Teesside Power Limited ('NZT Power') and Net Zero North Sea Storage Limited ('NZNS Storage'). NZT Power and NZNS Storage (together the Applicants for the purposes of the DCO Application) have been incorporated on behalf of bp as operator of the two Partnerships.

2.2.4 The electricity generation with post-combustion carbon capture Partnership comprises bp, Eni, Equinor and Total, with bp leading as operator. NZT Power will be responsible for the Proposed Development in so far as it relates to the construction, operation and eventual decommissioning of the Electricity Generating Station together with its carbon capture plant (both within the scope of the DCO Application).

2.2.5 The CO_2 gathering network, CO_2 compression and onshore section of CO_2 export pipeline Partnership comprises bp, Eni, Equinor, National Grid, Shell and Total, with bp leading as operator. NZNS Storage will be responsible for the Proposed Development in so far as it relates to the construction, operation and eventual decommissioning of the equipment required for the high-pressure compression of CO_2 from the electricity generating station and industrial emitters via the CO_2

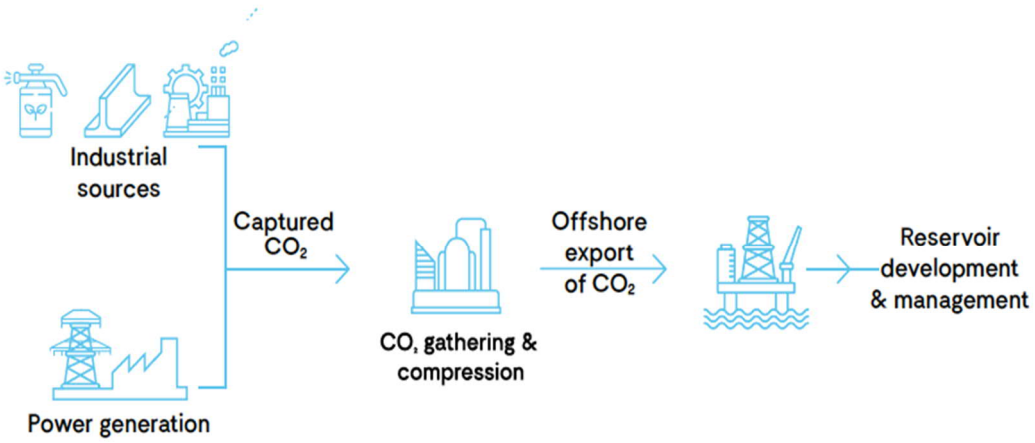
gathering network and the onshore section of the CO_2 export pipeline (these are all within the scope of the DCO Application).

2.2.6 NZNS Storage will also be responsible for the offshore elements of NZT, comprising the offshore section of the CO_2 export pipeline (below Mean Low Water Springs ('MLWS')) to a suitable offshore geological CO_2 storage site under the North Sea, CO_2 injection wells and associated infrastructure. The offshore elements of NZT (with the exception of the gas and CO_2 pipeline crossings of the River Tees and the water outfall from the Electricity Generating Station) do not form part of the DCO Application.

2.3 What is Carbon Capture, Usage and Storage?

2.3.1 Carbon Capture, Usage and Storage ('CCUS') is a process that removes CO_2 emissions at source, for example emissions from an Electricity Generating Station or industrial installation, and then compresses the CO_2 so that it can be safely transported to secure underground storage sites. It is then injected into layer of solid rock filled with interconnected pores where the CO_2 becomes trapped and locked in place, preventing it from being released into the atmosphere. Figure 2.1 below shows what is involved in the process.

Figure 2.1: CCUS Process



2.3.2 The technologies used in CCUS are proven and have been used safely across the World for many years. Storage sites are located several kilometres underground and are subject to stringent tests to ensure that they are geologically suitable. In the UK, it is expected that the storage sites will be located offshore, in areas such as the North Sea.

2.3.3 CCUS is one of a number of technologies that are crucial to reducing CO_2 emissions and combatting global warming. The UK Government has committed to achieving 'Net Zero' in terms of greenhouse gas emissions by 2050. This is a legally binding target.

2.4 The Site

2.4.1 The Site lies within the administrative boundaries of both Redcar and Cleveland Borough Council and Stockton-on-Tees Borough Council. It also partly lies within the boundary of the Teesworks area that is controlled by the STDC.

2.4.2 Most of the Site lies within the administrative area of Redcar and Cleveland Borough Council, although parts of Site (for the Electricity Generating Station's gas supply connection to the National Transmission System for gas and the CO_2 gathering network) cross the River Tees into the administrative area of Stockton-on-Tees Borough Council. At this location, the River Tees is tidal. In addition, there are elements of the Site which extend into South Gare, Coatham Sands and the North Sea. Those sections of the Site that are below MLWS are outside the jurisdiction of either local authority being part of the UK marine area.

2.4.3 The Site extends to approximately 462 hectares ('ha') in area. Much of it comprises previously developed (including part of the former Redcar Steel Works Site) and existing industrial land, some of which was reclaimed from the Tees Estuary in the late C19th and during the C20th. The Site is relatively flat and low-lying and sits at a level of between sea level and approximately 9 metres Above Ordnance Datum ('AOD'). The area surrounding the Site is largely characterised by industrial and commercial uses, although there are open areas of land to the north in the form of South Gare and Coatham Sands, which are used for recreational purposes and that are of nature conservation importance.

2.4.4 A more detailed description of the Site and its surroundings is provided at Chapter 3 'Description of the Existing Environment' in the Environmental Statement ('ES') Volume I (Document Ref. 6.2).

2.5 The Proposed Development

2.5.1 The Proposed Development will work by capturing CO_2 from the Electricity Generating Station in addition to a cluster of local industries on Teesside and transporting it via a CO_2 export pipeline to the Endurance saline aquifer under the North Sea. The Proposed Development will initially capture and transport up to 4Mt of CO_2 per annum, although the CO_2 export pipeline has the capacity to accommodate up to 10Mt of CO_2 per annum thereby allowing for future expansion.

2.5.2 The Proposed Development comprises the following elements:

- a combined cycle gas turbine ('CCGT') Electricity Generating Station with an electrical output of between 750 and 860 megawatts and post-combustion carbon capture plant;
- cooling water, gas and electricity grid connections and infrastructure for the Electricity Generating Station;
- a CO_2 gathering network (including connections under the tidal River Tees) to collect and transport the captured CO_2 from industrial emitters to a CO_2 compressor station (the industrial emitters using the gathering network will be responsible for consenting their own carbon capture plant and connections to the gathering network);

- a high-pressure CO_2 compressor station to receive and compress the captured CO_2 from the Electricity Generating Station and gathering network before it is transported offshore; and
- a dense phase CO_2 export pipeline for the onward transport of the captured and compressed CO_2 to the Endurance saline aquifer under the North Sea.

2.5.3 The Electricity Generating Station, its post-combustion carbon capture plant and the CO_2 compressor station will be located on part of the STDC Teesworks area (on part of the former Redcar Steel Works Site). The CO_2 export pipeline will also start in this location before heading offshore. The Electricity Generating Station connections and the CO_2 gathering network will require corridors of land within both Redcar and Stockton-on-Tees, including crossings beneath the River Tees.

2.5.4 All of the above elements are included in the scope of the DCO Application, with the exception of the CO_2 export pipeline, where only the onshore section of pipeline above MLWS is included. The CO_2 export pipeline below MLWS and the CO_2 storage site under the North Sea (the Endurance saline aquifer) will be the subject of separate consent applications, including under the Petroleum Act 1998 and the Energy Act 2008. These applications will be supported by an Offshore Environmental Statement.

2.5.5 The ancillary development required in connection with and subsidiary to the above elements of the Proposed Development is detailed in Schedule 1 of the draft DCO (Document Ref. 2.1). A more detailed description of the Proposed Development is provided at Schedule 1 'Authorised Development' of the draft DCO and Chapter 4 ‘The Proposed Development’ in (ES Volume I, Document Ref. 6.2) and the areas within which each of the main elements of the Proposed Development are to be built are denoted by the coloured and hatched areas on the Works Plans (Document Ref. 4.4).

2.6 The Purpose and Structure of this Document

2.6.1 The Proposed Development will require the installation of a number of luminaires to provide visual comfort, safety and operational performance, which in turn will have the potential to result in obtrusive light at receptor locations.

2.6.2 At the time of submission of the Application, the engineering, procurement and construction contractor has not been appointed and detailed design work for the Proposed Development has not been carried out. Therefore, detailed information on the lighting to be used at the Proposed Development is not yet available. Nevertheless, it is recognised that to prevent potential nuisance from lighting, the Application should set out general proposals as to the purposes, types and levels of lighting required, to allow an appropriate level of control to be secured within the DCO. In addition, the environmental impact assessment (in particular the landscape and visual, and ecology assessments) assume that the measures to reduce obtrusive light at receptor locations as set out within this document are in place.

2.6.3 The Indicative Lighting Strategy is structured as follows:

- information on pertinent standards and guidance relating to obtrusive lighting and lighting design are outlined in Section 3.0 and 4.0;
- a description of the type and location of the light sensitive receptors in relation to the Proposed Development are presented in Section 5.0;
- obtrusive light limits for the operational phase of the Proposed Development are defined in Section 6.0;
- lighting requirements for the construction and operational phases of the Proposed Development are discussed in Sections 7.0 and 8.0;
- proposed measures to avoid obtrusive light impacts are summarised in Section 9.0; and
- Section 10.0 provides a summary and conclusions.

3.0 OBTRUSIVE LIGHT STANDARDS AND GUIDANCE

3.1 Definition of Obtrusive Light

3.1.1 Obtrusive Light, whether it keeps someone awake through a bedroom window or impedes their view of the night sky, 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.

3.1.2 Obtrusive light (sometimes referred to as light pollution) may be thought of as having three direct components; and are all forms of obtrusive light which may cause nuisance to others, adversely affect fauna and flora and waste money and energy. The three components of obtrusive light are as outlined below and illustrated on Plate 3.1, adapted from Figure 1 of Guidance Note 01: Guidance notes for the Reduction of Obtrusive Light produced by the Institute of Lighting Professionals, Ref. 1):

- Sky glow - light that contributes to the brightening of the night sky;
- Glare – the uncomfortable brightness of a light source when viewed against a darker background; and
- Light intrusion – the spilling of light beyond the boundary of the property or area being lit.

Plate 3.1 Types of Intrusive Light (adapted from Figure 1 in ILP, 2020 guidance)

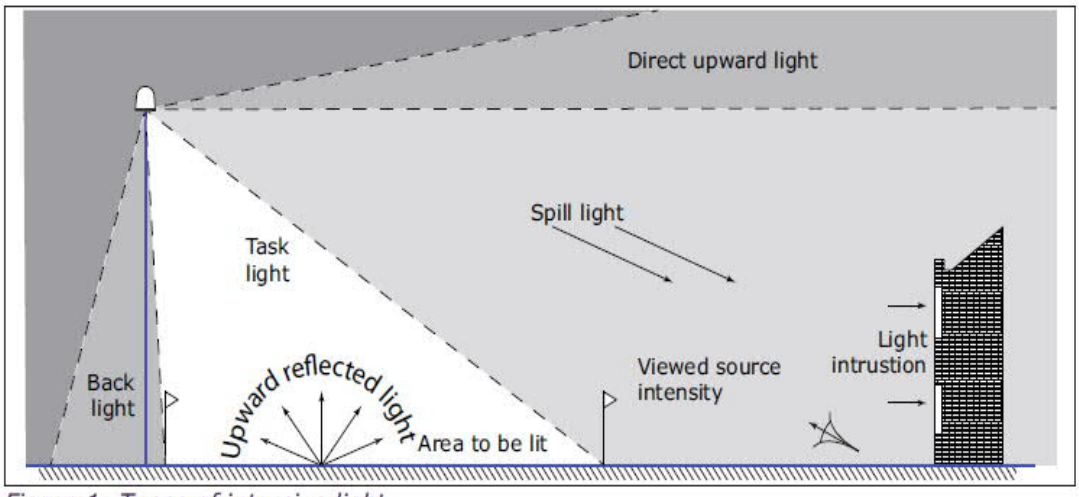


Figure 1: Types of intrusive light

3.2 Legislative Background

3.2.1 Light pollution was introduced within the Clean Neighbourhoods and Environment Act 2005 (Ref. 2) as a form of statutory nuisance under the Environmental Protection Act 1990 ('the EPA', Ref. 3) which was amended in 2006 to include the following nuisance definition:

> *"(fb) artificial light emitted from premises so as to be prejudicial to health or nuisance"*

3.2.2 Although light is described as having the potential to cause statutory nuisance (see also the Statutory Nuisance Statement (Document Ref. 5.9)), no prescriptive limits or rules were set for impact assessment purposes. ILP guidance GN01/20 (Ref. 1) has, therefore, been referred to for the purposes of this assessment.

3.2.3 Guidance produced by Department for Environment, Food and Rural Affairs (DEFRA, 2006) within the document Statutory Nuisance from Insects and Artificial Light on Section 101 to Section 103 of the Clean Neighbourhoods and Environment Act 2005 (Ref. 4) has also been referred to, which places a duty on local authorities to ensure that 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 reoccur, local authorities must issue an abatement notice (in accordance with Section 80(2) of the EPA 1990, Ref. 3), requiring that the nuisance cease or be abated within a set timescale.

3.2.4 It is a requirement of the Conservation of Habitats and Species Regulations 2017 (as amended) ('the Habitats Regulations') (Ref. 5) that plans, and projects are subject to an Appropriate Assessment if it is likely that they will lead to significant adverse effects on a Natura 2000 site (the collective name for European designated sites).

3.3 Planning Policy Context

National Policy Statement

3.3.1 The Overarching National Policy Statement (NPS) for Energy (EN-1) (Department of Energy and Climate Change, 2011) (Ref. 6) reference states in section 5.6.4:

- *"'The applicant should assess the potential for artificial light to have a detrimental impact on amenity, as part of the Environmental Statement.*
  - *In particular, the assessment provided by the applicant should describe:*
  - *the type, quantity and timing of emissions;*
  - *aspects of the development which may give rise to emissions;*
  - *premises or locations that may be affected by the emissions;*
  - *effects of the emission on identified premises or locations; and*
  - *measures to be employed in preventing or mitigating the emissions."*

and

"The IPC [now Secretary of State] should satisfy itself that:

- *an assessment of the potential for artificial light…to have a detrimental impact on amenity has been carried out; and*
- *that all reasonable steps have been taken, and will be taken, to minimise any such detrimental impacts."*

3.3.2 This Indicative Lighting Strategy for the Project considers the lighting requirements with reference to relevant standards and guidance, and measures to avoid adverse effects on sensitive receptors, as required by NPS EN-1.

National Planning Policy Framework

3.3.3 The National Planning Policy Framework (NPPF) Ministry of Housing, Communities and Local Government 2019 (MHCLG) (Ref. 7) states that the purpose of the planning system is to contribute to the achievement of sustainable development and constitute the Government's view on what sustainable development in England means in practice for the planning system. A principal concept contained within the NPPF is the presumption in favour of sustainable development and with regard to artificial lighting, the NPPF states:

> *"c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation."*

International Guidance

3.3.4 The purpose of Commission Internationale De L'Eclairage (CIE) 150:Guide on the limitation of the effects of obtrusive light from outdoor lighting installations (CIE 150:2017) (Ref. 8) is to aid in formulating guidelines for assessing the environmental effects of exterior lighting and to provide limits for relevant lighting parameters to control the obtrusive effects of exterior lighting to tolerable levels. CIE 150:2017 refers to the potentially adverse effects of exterior lighting on both natural and man-made environments.

3.3.5 CIE 126: Guidelines for Minimising Sky Glow (CIE, 1997) (Ref. 9) gives general guidance for lighting designers and policy makers on the reduction of sky glow. The report gives recommendations about maximum permissible values for exterior lighting installations. These values are regarded as limiting values. Lighting designers should strive to meet the lowest criteria for the design. Practical implementation of the general guidance is left to national regulations.

National Guidance

3.3.6 The Institute of Lighting Professionals (ILP) Guidance note 01: Guidance notes for the reduction of obtrusive light (2020) (GN01/20) (Ref. 1) propose lighting guidance and criteria for local authorities with a recommendation that these are incorporated at the local plan level.

3.3.7 GN01/20 (Ref. 1) reflect the changes in international guidance regarding obtrusive light as detailed in CIE 150:2017 (Ref. 8). It also considers industry comment regarding the assessment and definition of obtrusive lighting.

3.3.8 The ILP also provides guidance on lighting and effects on bat species within Guidance note 8: Bats and artificial lighting (2018) (GN08/18) (Ref. 10) which is intended to raise awareness of the impacts of artificial lighting on bats and provides potential solutions to avoid and reduce this harm.

3.3.9 The Chartered Institution of Building Services Engineers (CIBSE) Society for Light and Lighting (SLL) guidance document offers some further guidance in terms of the

standard of road lighting used and population density within their guidance document Guide to Limiting Obtrusive light (2012) (SLL/LOL) (Ref. 11). This provides a more qualitative common-sense consideration for the interpretation of the character of illuminated areas.

3.3.10 This strategy has been based upon ILP guidance and informed by considerations presented by SLL LOL (Ref. 11). GN01/20 (Ref. 1) should be used in conjunction with CIE 150:2017 (Ref. 8) and CIE 126:1997 (Ref. 9) (described in the International Guidance sub-section above) and not as a replacement for the procedures contained therein.

3.3.11 Further information is provided for application of the policy and guidance documents is provided in Section 6.0.

4.0 LIGHTING DESIGN STANDARDS AND GUIDANCE

4.1.1 British Standards are published standards and guidance for most lighting tasks, adherence to which will help mitigate obtrusive lighting aspects and referred to in establishing the expected lighting requirements for the Proposed Development during Construction and Operational phases.

4.1.2 Described below are certain relevant extracts of standards and guidance expected to be used when developing the exterior lighting design for the proposed development.

4.2 British Standards

BS EN 12464-2: 2014 'Light and lighting – Lighting of workplaces. Part 2: Outdoor work places' (British Standards Institute, 2014) (Ref. 12)

4.2.1 BS EN 12464-2:2014 specifies lighting requirements for outdoor work places, which meet the needs for visual comfort and performance. All usual visual tasks which are likely to take place are considered and discussed further in Section 7.0. Guidance and Reference Documents

The Society of Light & Lighting (SLL) Handbook (2018) (Ref. 13)

4.2.2 Aimed at lighting practitioners, specifiers and students of lighting, this handbook summarises the fundamentals of light and vision, the technology of lighting and guidance on a wide range of applications, both interior and exterior. It is intended to act as a link between the Society of Light and Lighting (SLL)'s 'Code for Lighting' and the Lighting Guides (LG). The handbook also includes a chapter dedicated to exterior workplace lighting (Chapter 24) which has been referred to in the preparation of this Strategy.

The SLL Code for Lighting: 2018 (SLL, 2012) (Ref. 14)

4.2.3 The SLL Code for Lighting provides information on three areas of lighting practice and complements the SLL Lighting Handbook (Ref. 13), this includes: 1) a summary of the effects of lighting on task performance, behaviour, safety, perception, health, and its financial and environmental costs; 2) a compendium of lighting recommendations relevant to the UK, and 3) detailed descriptions of the calculations required for quantitative lighting design.

4.2.4 The lighting requirements for workplaces as set out in the SLL Code are very much aligned with those as set out in BS EN 12464-2: 2014 (Ref. 12) and so are not expanded on in this section.

4.3 Aviation Lighting Requirements

Civil Aviation Authority (CAA) Policy Statement 'Lighting of En-Route Obstacles and Onshore Wind Turbines' (CAA, 2010) (Ref. 15)

4.3.1 The Civil Aviation Authority (CAA) Policy Statement provides an overview of the more generic need for aviation warning lighting on 'tall structures' and onshore wind turbines as set out at Article 219 of the UK Air Navigation Order 2009 (superseded by Article 222 within UK Air Navigation Order 2016). The CAA Policy Statement

clarifies, "*Notwithstanding the Article 219 requirements, some structures of a height of less than 150 metres might need aviation warning lights*". Whilst structures of such heights are not routinely lit for civil aviation purposes, it is possible that aviation stakeholders, including the CAA, may make a case for aviation warning lighting where a structure is considered, by virtue of its location and nature, a significant navigational hazard.

Air Navigation Order 2016 (UK Government, 2016) (Ref. 16)

4.3.2 Article 222 of the Air Navigation Order sets out the requirements for the lighting of en-route obstacles and is reproduced below:

"(1) The person in charge of an en-route obstacle must ensure that it is fitted with medium intensity steady red lights positioned as close as possible to the top of the obstacle and at intermediate levels spaced so far as practicable equally between the top lights and ground level with an interval of not more than 52 metres.

(2) The person in charge of an en-route obstacle must, subject to paragraph (3), ensure that by night the lights required to be fitted by this article are displayed.

(3) In the event of the failure of any light which is required by this article to be displayed by night the person in charge must repair or replace the light as soon as reasonably practicable.

(4) At each level on the obstacle where lights are required to be fitted, sufficient lights must be fitted and arranged so as to show when displayed in all directions.

(5) In any particular case the CAA may direct that an en-route obstacle must be fitted with and must display such additional lights in such positions and at such times as it may specify.

(6) A permission may be granted for the purposes of this article for a particular case or class of cases or generally.

(7) This article does not apply to any en-route obstacle for which the CAA has granted a permission to the person in charge permitting that person not to fi t and display lights in accordance with this article.

(8) In this article, an 'en-route obstacle' means any building, structure or erection, the height of which is 150 metres or more above ground level, but it does not include a building, structure or erection:

(a) Which is in the vicinity of a licensed aerodrome; and

(b) to which section 47 of the Civil Aviation Act 1982(a) (warning of presence of obstructions near licensed aerodromes) applies."

4.3.3 Article 224 of the Air Navigation Order sets out the restrictions on lights liable to endanger and is reproduced below:

"(1) A person must not exhibit in the United Kingdom any light which:

(a) by reason of its glare is liable to endanger aircraft taking off from or landing at an aerodrome; or landing at an aerodrome; or

(b) by reason of its liability to be mistaken for an aeronautical ground light is liable to endanger aircraft.

(2) If any light which appears to the CAA to be a light described in paragraph (1) is exhibited, the CAA may direct the person who is the occupier of the place where the light is exhibited or who has charge of the light, to take such steps within reasonable time as are specified in the direction:

(a) to extinguish or screen the light; and

(b) to prevent in the future, the exhibition of any other light which may similarly endanger aircraft.

(3) The direction may be served either personally or by post, or by affixing it in some conspicuous place near to the light to which it relates."

CAP 1096: Guidance to Crane Operators on Aviation Lighting and Notification (CAA, 2014) (Ref. 17)

4.3.4 CAP 1096 sets out the requirements for aviation warning lighting to cranes and sets out the potential requirement for crane activity to be notified to the aviation community.

4.3.5 As the details of aviation lighting requirements are set out in legislation and CAA guidance, and will be secured by a DCO requirement, aviation lighting is not discussed further in this Indicative Lighting Strategy.

5.0 OBTRUSIVE LIGHT RECEPTORS (BASELINE)

5.1 Introduction

5.1.1 There are several categories of potentially light sensitive receptors in relation to the Proposed Development: these being, residential, ecological, road and rail.

5.1.2 As the Proposed Development design progresses, a computational light modelling exercise will be undertaken in order to ensure that obtrusive light is suitably controlled for permanent operational conditions. It is also necessary for the use and placement of temporary lighting to be considered during the construction phase so that effects to receptors are adequately managed.

5.1.3 This section sets out indicative light-sensitive receptor locations for consideration when undertaking such an obtrusive light assessment. The indicative light-sensitive receptors in relation to the Proposed Development Site boundary are shown on Figure 1: Potential Lighting Sensitive Receptors (Ecological) and Figure 2: Potential Lighting Sensitive Receptors (Human and Other) included in Appendix 1 of this report. The potential light sensitive receptors included on Figure 1 and Figure 2 are listed in Table 5-1 and described in more detail below. Receptors have been selected based on proximity to the Proposed Development Site boundary and likelihood of being sensitive to lighting impacts. For the purposes of this Indicative Lighting Strategy a precautionary buffer of 2 km has been applied to the Site Boundary.

Table 5-1: List of Potential Lighting Sensitive Receptors

FIGURE 1 POTENTIAL LIGHTING SENSITIVE RECEPTORS (ECOLOGICAL)	FIGURE 2 POTENTIAL LIGHTING SENSITIVE RECEPTORS (HUMAN AND OTHER)
Statutory Designated Sites -Special Protection Area (SPA) -Ramsar Site	Human Residential Receptors
Statutory National and Local Nature Conservation Designations -Site of Special Scientific Interest (SSSI) -National Nature Reserve (NNR)	Transportation Roads including: -Primary Road/A Road -B Road -Minor Road/Local Road -Railway Tracks
Non-Statutory Nature Conservation Designations -Local Wildlife Sites (LWS) Other -RSPB Reserves	Public Rights of Way -Long Distance Route -England Coast Path -Other Public Rights of Way

5.2 Ecological Receptors

5.2.1 Ecological receptors have been identified and are summarised below. Further details can be found in Chapter 12: Terrestrial Ecology and Nature Conservation and Chapter 15: Ornithology (ES Volume I, Document Ref. 6.2).

Relevant Statutory Designated Sites

- Teesmouth and Cleveland Coast SPA/Ramsar.
  - Immediately north of the PCC Site. The proposed CO_2 Export Pipeline and Water Discharge Pipeline are partly located within the SPA and Ramsar designations; and
  - Sections of the CO_2 Gathering Network, Natural Gas Connection are located within the SPA.

Relevant Statutory National and Local Nature Conservation Designations within 2 km

- Teesmouth and Cleveland Coast SSSI
  - Proposed On-shore CO_2 Export and Water Discharge Pipeline are located within the SSSI. The SSSI is located adjacent to the north of the PCC Site.

Relevant Local Non-Statutory Nature Conservation Designations within 2 km

- Eston Pumping Station LWS
  - Adjacent to the Site boundary for CO2 Gathering Network south of Dabholm Gut. Located 1.4 km south of the PCC Site.
- Coatham Marsh LWS.
  - Adjacent to Water Connection Corridor. Located 500 m east of the PCC Site.
- Zinc Works Field LWS
  - Opposite Side of Tees Mouth to the PCC Site. Approximately 2 km from the Site boundary.
- Greenabella Marsh (1&2) LWS's
  - North of Seal Sands Industrial Estate
- Greatham North West LWS
  - North of Seal Sands Industrial Estate but further west of Grenabella Marsh.
- Cowpen Bewley Woodland Park LWS
  - Approximately 1.8 km west of the CO_2 Gathering Network.
- Teessaurus Park LWS

- 1.7 Km south of the CO_2 Gathering Network at Riverside Park Industrial Estate.

Other (not presented on Figure 1[1])

- RSPB Reserves
  - Saltholme Reserve is located adjacent to the Site boundary in the areas near Cowpen Bewley and north of Port Clarence as well as to the north of west of the PCC Site.
- RSPB Important Bird Areas- These generally overlap with the SSSI boundaries so have not been mapped separately.
  - Located within the area of the On-shore CO_2 Export Pipeline and Water Discharge Corridor

5.2.2 As outlined with Chapter 12: Terrestrial Ecology and Chapter 15: Ornithology (ES Volume I, Document Ref. 6.2) the following Relevant Species have been included within the Ecological Impacts Assessment as light sensitive receptors. These have not been included on Figure 1 and Figure 2 but baseline detail is provided in Appendix 12C: PEA (ES Volume III, Document Ref. 6.4).

- Bats - which utilise habitats in the vicinity of the PCC Site.
- Birds - utilising habitats associated with the Statutory and Non-Statutory designations listed above.

5.3 Residential Receptors

5.3.1 Residential light-sensitive receptor locations have been identified (refer to Figure 2) and can be summarised as follows:

- There are no residential receptors within 500 m of the PCC. The closest residential properties (individual receptors) to the PCC Site are those at Marsh House Farm, in Warrenby 650 m to the east and Dormanstown (Broadway West) approximately 1.4 km to the south-east.
- There are no residential receptors within the Site boundary. There are, however, a number of residential receptors located within 2km in the following areas:
  - Grangetown – multiple residential properties north and south of Broadway (A66);
  - Dormanstown – multiple residential properties east and west of the A1042;

[1] Mapping permissions do not allow for reproduction of data.

- Billingham- multiple residential properties west of Cowpen Lane industrial estate (west of the CO_2 Gathering Network).
- Port Clarence- residential properties along Port Clarence Road (south of the CO_2 Gathering Network).

5.4 Road Receptors

5.4.1 The Power and Carbon Capture elements of the Proposed Development are located approximately 2 km north west of Redcar on the former Redcar Steelworks site (now the Teessworks site) and will be accessed via the existing roundabout junction with the A1085 and West Coatham Lane. The wider road network within 2 km covers land to the north and south of the River Tees.

5.4.2 The A1085 Trunk Road is a dual carriageway road running east to west between Redcar and the A1053 Tees Dock Road. The carriageway is street lit.

5.4.3 West from the PCC the A1085 provides a link to the A1053 which in turn connects to the A174 to the south and the A66 to the north. The A1053 and A174 are part of Highways England's strategic network. All other routes are managed by Redcar and Cleveland Borough Council Highways. Authority.

5.4.4 Road user receptor locations have been identified within the Site boundary and within in the vicinity of the Site. Main road locations, designated as A and B routes and their associated junctions, include:

- A66;
- A174;
- A1053 (west of the A1085);
- A1042;
- A178 / Seaton Carew Road;
- A1046;
- A1185 (north and west of the CO_2 Gathering Network);
- B1275; and
- B1513

5.4.5 There are a number of local roads which connect main routes through and near the Site boundary. The following local roads provide an overview of the transportation network in the area. These do not constitute an exhaustive list, and those that should also be considered include:

- Old Station Road;
- Dockside Road;
- Haverton Hill Road; and
- Cowpen Bewley Road.

5.5 PRoWs

5.5.1 A number of Public Rights of Way (PRoW) are located within 2 km of the Proposed Development Site. These include the following:

- 116 32/1;
- 116 33/1;
- 116 36/1
- 116 39/1;
- 116 9/1;
- 116 9/2
- 116 10/1
- 116 10/2
- 116 2/1;
- 102 2/5;
- 102 31/2;
- 102 194/2; and
- 102 31/3.

England Coast Path

5.5.2 The long-distance route 'England Coast Path: North East' follows the north-east coast line, before it turns south-west, inland to follow a route along a disused railway line at the edge of the industrial area which borders the River Tees. The Path crossed the Proposed Development Site boundary (CO_2 Gathering Network) at the roundabout junction of the A1185 and A178 Seaton Carew Road. The route then follows closer to the edge of the Tees, before it crosses the water at the Newport Bridge, following the route of the A1032 to the north, then east. It then turns north and follows the A178, deviating to the east towards North Gare Sands before it then follows the A178 along the coast.

Long Distance Route

5.5.3 The long-distance path Teesdale Way starts at South Gare lighthouse to the north where it runs south before linking with the England Coast Path route along the south of the River Tees. It crosses the Newport Bridge in Middlesborough and then runs south and then west, following the northern bank of the River Tees.

5.5.4 The Teesdale Way intersects with the Proposed Development to the north of the PCC Site and further south near Teesport.

5.6 Rail Receptors

5.6.1 The nearest railway station to the Site is British Steel Redcar which is located within the Site boundary. The station is located on the Tees Valley Line and is operated by Northern Rail. Historically there were two eastbound services per day to Saltburn via

Redcar and two westbound services per day to Bishop Auckland via Middlesbrough and Darlington. Northern Rail suspended all services to and from the station on 14th December 2019 due to the lack of passengers using the station. There is potential for the station to be re-opened in the future.

5.6.2 The nearest station to the Site that is still open is Redcar Central, located approximately 3 km east of the Site. This is located on the Tees Valley line connecting Middlesbrough Station to Redcar Central via South Bank Station runs through a portion of the Site.

5.6.3 This line intersects the Site to the south of the PCC Site (to the west of the A1085 roundabout junction with West Cotham Lane).

5.6.4 There is a section of single-track line which intersects the Site boundary (CO_2 Gathering Network) south of Belasis Avenue (B1275).

6.0 RECOMMENDED MAXIMUM VALUES OF LIGHT PARAMETERS FOR THE CONTROL OF OBTRUSIVE LIGHT

6.1.1 The ILP has developed an Environmental Zone classification system for the categorisation of location brightness characteristics presented in GN01 (Ref. 1). These characteristics are broadly summarised in Table 6-1 below.

6.1.2 SLL LOL (Ref. 11) provides additional consideration for other factors that can be considered alongside the examples provided for the overarching local area character and consider that as a general rule, zone E1 has no road lighting and a low population density; zone E2 has road lighting lit to the standards of residential roads and a moderate population density; zone E3 contains roads lit to traffic route standards and a high population density. Zone E4 is more suitable for areas of high activity after dark, such as out-of-town shopping centres and urban areas with a high concentration of restaurants and clubs.

6.1.3 There is one other class, (E0), which is associated with dark-sky preserves, reserves or parks recognised by the International Dark-Sky Association (IDA). These are locations where the use of light outside at night is not advised and generally should be limited. Lighting may be allowed under some circumstances, but only after great care is taken to minimise obtrusive effects, particular sky glow which could harm a dark night sky condition.

6.1.4 It is important to appreciate that an environmental zone does not necessarily coincide with an administrative boundary, such as a city, town or village. While an overarching lighting character may describe an area, each of these locales can be subdivided into a number of sub-environmental zones which depend on the activities expected to be undertaken in each area and reflecting the lighting characteristics that are and should be applied to them. This may include areas of specific ecological concern or particular features which would be detrimentally affected by a change in lighting condition as well as areas where industrial activities are present which are present within the same overall setting.

6.1.5 Due to the size of the development and range of lighting characteristics outside and within the Site boundary, no one categorisation has been given in terms of site-wide performance.

6.1.6 Instead, lighting needed to be carefully considered and controlled depending on the activities, to the levels required for safe working and egress within BS EN 12464 (Ref. 12), whilst maintaining or improving the current lighting condition in or near sensitive ecological environments, or other sensitive receptors identified in Section 5.0 and on Figures 1 and 2 in Appendix 1. It is assumed that where static, permanent lighting is used in existing sensitive locations that human or ecological receptors of note will have adapted to its use over time and these effects should not be increased.

6.1.7 Figures 1 and 2 highlight possible human and other non-ecological receptors within a 2 km radius and as a rule the following recommendations for the application of Environmental Classifications for consideration during construction and operation are made, subject to localised instances of existing lighting which should be considered when developing detailed design strategies. Lighting constraints near

designated routes / paths may also be informed by further surveys in adjacent areas that would be confirmed as the detailed design develops.

- Residential / Premises – E2 – E3
- Roads, including junctions – E2 – E3
- Railway, line and Station – E2
- Public Rights of Way (including Designated routes / paths)
  - Long Distance Route – E2 maximum near existing lit development
  - England Cost Path – E2 maximum near existing lit development
  - Public Rights of Way (PROW) – E2 maximum near existing lit development

6.1.8 Figure 1 highlights possible ecological receptors within a 2 km radius and as a rule the following recommendations for the application of Environmental Classifications for consideration during construction and operation are made, subject to localised instances of existing lighting which should be considered when developing detailed design strategies and advice derived from ecological survey.

- SPA – E1 generally, targeting E0 where possible
- Ramsar – E1 generally, targeting E0 where possible
- SSSI – E2 maximum, targeting E0 where possible
- NNR – E1 maximum, targeting E0 where possible
- LWS – E1 maximum, targeting E0 where possible
- RSPB Reserves – E1 maximum, targeting E0 where possible (not shown on Figure 1)

Table 6-1: ILP 2020 Environmental Zone Classifications

Zone	Surrounding	Lighting Environment	Examples
E0	Protected	Dark (SQM 20.5+)	UNESCO Starlight Reserves, IDA Dark Sky Parks 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 areas	Town/ city centres with high levels of night-time activity

6.1.9 For each Environmental Zone, obtrusive light limits for exterior lighting installations are specified for light intrusion (to windows), sky glow (upward light ratio) and glare (refer to Tables 6-2 to 6-4).

6.1.10 These limits are intended to support decision makers in establishing whether obtrusive lighting is detrimental to local amenity or a potential statutory nuisance. These limits can also be used together with ecological recommendations to determine the potential influence of light on a sensitive species or habitat.

Table 6-2: Maximum Values of Vertical Illuminance on Properties (to Windows)

Lighting Technical Parameter	Application Conditions	Environmental Zones				
		E0	E1	E2	E3	E4
Illuminance in the vertical plane (Ev)	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

Table 6-3: Maximum Values of Upward Light Ratio (ULR)

Lighting Technical Parameter	Environmental Zones				
	E0	E1	E2	E3	E4
Upward light Ratio (ULR)/%	0	0	2.5	5	15

6.1.11 As stated in section 6.1.5, due to the size of the development and range of lighting characteristics outside and within the Proposed Development Site boundary, no one categorisation be given. Rather, different lighting characteristics reflective of the different conditions relative to the setting of the redline boundary are used, so that the recommended lighting constraints can be applied more flexibly, and sensitive locations be better shielded.

Table 6-4: Limits for Luminous Intensity of Bright Luminaires (GLARE)

Limits for Luminous Intensity of Bright Luminaires (Glare): (CIE 150 Table 3 (amended)							
Light Technical Parameter	Application Conditions	Luminaire Group (projected area ap in m^2)					
		0 <Ap ≤ 0.002	0.002 <Ap ≤ 0.01	0.01< Ap ≤ 0.03	0.03<A p ≤ 0.13	013<Ap ≤ 0.50	Ap>0. 5
Max 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	0.29d	0.63d	01.3d	2.5d	5.1d	2500
	Post-Curfew	0	0	0	0	0	0
	E2						
	Pre-Curfew	0.57d	01.3d	2.5d	5.0d	10d	7500
	Post-Curfew	0.29d	0.63d	01.3d	2.5d	5.1d	500
	E3						
	Pre-Curfew	0.86d	1.9d	3.8d	7.5d	015d	10000
	Post-Curfew	0.29d	0.63d	01.3d	2.5d	5.1d	1000
	E4						
	Pre-Curfew	1.4d	3.1d	6.3d	13d	26d	25000
	Post-Curfew	0.29d	0.63d	01.3d	2.5d	5.1d	2500
Aid to gauging Ap		2 to 5cm	5 to 10cm	10 to 20cm	20 to 40cm	40 to 80cm	>80c m
Geometric mean of diameter (cm)		3.2	7.1	14.1	26.3	56.6	>80
Corresponding Ap representative area (m2)		0.000 8	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 cutoff in the designated directions;
3. Ap 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 Ap>0.5

6.2 Proposed Obtrusive Limits (Residential / Premises Receptors)

6.2.1 To avoid intrusion or nuisance lighting to surrounding properties, limits apply to nearby dwellings / premises or potential dwellings / premises and specifically windows; the values are the summation of all lighting installations.

6.2.2 Table can be considered for the management of spill light in general; however, designers must consider the task performance requirements of any adjacent lit areas and ensure that any spill light does not adversely affect task performance parameters and safe use of the Site / Proposed Development. This may result in a need to minimise spill and intrusive lighting values to less than might be expected for the environmental zone within which the installation lies in some cases which should be identified during detailed design and construction planning.

6.2.3 The limits for the luminous intensity of bright luminaires (glare) are dependent on the viewing distance d (between the observer and the bright luminaire(s)) and the projected area Ap, of the bright part of the luminaire in the direction of the observer. Table 6-4 provides values for luminous intensity of bright luminaires for each environmental zone as a function of visible light source as well as providing the outside maximum values that should be considered as permissible under pre and post-curfew periods.

6.2.4 Table 6-2 and Table 6-4 refer to pre and post curfew period conditions. While construction phase work will be mainly carried out in the daytime schedule, working hours will vary as the project develops. Generally working hours will be Monday to Friday 07:00 to 19:00 and Saturday 07:00 to 13:00, however it is likely that some construction activities will be required to be 24 hours at certain times. This is principally for certain construction activities that cannot be stopped, such as concrete pouring and certain specialist crossing activities (e.g. HDD or MBT). Also 24-hour security at the Site will be required where works can be carried out at night. Lighting therefore is also likely to be required for equipment compounds during the construction phase, presenting a static lighting presence throughout the night to support safety and security. Where on-site works are to be conducted outside the core working hours, they will comply with any restrictions agreed with the local planning authorities.

6.2.5 During the operation phase, as a worst case scenario it is assumed that the Proposed Development will operate continually 24 hours a day, so lighting is required for safety and security throughout the entire period of darkness or under reduced daylight conditions. For this reason, it is considered that imposing a lighting curfew for the full Site area would be unreasonable and result in a potential conflict with Site health

and safety requirements. This is in line with advice provided by ILP GN01/20 (Ref. 1), which states:

"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'.

6.2.6 BS EN 12464-2: 2014 (Ref. 12) states the following with regard to obtrusive light in terms of pre and post curfew regulations, "*In case no curfew regulations are available, the higher values shall not be exceeded and the lower values should be taken as preferable limits*".

6.2.7 This does mean that lighting should be used without consideration for receptors during the hours of darkness, but that the placement of lighting in areas where 24-hour use is both required and unavoidable should be carefully considered. Where 24-hour operations are located near sensitive locations, application of mitigation measures may be necessary.

6.3 Proposed limitation of effects on Transport Systems

6.3.1 Limits for veiling luminance based on permissible threshold increment apply where users of road networks are subject to a reduction in the ability to see essential information based on the road classification. Table 4 within CIE 150 2017 (Ref. 8) is referenced by Table 5 of ILP GN01/20 (Ref. 1) and together provide values for maximum allowances of veiling luminance and threshold increment based on the type of road / road lighting for viewing directions in the path of travel for road users. Please note that this is independent of environmental zone classification.

6.3.2 The proposed permitted obtrusive light level limits for road users are as follows:

- no road lighting: threshold increment of 15% based on adaptation luminance of 0.1 cd/m2 and veiling luminance of 0.04;
- ME6/ ME5: threshold increment of 15% based on adaptation luminance of 1 cd/m2 and veiling luminance of 0.25;
- ME4/ ME3: Threshold increment of 15% based on adaptation luminance of 2 cd/m2 and veiling luminance of 0.40; and
- ME2/ ME1: Threshold increment of 15% based on adaptation luminance of 5 cd/m2 and veiling luminance of 0.84.

6.3.3 Lighting near rail should not contribute to excess light spill or glare that would contribute to visual disability to the train driver and obscure signal lighting leading to potential overrun.

6.4 Proposed Obtrusive Light Limits (Ecological Receptors)

6.4.1 Construction phase lighting will be managed via a Light Management Plan (LMP). The LMP should accompany the detailed Construction Environmental Management Plan (CEMP) which sets out the approach for use of lighting during the construction phase

and will include consideration of effects to ecological receptors. While a primarily daylight schedule is assumed for construction phase works, it is recognised that some activities may take place during dark hours. This may include scheduled work in winter months or emergency works taking place at night after standard working hours.

6.4.2 The operational Site lighting scheme will be designed to generally minimise any impact on ecological receptors by means of controlling the placement of lighting and minimising illuminance at the receptors, along with the 'viewed' source intensity.

6.4.3 The permitted obtrusive light level limits for the ecological receptors are initially recommended to be consistent with limitations for light intrusion that responds to the current brightness character, or to meet or exceed good practice performance based on the lighting condition current at the receptor location. This will be confirmed at detailed design stage and updated if necessary following pre-construction ecological surveys.

7.0 SITE LIGHTING REQUIREMENTS (CONSTRUCTION PHASE)

7.1 Introduction

7.1.1 This section sets out the general schedule assumed for the construction phase and provides an indication of activities that are anticipated to be undertaken for various works. This allows an overall lighting strategy to be developed covering temporary works and work areas, although this strategy will be developed further by the contractor. See Section 6.2.4 in relation to Site working hours during the construction phase.

7.1.2 To enable people to perform temporary outdoor visual tasks safely, efficiently and accurately during winter months and times of darkness, adequate and appropriate lighting must be provided during the construction phase.

7.1.3 A start up and shut down period is expected for one hour prior and one hour after the standard working hours where site or task lighting may be required. These hours may be restricted to 8am – 1pm on Saturday with no working on Sundays where near residential locations or near particularly sensitive ecology, as advised by the Local Authority and ecological survey.

7.1.4 The degree of visibility and comfort that is required in a wide range of outdoor work-places is governed by the type and duration of activity.

7.1.5 Exterior lighting can be covered in the following categories:

- Access and Egress lighting supporting safety and security for pedestrian, vehicular and shared surface areas;
- Task lighting, this may comprise of lighting that is intended to provide additional light over a designated ‘small’ area, not covering the full site, in order to carry out specific construction activities; and
- Exterior flood / area lighting, which is intended to provide light areas larger than a designated task area, primarily comprised of downward light onto horizontal or near horizontal surfaces, including roadways, car parks, paths, stairs, ramps, and other open spaces.

7.1.6 Associated potential obtrusive light effects on the receptors described in Section 5.0 will be minimised through the controlled application of lighting in accordance with current best practice, and as set out in the LMP accompanying the CMP or detailed CEMP for the Proposed Development.

7.2 Recommended Lighting Values (Construction Activities)

7.2.1 The lighting strategy for the Site during construction is intended to be an outline design strategy only, rather than a detailed design solution for the reasons presented in Section 2.0.

7.2.2 Criteria that are potentially relevant to the Site are given in Tables 7-1 to 7-4 below, where Em is the minimum average illuminance in lux (lx), U° refers to the uniformity of illumination, RGL refers to the Glare Rating Limit (a metric for the assessment of

glare related to the task area, separate to light source intensity set out in ILP guidance (Ref. 1)), and Ra relates to colour rendering.

Table 7-1: BS EN 12464-2: 2014 General requirements for areas and for cleaning at outdoor work places

Type of Area, Task or Activity	Average Em lx	U°	RGL	Ra
Walkways exclusively for pedestrians	5	0.25	50	20
Traffic areas for slowly moving vehicles (max. 10 km/h), e.g. bicycles, trucks and excavators	10	0.40	50	20
Regular vehicle traffic (max. 40 km/h)	20	0.40	45	20
Pedestrian passages, vehicle turning, loading and unloading points	50	0.40	50	20
Cleaning and servicing	50	0.25	50	20

Table 7-2: BS EN 12464-2: 2014 General requirements for industrial sites and storage areas

Type of Area, Task or Activity	Average Em lx	U°	RGL	Ra
Short-term handling of large units and raw materials, loading and unloading of solid bulk goods	20	0.25	55	20
Continuous handling of large units and raw materials, loading and unloading of freight, lifting and descending location for cranes, open loading platforms	50	0.40	50	20
Reading of addresses, covered loading platforms, use of tools, ordinary reinforcement and casting tasks in concrete plants	100	0.50	45	20
Demanding electrical, machine and piping installations, inspection	200	0.50	45	60

Table 7-3: BS EN 12464-2: 2014 General requirements for parking areas

Type of Area, Task or Activity	Average Em lx	U°	RGL	Ra
Light traffic, e.g. parking areas of shops, terraced and apartment houses; cycle parks	5	0.25	55	20
Medium traffic, e.g. parking areas of department stores, office buildings, plants, sports and multipurpose building complexes	10	0.25	50	20
Heavy traffic, e.g. parking areas of major shopping centres	20	0.25	50	20

Table 7-4: BS EN 12464-2: 2014 General requirements for power, electricity, gas and heat plants

Type of Area, Task or Activity	Average Em lx	U°	RGL	Ra
Pedestrian movements within electrically safe areas	5	0.25	50	20
Handling of servicing tools, coal	20	0.25	55	20
Overall inspection	50	0.40	50	20
General servicing work and reading of instruments	100	0.40	45	40
Repair of electric devices	200	0.50	45	60

7.2.3 Criteria that are potentially relevant to the Site are given in Tables 7-5 and 7-6 below.

Table 7-5: SLL Handbook illuminance recommendations for exterior workplaces

Activity	Minimum maintained Illuminance (lx)	Illuminance Uniformity (u°)
Safe pedestrian movement in low risk areas	5	0.25
Safe movement of slow vehicles	10	0.4
Safe movement in medium risk areas	20	0.4
Normal traffic	20	0.4
Very rough work	20	0.25
Rough work	50	0.25
Safe movement in high risk areas	50	0.4
Normal work	100	0.5
Fine work	200	0.5

Table 7-6: SLL Handbook recommendations for loading

Application	Horizontal Illuminance (lx)	Horizontal Illuminance Uniformity (u°)	Maximum Glare Rating	Minimum Colour Rendering Index
Loading bay	150	0.4	25	40
Outdoor loading area	100	0.5	45	20

8.0 SITE LIGHTING REQUIREMENTS (OPERATIONAL PHASE)

8.1 Introduction

8.1.1 This section sets out the general activities anticipated for the operational site lighting. Further details will be confirmed at the detailed design stage.

8.1.2 The main focus of lighting requirements during the operational phase will be at the PCC where the power station and carbon capture and compression plant will be located.

8.1.3 To enable people to perform outdoor visual tasks safely, efficiently and accurately, especially during the night, adequate and appropriate lighting will be provided during the operational phase. The PCC Site will operate 24 hours, 7 days a week, although not all areas of the Site will require lighting on a 24-hour basis.

8.1.4 The degree of visibility and comfort required in a wide range of outdoor work places is governed by the type and duration of activity.

8.1.5 Exterior lighting can be covered in the following categories:

- Access and Egress lighting supporting safety and security for pedestrian, vehicular and shared surface areas;
- Task lighting, this may comprise of lighting that is intended to provide additional light over a designated 'small' area, not covering the full site, in order to carry out specific construction activities; and
- Exterior flood / area lighting, which is intended to provide light areas larger than a designated task area, primarily comprised of downward light onto horizontal or near horizontal surfaces, including roadways, car parks, paths, stairs, ramps, and other open spaces.

8.2 Recommended Lighting Values (Operational)

8.2.1 The lighting strategy for the Site during operation is intended to be an outline design strategy only, rather than a detailed design solution for the reasons presented in Section 2.0.

8.2.2 Criteria that are potentially relevant to the Site are given in Table 8-1 to Table 8-7 below, where U° refers to the uniformity of illumination, RGL refers to the Glare Rating Limit (a metric for the assessment of glare related to the task area, separate to light source intensity set out in ILP guidance (Ref. 1)), and Ra relates to colour rendering.

Table 8-1: BS EN 12464-2: 2014 General requirements for areas and for cleaning at outdoor work places

Type of Area, Task or Activity	Average Em lx	U°	RGL	Ra
Walkways exclusively for pedestrians	5	0.25	50	20
Traffic areas for slowly moving vehicles (max. 10 km/h), e.g. bicycles, trucks and excavators	10	0.40	50	20
Regular vehicle traffic (max. 40 km/h)	20	0.40	45	20
Pedestrian passages, vehicle turning, loading and unloading points	50	0.40	50	20
Cleaning and servicing	50	0.25	50	20

Table 8-2: BS EN 12464-2: 2014 General requirements for building sites

Type of Area, Task or Activity	Average Em lx	U°	RGL	Ra
Clearance, excavation and loading	20	0.25	55	20
Construction areas, drain pipes mounting, transport, auxiliary and storage tasks	50	0.40	50	20
Framework element mounting, light reinforcement work, wooden mould and framework mounting, electric piping and cabling	100	0.40	45	40
Element jointing, demanding electrical, machine and pipe mountings	200	0.50	45	40

Table 8-3: BS EN 12464-2: 2014 General requirements for industrial sites and storage areas

Type of Area, Task or Activity	Average Em lx	U°	RGL	Ra
Short-term handling of large units and raw materials, loading and unloading of solid bulk goods	20	0.25	55	20
Continuous handling of large units and raw materials, loading and unloading of freight, lifting and descending location for cranes, open loading platforms	50	0.40	50	20
Reading of addresses, covered loading platforms, use of tools, ordinary reinforcement and casting tasks in concrete plants	100	0.50	45	20
Demanding electrical, machine and piping installations, inspection	200	0.50	45	60

Table 8-4: BS EN 12464-2: 2014 General requirements for parking areas

Type of Area, Task or Activity	Average Em lx	U°	RGL	Ra
Light traffic, e.g. parking areas of shops, terraced and apartment houses; cycle parks	5	0.25	55	20
Medium traffic, e.g. parking areas of department stores, office buildings, plants, sports and multipurpose building complexes	10	0.25	50	20
Heavy traffic, e.g. parking areas of major shopping centres	20	0.25	50	20

Table 8-5: BS EN 12464-2: 2014 General requirements for power, electricity, gas and heat plants

Type of Area, Task or Activity	Average Em lx	U°	RGL	Ra
Pedestrian movements within electrically safe areas	5	0.25	50	20
Handling of servicing tools, coal	20	0.25	55	20
Overall inspection	50	0.40	50	20
General servicing work and reading of instruments	100	0.40	45	40
Repair of electric devices	200	0.50	45	60

8.2.3 Criteria that are potentially relevant to the Site are given in Table 8-6 and 8-7 below.

Table 8-6: SLL Handbook illuminance recommendations for exterior workplaces

Activity	Minimum maintained Illuminance (lx)	Illuminance Uniformity (u°)
Safe pedestrian movement in low risk areas	5	0.25
Safe movement of slow vehicles	10	0.4
Safe movement in medium risk areas	20	0.4
Normal traffic	20	0.4
Very rough work	20	0.25
Rough work	50	0.25
Safe movement in high risk areas	50	0.4
Normal work	100	0.5
Fine work	200	0.5

Table 8-7: SLL Handbook recommendations for loading

Application	Horizontal Illuminance (lx)	Horizontal Illuminance Uniformity (u°)	Maximum Glare Rating	Minimum Colour Rendering Index
Loading bay	150	0.4	25	40
Outdoor loading area	100	0.5	45	20

9.0 GENERAL OBTRUSIVE LIGHT IMPACT AVOIDANCE MEASURES

9.1.1 Through the adoption of good lighting design practice, incorporating general obtrusive lighting impact avoidance measures such as those described below, obtrusive light will be suitably controlled. It should be noted that the measures listed below are indicative only, and the final measures will be subject to detailed design and / or agreement with the Local Authority.

9.1.2 General obtrusive lighting impact avoidance measures may include:

- adopting a lighting control strategy that turns lights off or dims as necessary for site safety and security;
- using photocells as a primary means of control to prevent light from being used when sufficient daylight is available;
- where possible, adopting LED luminaires to control obtrusive light due to their high directionality and accordingly the achievable ratio of useful light to spill light;
- careful consideration of placement of lighting column and luminaire positioning;
- adopting luminaires with minimal upward lighting ratio and full cut-off, where possible;
- not tilting luminaires to have uplift above the horizontal, if this is not possible add shielding, hoods baffles, louvres as necessary to ensure potential upward light is controlled;
- optimising column heights to allow for sufficient light coverage and minimal tilt of luminaires;
- minimising building mounted luminaire heights;
- adopting lamps with similar correlated colour temperatures;
- using lamps with a limited UV spectrum in locations which might affect ecological receptors;
- using shields and baffles to luminaires;
- lighting the site boundaries with low power periphery lighting with an asymmetric forward optic having good back-light cut-off characteristics; and
- directing luminaires away from ecologically sensitive receptors.

10.0 SUMMARY AND CONCLUSIONS

10.1.1 This indicative Lighting Strategy document has been prepared in order to support the Application for the Proposed Development.

10.1.2 At the time of submission of the Application, the contractor has not been appointed and detailed design work for the Proposed Development has not been carried out. Therefore, detailed information on the lighting to be used at the Proposed Development is currently unknown. Nevertheless, it is recognised that potential nuisance from lighting of the Proposed Development may be a concern for local communities and certain consultees. Therefore, the Applicant has commissioned this strategy in order to provide some definition to the type and level of lighting that will be employed at the Proposed Development.

10.1.3 This document therefore sets out the indicative lighting strategy in the form of an outline lighting requirements specification for site lighting under construction and operational phases. It also addresses obtrusive lighting by means of specifying off-site obtrusive lighting constraints. The report also identifies potential measures and guidance that may be taken to control obtrusive light through the detailed design of the Proposed Development lighting scheme and management of lighting used during the construction phase. At the detailed design stage, a computational light modelling exercise will be undertaken. This will ensure that the Site is adequately lit and that obtrusive light is suitably controlled, in accordance with this Strategy.

10.1.4 In summary, it is concluded that the Indicative Lighting Strategy provides an appropriate outline of the lighting requirements for the Proposed Development as part of the Application and identifies measures which can be employed as required and which will adequately control obtrusive light through detailed design of the lighting scheme. The controls are secured through a requirement in the Draft DCO (Document Ref. 2.1).

11.0 REFERENCES

Ref. 1 - Institute of Lighting Professionals (2020) GN01 Guidance Note 01 - Guidance Notes for the Reduction of Obtrusive Light

Ref. 2 - Clean Neighbourhoods and Environment Act 2005

Ref. 3 - Environmental Protection Act, 1990

Ref. 4 - Department for Environment, Food and Rural Affairs (2006) Statutory Nuisance from Insects and Artificial Light: Guidance on Sections 101 to 103 of the Clean Neighbourhoods and Environment Act 2005

Ref. 5 - Conservation of Habitats and Species Regulations (2017)

Ref. 6 - Department of Energy and Climate Change (2011) Overarching National Policy Statement for Energy (EN-1)

Ref. 7 - Ministry of Housing, Communities and Local Government 2019 (MHCLG) National Planning Policy Framework.

Ref. 8 - Commission Internationale De L'Eclairage (2017) CIE 150:2017 Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations.

Ref. 9 - Commission Internationale De L'Eclairage (1997) CIE 126: Guidelines for Minimising Sky Glow.

Ref. 10 - Institute of Lighting Professionals (2018) GN08 Guidance Note 08 – Bats and artificial lighting

Ref. 11 - CIBSE Society of Light and Lighting (2012) SLL LOL Guide to Limiting Obtrusive Light

Ref. 12 - British Standards Institute (2014) BS EN 12464-2: 2014 'Light and lighting – Lighting of workplaces. Part 2: Outdoor work places'.

Ref. 13 - CIBSE SLL Society of Light and Lighting (2018) The Society of Light & Lighting Handbook.

Ref. 14 - CIBSE SLL Society of Light and Lighting (2012) The Society of Light & Lighting Code for Lighting

Ref. 15 - Civil Aviation Authority (2010) Policy Statement: Lighting of En-Route Obstacles and Onshore Wind Turbines.

Ref. 16 - UK Government (2016) The Air Navigation Order 2016 (SI 2016 No. 765). Available online: https://www.legislation.gov.uk/uksi/2016/765/contents/made

Ref. 17 - Civil Aviation Authority (2014) CAP 1096: Guidance to Crane Operators on Aviation Lighting and Notification.

FIGURES

Project Management Initials: RL Designer: LC Checked: RM Approved: LK

AECOM

PROJECT
NET ZERO TEESSIDE PROJECT

Net Zero Teesside

APPLICANTS
NZT POWER LTD. AND NZNS STORAGE LTD.

KEY

- Site Boundary
- Site Boundary - 2km Buffer
- Special Protection Area
- Ramsar
- Site of Special Scientific Interest
- National Nature Reserve
- Local Nature Reserve
- Local Wildlife Site

TITLE
FIGURE 1 V2
POTENTIAL LIGHTING SENSITIVE RECEPTORS (ECOLOGICAL)

DCOUMENT REF. 5.12

REFERENCE
NZT_210915_LSR_1_v3

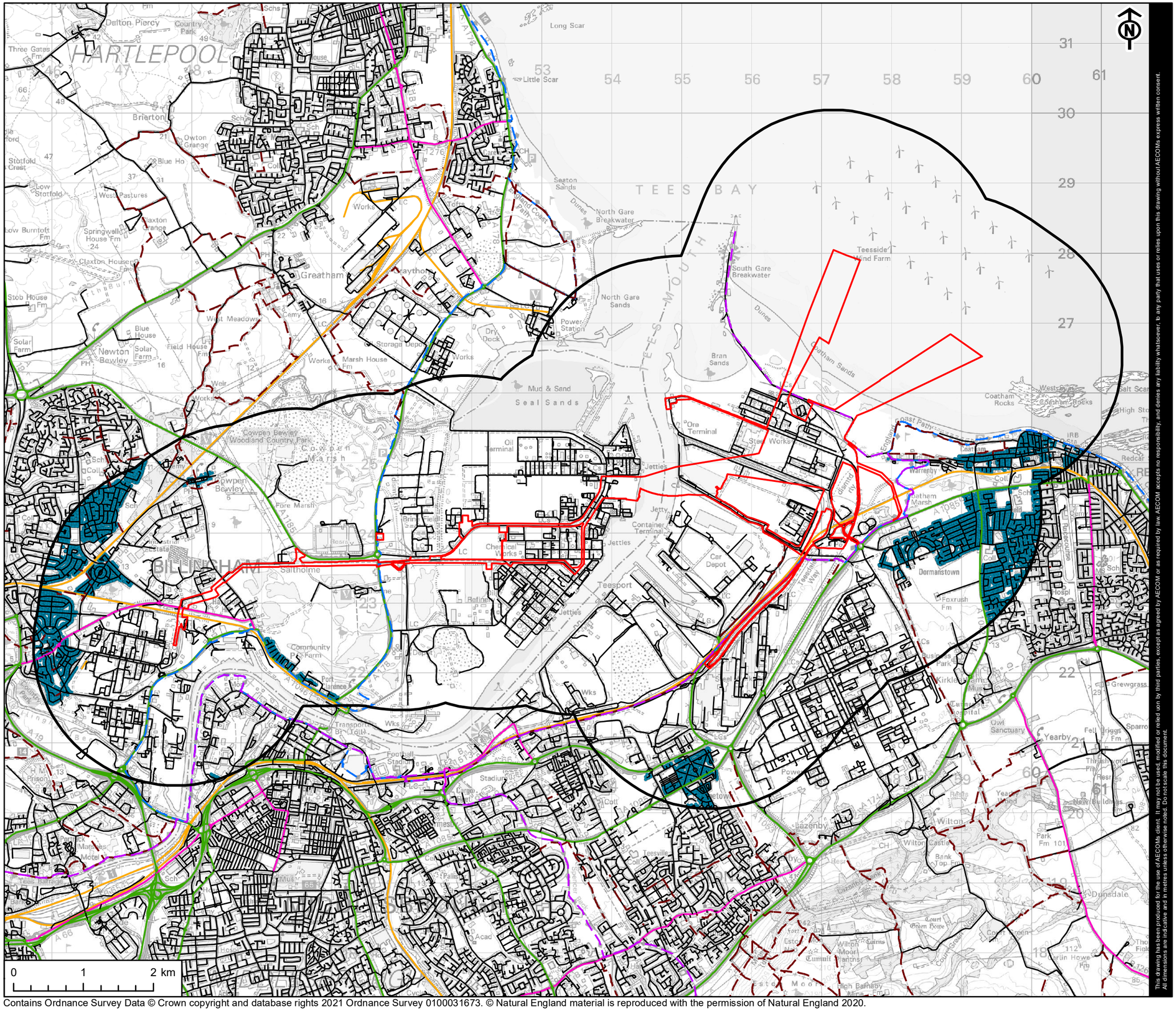
SHEET NUMBER
1 of 1

DATE
12/10/21

Scale @ A3 1:50,000

0 1 2 km

Project Management Initials: RL Designer: LC Checked: RM Approved: LK



AECOM

PROJECT
NET ZERO TEESSIDE PROJECT

Net Zero Teesside

APPLICANTS
NZT POWER LTD. AND NZNS STORAGE LTD.

KEY

- Site Boundary
- Site Boundary - 2km Buffer
- Residential Receptor within 2km
- Primary Road / A Road
- B Road
- Minor Road / Local Road
- Railway Track
- Long Distance Walking Route
- Public Right of Way
- England Coast Path

TITLE
FIGURE 2
POTENTIAL LIGHTING SENSITIVE RECEPTORS (HUMAN AND OTHER)

DCOUMENT REF. 5.12

REFERENCE
NZT_210507_LSR_2_v2

SHEET NUMBER
1 of 1

DATE
07/05/21