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Global Centre for Rail Excellence

Phase 1- Railway Sidings

Lighting Design Review for compliance with Dark Skies

at the

Nant Helen Surface Mine site, Powys

&

Onllwyn Distribution Centre, Neath Port Talbot





Scope of Works:

The following simple core structure working document details the schedule of works required to be undertaken to assist with ensuring the Global Centre for Rail Excellence project objectives are met.

The initial areas to be covered by the project include the railway sidings being constructed in Phase 1 at the old Nant Helen Surface Mine site - Powys, and Onllwyn Distribution Centre - Neath Port Talbot [GCRE-PH1].

Design confirmation requirements:

1. Construct a 3D digital lighting model to represent GCRE-PH1
2. Assess proposed lighting provision for illuminating the walkways and surrounding areas at the railway siding
 - i. worst-case scenario where all lighting defaults to ON
 - ii. typical application scenario where only limited walkway lights are ON
 - iii. potential impact on neighbouring areas and compliance with the Dark Skies initiative

Lighting requirements:

1. Lights to provide illumination along the walkways between rail tracks, primarily for engineer footfall. Task lighting will also be required for performing inspections and manual tasks. These lights would be temporary in nature with a huge emphasis on health and safety in the workplace and therefore are exempt from any required calculations, as would be any temporary safety lighting.
2. Minimal light spill.
3. Reduced impact on Brecon Beacons National Park Trust land and locale.

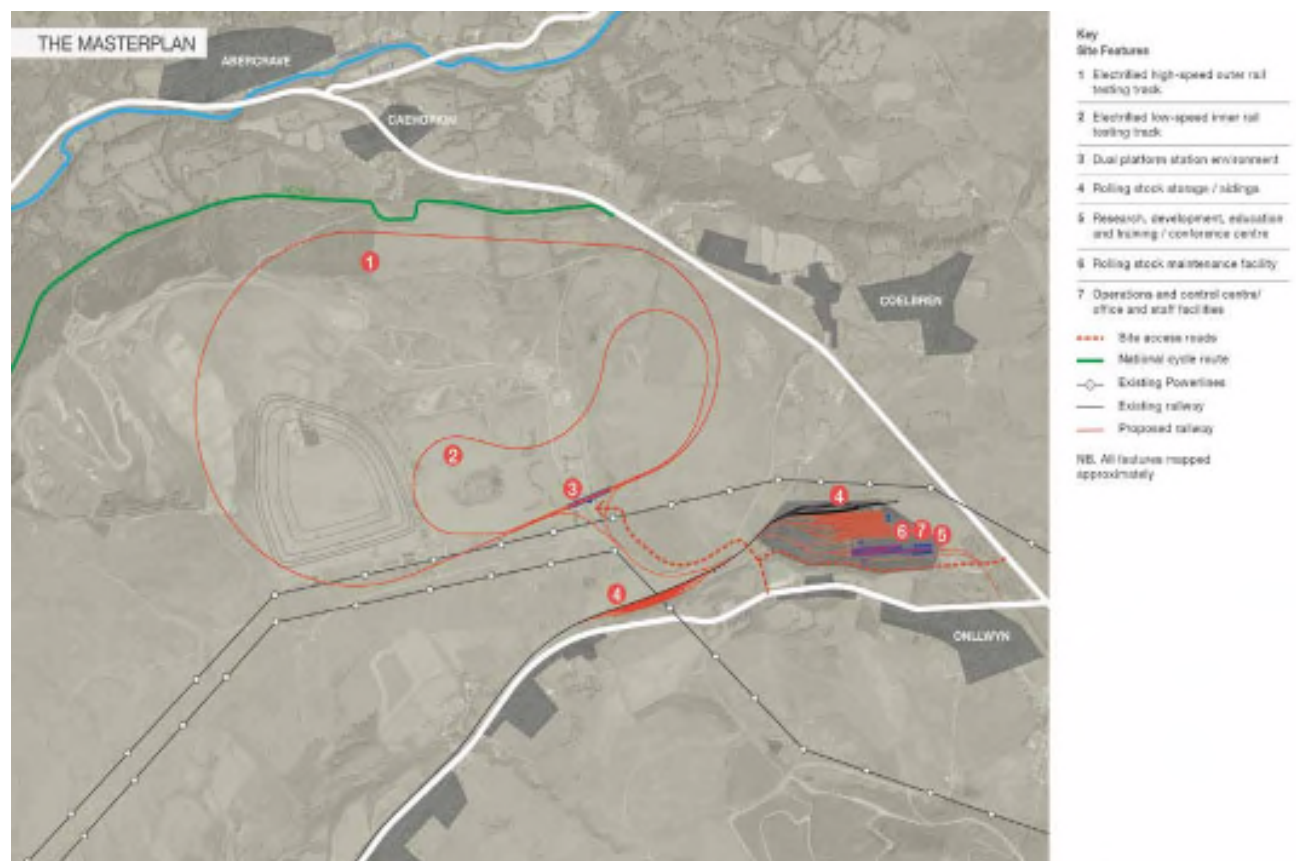
Lighting Design Background Criteria:

GCRE-PH1 is situated just South of the intersection between the A4221, Intervalley Road, and the A4067, Brecon Road, just outside the Brecon Beacons National Park, Wales. The site will be operated by the Global Centre for Rail Excellence.

The site will eventually be comprised of two loop test tracks with overhead electrification, two rail platforms for test and verification, together with offices, staff accommodation, shunter cabins, research and development, education and training, rolling stock storage sidings and engineering facilities. There will also be internal vehicular accesses, branch line rail connection, staff and visitor parking post extensive landscaping. For this exercise, we are only considering the items pertaining to Phase 1, namely being the externally exposed railway sidings consisting of railway tracks and engineer service walkways for staff access.

The entire site will ultimately be lit to a variety of levels, ranging from natural light only, to those similarly experienced by the general public on an industrial estate, office complex, or other public area, wherever the public will pass. However, the throughput of people in this instance is restricted to engineers and other qualified staff, who will be trained in the GCRE-PH1 layout, safety procedures and other processes. Therefore, illumination of these pathways is to be considered to be of a level required for those 'familiar' with the site, the 'procedures' and 'safety risks' inherent with such a site.

The image below shows the extents of the entire site; GCRE-PH1 is directly adjacent to the area identified below as item 4 on the Eastern side of the site. There are multiple phases for developing additional tracks, over and above those scheduled in Phase 1.



Design requirements:

The Planning Approval, P2021/0327 from Neath Port Talbot County Borough Council, contains a condition pertinent to general lighting (Condition 29) and specifically external lighting (Condition 56).

Condition 29:

As part of the submission of the first reserved matters application (for any phase of development as agreed under Condition 7) a detailed light pollution/dark skies assessment shall have been undertaken and submitted to the local planning authority for its approval in writing. The result of such assessment shall be used to inform and influence the final external lighting scheme required under condition 56.

Condition 56:

No external lighting shall be installed or operated at the site other than in accordance with a detailed external lighting scheme, which shall first have been submitted to and approved in writing by the local planning authority. The scheme shall take into account the Dark Skies Assessment required by condition 29, together with the lighting needs and mitigation requirements associated with the development during operational hours and shall be the minimum required to perform the relevant lighting task. It shall also be specifically designed to minimise the risk of light spillage beyond the development site boundary and within ecologically sensitive areas.

The scheme shall include:

- a) A report, prepared by a lighting engineer, setting out the technical details of the luminaires and columns, including their location, type, shape, dimensions and, expected luminance output and specifically explaining what design attributes have been chosen to minimise light pollution.*
- b) A plan illustrating illuminance levels across the development site and at the boundary of the site. The level of illuminance should be appropriate to the character of the surrounding area as a whole.*
- c) A statement which demonstrates how the lighting scheme will be viewed against the wider landscape and, where appropriate, the potential role of landscaping in minimising the day and night-time visual impact of the installation.*
- d) An Environmental Lighting Impact Assessment against conservation requirements for protected species and designated landscapes.*

All lighting installed at the site shall be in full accordance with the approved details.

NB: At this time, a complete assessment cannot be made as the majority of the phased construction is still in the early design stages. However, to fulfil the need to comply with the Dark Skies initiative for GCRE-PH1, a phase assessment has been undertaken to study the lighting impact of the lighting used in GCRE-PH1. This will involve minimal direct illumination along the 7no. walkways between the 14no. sets of tracks within the scope of the phase. Consideration is given to the fact that the National Park is paramount and impact on local residents / wildlife must be minimal and negated if possible.

1. Creation of a digital lighting model

A 3D digital lighting model has been created in RELUX. A lighting design software programme used globally by lighting professionals across the globe for lighting calculations and analysis for over 25 years. Until recently, it was the only widely used lighting design package that permits designers to measure direct and indirect illumination above the working plane by adding an inverted measuring plane above the model in question.

The area fenced by the red rectangular shape, lower right quadrant in the image below, is what has been modelled based on approved drawings supplied by the client and the design team, generated from Microstation DGN exports; a software commonly used in the architectural and engineering industries.

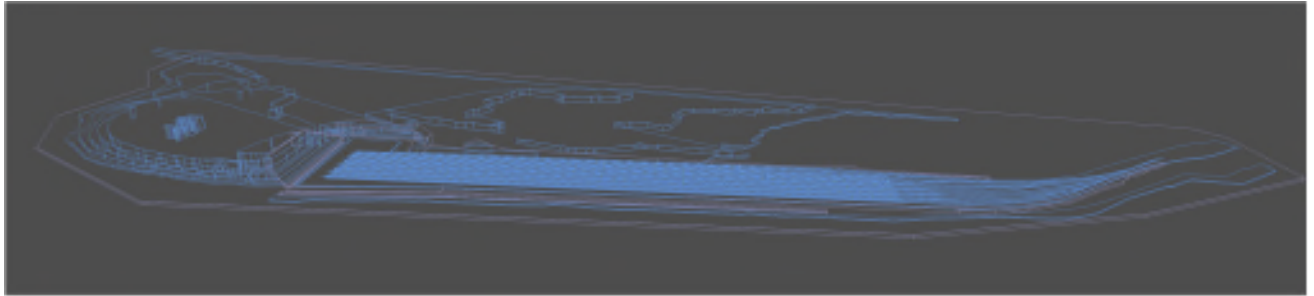


© Google Maps 2023

The view from the North provides a better aspect as the terrain rises from North to South and there will be considerable groundworks at the East end of the sidings, to reduce impact outside of the site and provide a natural looking slope rising away from the tracks (to the left of the image below).

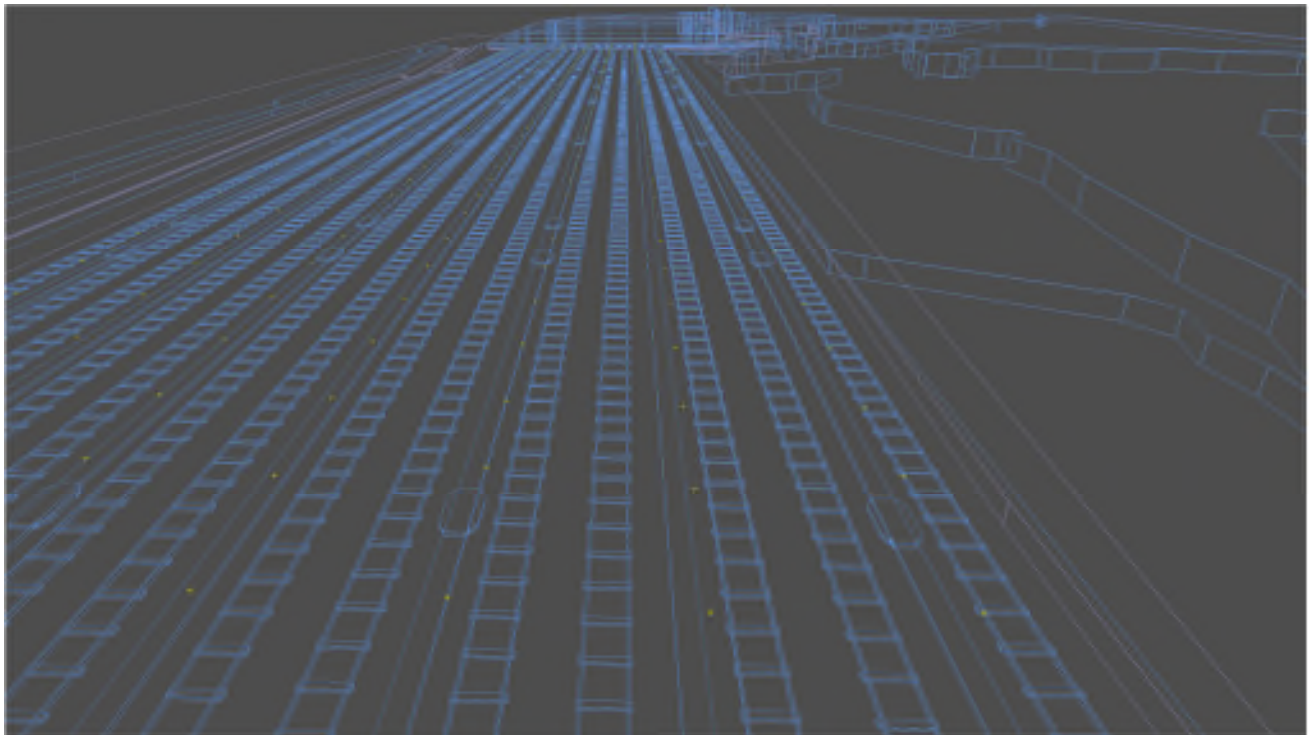


© Google Maps 2023



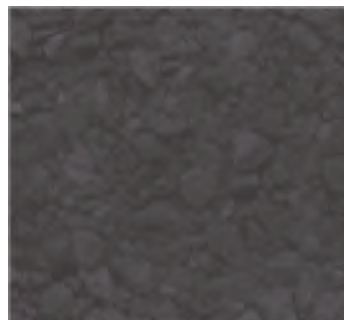
The above image is an overview of the 3D wire model for the extent of GCRE-PH1 which shows little detail because of the scale of the site.

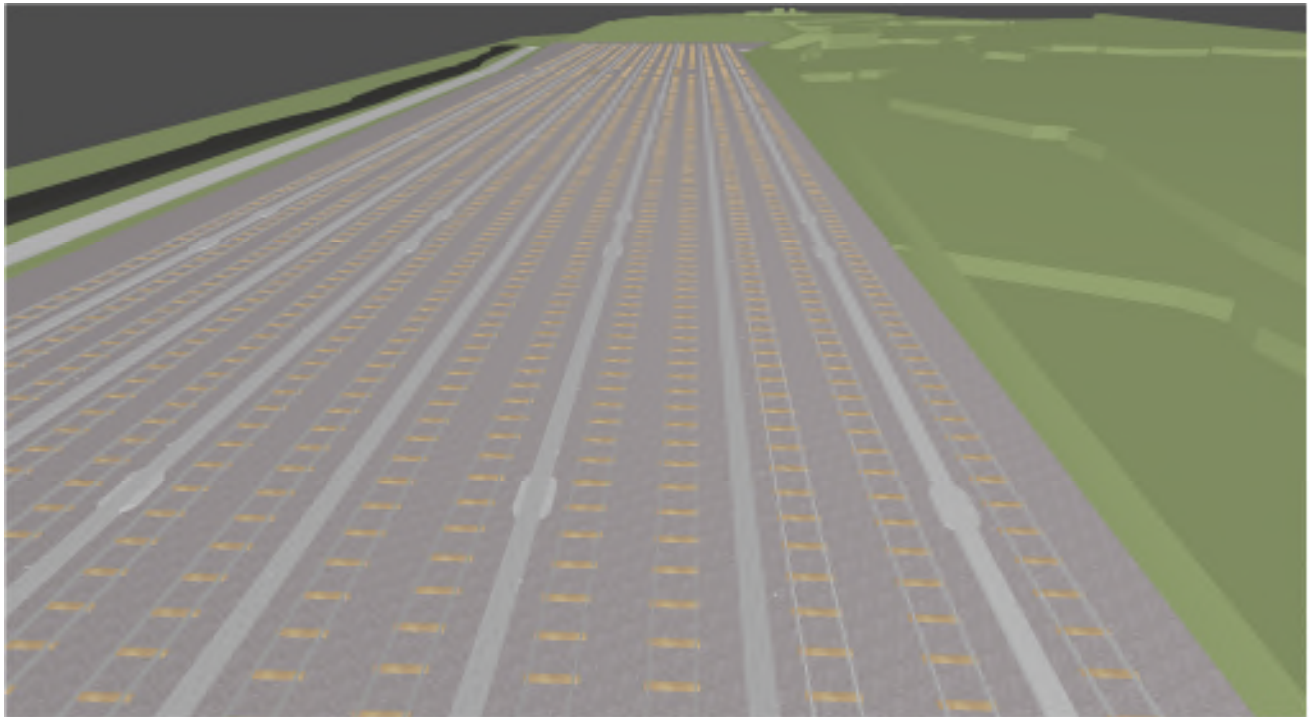
The image below shows the construction of the model looking down the tracks of the siding, towards the newly created embankment, rising away from the track stops, as previously described. The terrain rising to the South (right) and falling to the North (left) with the associated roadway and drainage ditches.



The materials used in the model have been chosen to approximate the real-life reflectance values for site materials used in GCRE-PH1; for example the track ballast has a value of 16.5%, and is used in the all calculated scenarios.

The surrounding areas of grassland all use a value of 36.3% reflectance. All concrete is set to a value of 57.7%. Rails are set to 50.0%





The Relux model simplifies the appearance of all these materials to minimise graphic lag and speed up the design process, as can be seen above. These simple colour representations are used by the programme, pre and post calculations, for all outputs unless a complex raytracing calculation is performed: this is not practical on a project of this scale as every track and stone would need raytraces calculated for every light installed resulting in billions of calculation sum points.

There are 9 measuring planes used in the modelling:

- *All Tracks* - an area of approx.. 450m x 100m mounted just above the tracks to measure illuminance on the overall working plane
- *Inverted Sky Glow* - an area of 500m x 100m mounted 20m above the tracks
- *Path 1 to Path 7* - each an area of approx.. 450m x 1m just above each walkway

NB. The reason the Sky Glow plane is inverted (upside down) is because there is no direct light falling downwards from the luminaires onto the plane at that height but there is upward reflected light from site surfaces, hence the reversed orientation of the plane, to measure the illumination of that height accurately.

2. Assess proposed lighting provision

The Government has published several studies relating to the Dark Skies Initiative and how that relates to the planning system. The guidance on light pollution is detailed below:

What light pollution considerations does planning need to address?

Artificial lighting needs to be considered when a development may increase levels of lighting, or would be sensitive to prevailing levels of artificial lighting. Artificial light provides valuable benefits to society, including through extending opportunities for sport and recreation, and can be essential to a new development. However, for maximum benefit, it is important to get the right light, in the right place and for it to be used at the right time.

Artificial light is not always necessary. It 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 and undermine enjoyment of the countryside or the night sky, especially in areas with intrinsically dark landscapes. Intrinsically dark landscapes are those entirely, or largely, uninterrupted by artificial light. National parks and nature reserves can serve as good examples, particularly where they support habitats for native nocturnal animals.

Lighting schemes can also 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, harbour premises, 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 for these premises right at the outset.

Paragraph: 001 Reference ID: 31-001-20191101

Revision date: 01 11 2019

What factors can be considered when assessing whether a development proposal might have implications for light pollution?

The following questions indicate matters that may need to be considered in relation to managing the effects of light pollution:

- Does an existing lighting installation make the proposed location for a development unsuitable, or suitable only with appropriate mitigation? For example, this might be because:
 - the artificial light has a significant effect on the locality; and/or
 - users of the proposed development (e.g. a hospital) may be particularly sensitive to light intrusion from the existing light source.

Where necessary, development proposed in the vicinity of existing activities may need to put suitable mitigation measures in place to avoid those activities having a significant adverse effect on residents or users of the proposed scheme, reflecting the [agent of change principle](#). Additional guidance on applying this principle is set out in the [planning practice guidance on noise](#).



- Will a new development, or a proposed change to an existing site, be likely to materially alter light levels in the environment around the site and/or have the potential to adversely affect the use or enjoyment of nearby buildings or open spaces?
- Will the impact of new lighting conflict with the needs of specialist facilities requiring low levels of surrounding light (such as observatories, airports and general aviation facilities)? Impacts on other activities that rely on low levels of light such as astronomy may also be a consideration, but will need to be considered in terms of both their severity and alongside the wider benefits of the development.
- Is the development in or near a protected area of dark sky or an intrinsically dark landscape where new lighting would be conspicuously out of keeping with local nocturnal light levels, making it desirable to minimise or avoid new lighting?
- Would new lighting have any safety impacts, for example in creating a hazard for road users?
- Is a proposal likely to have a significant impact on a protected site or species? This could be a particular concern where forms of artificial light with a potentially high impact on wildlife and ecosystems (e.g. white or ultraviolet light) are being proposed close to protected sites, sensitive wildlife receptors or areas, including where the light is likely to shine on water where bats feed.
- Does the proposed development include smooth, reflective building materials, including large horizontal expanses of glass, particularly near water bodies? (As it may change natural light, creating polarised light pollution that can affect wildlife behaviour.)

If the answer to any of the above questions is 'yes', local planning authorities and applicants should think about:

- [where the light shines;](#)
- [when the light shines;](#)
- [how much light shines;](#) and
- [possible ecological impacts.](#)

Paragraph: 002 Reference ID: 31-002-20191101

Revision date: 01 11 2019

What factors are relevant when considering where light shines?

Light intrusion occurs when the light 'spills' beyond the boundary of the area being lit. For example, light spill can result in safety impacts related to the impairment or distraction of people (e.g. when driving vehicles), health impacts arising from impaired sleep, cause annoyance to people, compromise an existing dark landscape and/or adversely affect natural systems (e.g. plants, animals, insects, aquatic life). These adverse effects can usually be avoided with careful lamp and luminaire selection and positioning:

- Lighting near or above the horizontal is usually to be avoided to reduce glare and sky glow (the brightening of the night sky).



- Good design, correct installation and ongoing maintenance are essential to the optical effectiveness of lighting schemes such as fixed and/or regularly operated functional and decorative lighting elements.
- In combination with optical good practice aimed at limiting light pollution, efficient lamp and luminaire selection are important considerations to minimise energy use and associated carbon emissions.

Common causes of complaints to local authorities include domestic, shop or office exterior security lights, illuminated advertising and flood lighting, so these installations may require particular attention. Similarly, insensitively positioned decorative lighting, particularly in rural areas, can be a cause for concern.

Paragraph: 003 Reference ID: 31-003-20191101

Revision date: 01 11 2019

What factors are relevant when considering when light shines?

The use of lighting only when the light is required can have a number of benefits, including minimising light pollution, reducing energy consumption, reducing harm to wildlife and improving people's ability to enjoy the night sky:

- Lighting schemes could be turned off when not needed ('part-night lighting') to reduce any potential adverse effects - e.g. when a business is closed or between midnight and 5am or 6am. Planning conditions could potentially require this where necessary.
- Lighting could also be dimmed to minimise its visual impact at times of reduced need or increased sensitivity.
- Impacts on sensitive ecological receptors throughout the year, or at particular times (eg during bird migrations) may be mitigated by the design of the lighting or by turning it off or down at sensitive times.

Paragraph: 004 Reference ID: 31-004-20191101

Revision date: 01 11 2019

What factors are relevant when considering how much the light shines?

Consideration of how much light shines may include an assessment of the quantitative and spectral attributes of the lighting scheme (eg light source and performance levels) and whether it exceeds the levels required to fulfil its intended purpose. Consideration can also be given to whether the proposed lighting is purely for decorative purposes as opposed to being needed for functional reasons such as security. The character of the area and the surrounding environment may affect what will be considered an appropriate level of lighting for a development. In particular, lighting schemes for developments in protected areas of dark sky or intrinsically dark landscapes need to be carefully assessed as to their necessity and degree.

Glare needs to be avoided, particularly for safety reasons. Glare is the uncomfortable brightness of a light source due to the excessive contrast between bright and dark areas in the field of view. Consequently, the perceived glare depends on the brightness of the background against which it is viewed. It is affected by the quantity and directional attributes of the source. Where appropriate, lighting schemes could include

‘dimming’ to lower the level of lighting (e.g. during periods of reduced use of an area, when higher lighting levels are not needed).

More lighting does not necessarily mean better lighting. For example, large differences in adjacent lit areas can mask activity in shadow and cause areas of high contrast or glare.

White light, with more blue content or with ultraviolet content, is generally more disruptive to wildlife than, say, yellow/orange light. Similarly, for humans, light intrusion by white/blue light is more disruptive to sleep. Use of modern white light sources that filter out blue or ultraviolet light may mitigate these effects, as well as offering superior directional control. However, whiter light aids people’s vision and ability to perceive colour; it also facilitates CCTV use.

The needs of particular individuals or groups will need to be considered where appropriate. These include the safety of pedestrians and cyclists, and the needs of those whose activities rely on low levels of artificial light such as astronomers. Schemes designed for those more likely to be older or visually impaired may require higher levels of light and enhanced contrast, together with more control, as the negative effects of glare also increase with age.

Paragraph: 005 Reference ID: 31-005-20191101

Revision date: 01 11 2019

What factors are relevant when considering possible ecological impacts of lighting?

Wildlife species differ from humans in their sensitivity to light (e.g. they can be affected by very low levels of light) and may be adversely affected in a number of ways by it (see the Royal Commission on Environmental Pollution’s 2009 report, [Artificial light in the environment](#)). The positioning, duration, type of light source and level of lighting are all factors that can affect the impact of light on wildlife.

The ability of some building materials to polarise light may cause insects, birds and other wildlife to mistake the material for water. This is a daytime and night-time effect and is different to artificial light reflected off surfaces. The effect is particularly strong with smooth (shiny) dark surfaces and may be important to consider when assessing schemes near water bodies. The use of rough, matt, light-coloured materials may reduce the effect.

Further advice is available from the [Defra](#) and [Natural England](#) websites on handling the impact on wildlife – including from artificial light – where Protected Sites or protected species could be affected. The specific nature of any consideration will depend on the features of any protected site or presence of any protected species.

Paragraph: 006 Reference ID: 31-006-20191101

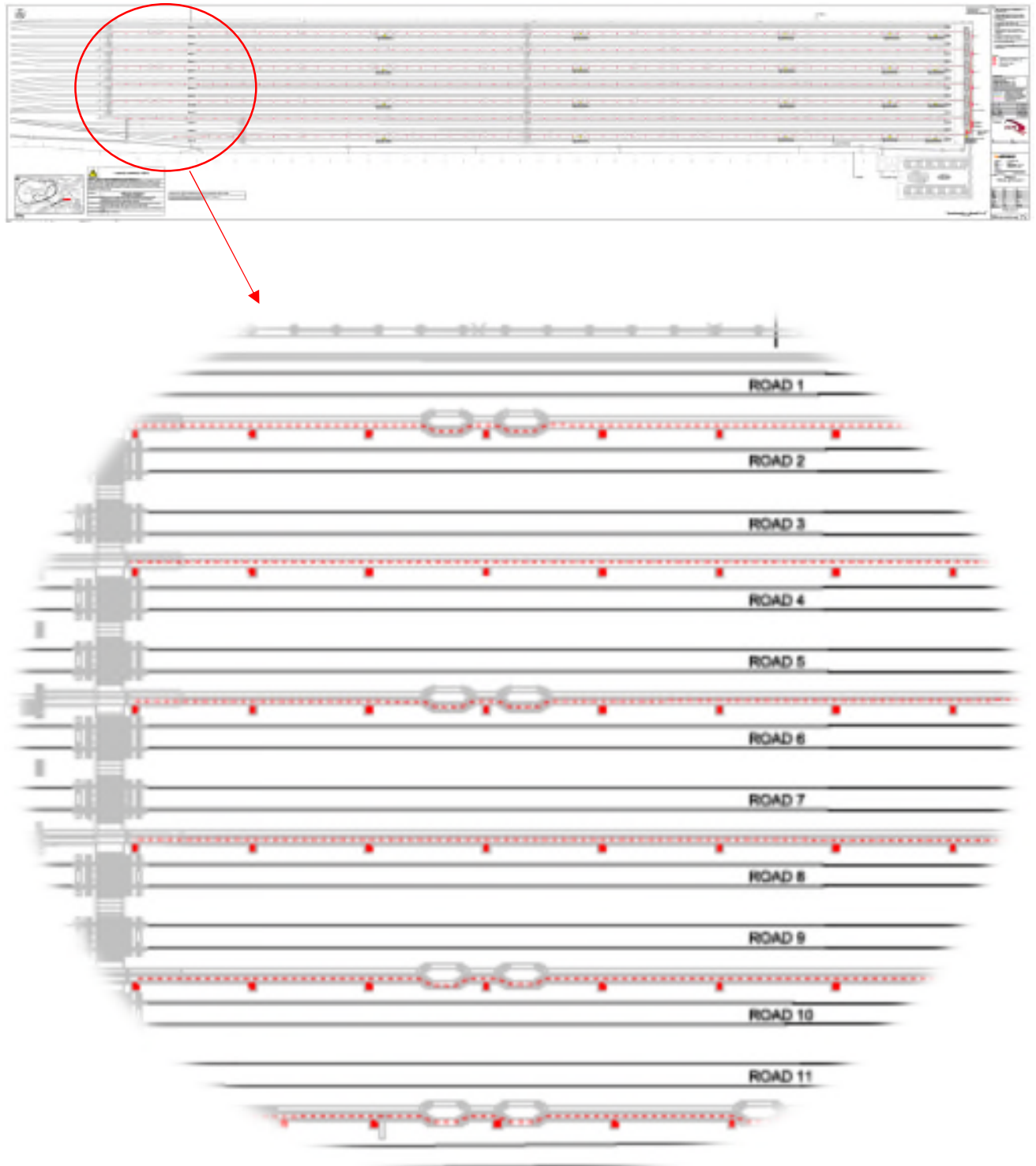
Revision date: 01 11 2019

The relevant sections of the above guidance will be commented on and referenced accordingly.



The installation at GCRE-PH1

The submitted design contains 387no. Designplan **TRK-1200-630N-MT** - Trackline Vandal Resistant Bollards. These are spaced between 7m and 8m apart, vertically mounted and rising in accordance with the terrain.





IP 66

IP 65

150 JOULES = IK 16

The bollard is designed specifically for trackside installations with a bilateral light distribution, emitted sideways at 90° to the luminaire aspect. The optics supplied also claim a zero upward light element.

The units are fabricated in metal and powder coated to ensure a robust and long-lasting finish.

For the model chosen by the design team, at the spacings supplied, the results expected would deliver a ground illumination of around 16Lx at 8.3m spacings. The required illuminance on an open walkway is an average of 10Lx created by artificial light. According to these specifications, the installation should be more than adequate for the requirement.

The datasheet for the fitting can be found in Appendix A at the rear of this report.

The photometry supplied by the manufacturer, and used in the model, is in keeping with the datasheet obtained from their website, this can be observed in the separate lighting calculation report:

Object : Railway Sidings - P1 Typical Scenario
Installation : LED Bollards
Project number : LD/GCRE/PH1
Date : 01.03.2023



1 Luminaire data

1.1 Designplan, Trackline TRK-1200-630N-MT (TRK-1200-630N-MT)

1.1.1 Data sheet

Manufacturer: Designplan

TRK-1200-630N-MT

Trackline TRK-1200-630N-MT

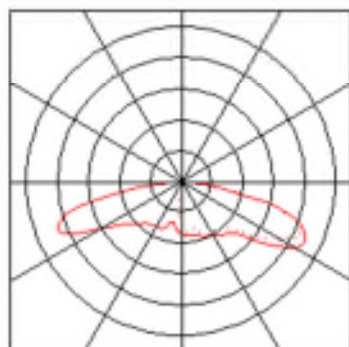
Luminaire data

Luminaire efficiency : 100%
Luminaire efficacy : 75.36 lm/W
Classification : A10 ↓100.0% ↑0.0%
CIE Flux Codes : 20 48 88 100 102
UGR 4H 8H : 34.7 / 13.3
Power : 8.4 W
Luminous flux : 633 lm

Equipped with

Quantity : 1
Designation : LED
Colour : 4000K
Luminous flux : 633 lm
Colour reproduction : >80

Dimensions : 135 mm x 92 mm x 50 mm



Planning conditions have already been submitted so *Paragraphs 001* and *002* are already answered.

Paragraph: 003

Direct sky illumination has been negated in GCRE-PH1 because luminaires with only direct (the downward fraction of light) lighting distribution have been utilised. Furthermore, the optics utilised also adapt this downward light so that it is mainly distributed sideways and not forwards or backwards, fulfilling the condition to illuminate the walkways and not the surrounding environment.

Reflected light from the ground surfaces needs to be calculated to measure the potential 'sky glow' created when the lights are illuminated.

Paragraph: 004

GCRE-PH1 will utilise lighting controls (please see **2ai** below) to ensure the lights will only be illuminated for the duration of time required whilst an engineer task is being carried out. This will, therefore, minimise the impact on the local environment, with minimal light activation overall and zero light activation outside of operating hours.

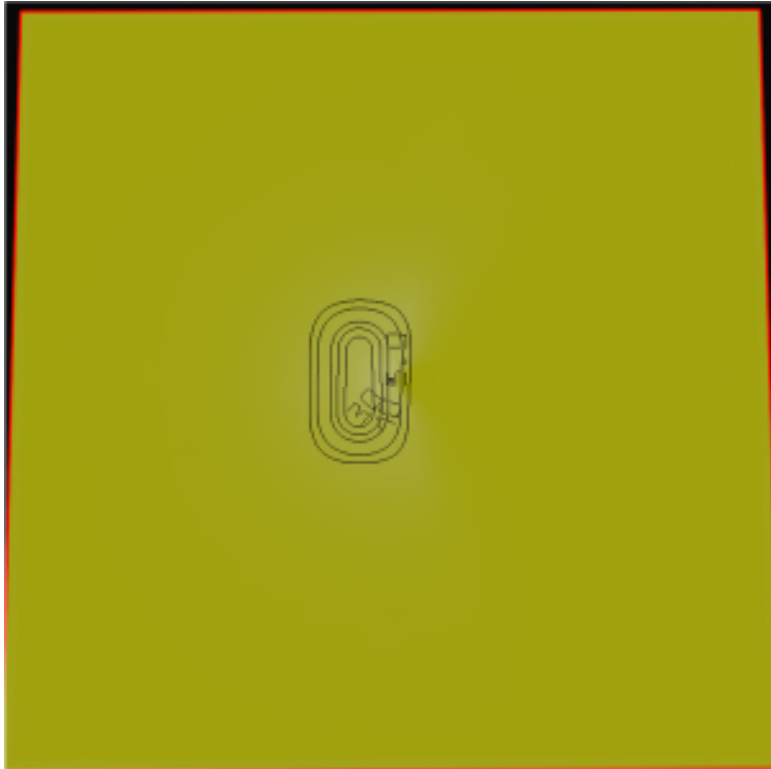
Paragraph: 005

These conditions are met with following installation criteria:

Glare will be negated because the lighting array is comprised of low level bollards with direct illumination only; the light cannot create glare for an observer, as the light source will be far below the observer eyeline, hidden by the construction of the luminaire and emitting light in only a direct (downward) distribution. The photometric curve for these can be seen in the product datasheet in Appendix A. To aid understanding of the light distribution, a single bollard has been isolated and placed in a 20m square room to demonstrate the lighting effect; this can be seen in the following images.

The graphic below shows the side view of bollard mounted in the centre of the room facing to the left. The lighting calculation, with no inter-reflectance, clearly shows there is no indirect (upward light) element as the surface reflectance's in these examples are set to 70% ceiling, 50% walls and 20% floor.





The image to the left, viewed from above, demonstrates the light distribution from the source; this shows the light pattern quite clearly in the isolines diagram.



The image to the left, viewed from above, demonstrates the light distribution from the source in a representative visual.



A key component for environmental matters was the selection of an appropriate colour temperature, as it needs to reflect nature / moonlight during the scotopic phase and meant the choice of CCT (Colour Correlated Temperature - the tone of white light used) was critical. A condition of the pre-agreed client conditions with the National park limited the range of CCT between 3000-4000°K range. The design is completed using 4000°K LEDs as this is closest to moonlight in perfect conditions at 4100°K.

There is no specific requirement in the planning conditions for a specific CCT, a CCT limit or specific local restrictions and therefore the 4000°K light sources may be used.

Paragraph: 006

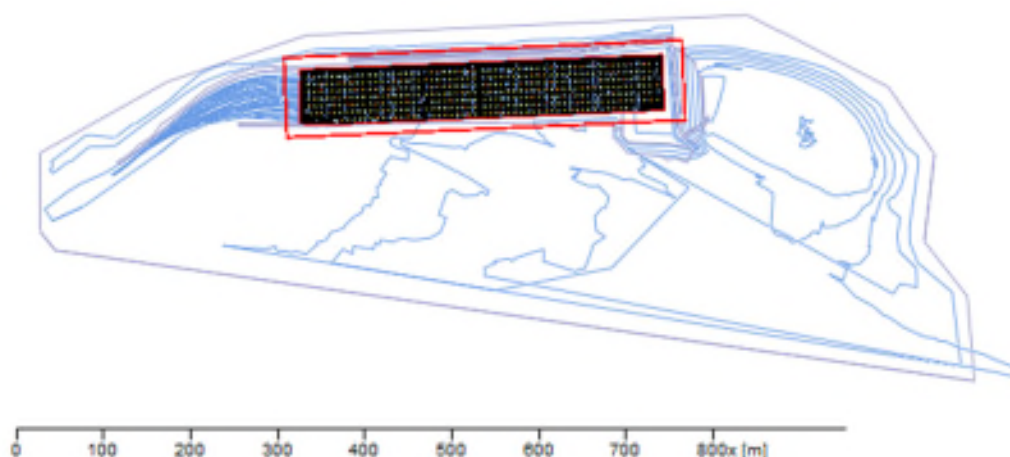
No specific impact studies have been provided, or requested, to be reviewed with the exception of compliance with Dark Skies. This report is specifically for that purpose.



2i. - Worst-case scenario where all lighting defaults to ON

The site illumination for the sidings will be operated in sections and it would be expected that only a single walkway would be illuminated at a time. It is further anticipated that any single walkway would be further divided into several sections containing a smaller number of bollards per section, approximately 20 in number, switched via a time-lag switch (or other lighting controls being considered) set to ensure that no more than 2 sections were illuminated at any single time.

The light will be attenuated by rolling stock present on the tracks and, therefore, the worse-case scenario would involve a control panel open switch failure ensuring all of the bollards were illuminated, with no rolling stock present - a scenario that could never happen in reality. The summary results for the worse-case scenario can be seen below but these should be read with the precept that this scenario would never occur.



General

Calculation algorithm used
Maintenance factor

low indirect fraction
see luminaires / maintenance plan

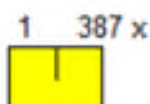
Total luminous flux
Total power
Total power per area (684048.62 m²)

244971 lm
3250.8 W
0.00 W/m²

Illuminance

Average illuminance	Em	7 lx
Minimum illuminance	Emin	0 lx
Maximum illuminance	Emax	121 lx
Uniformity Uo	Emin/Em	1:--- (---)
Diversity Ud	Emin/Emax	1:--- (---)

Type No.\Make

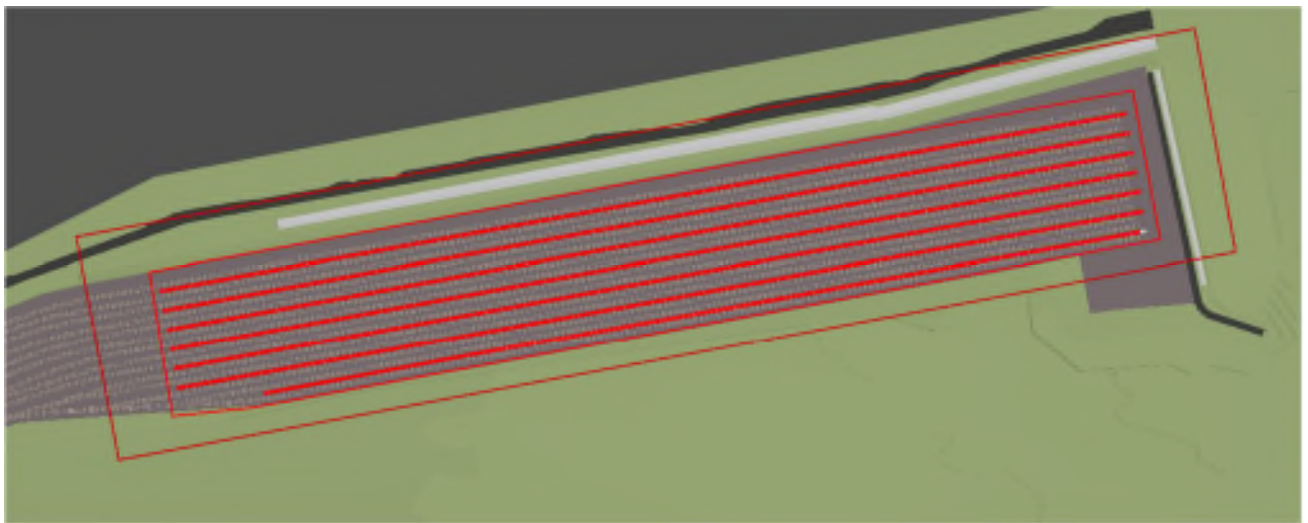


Designplan

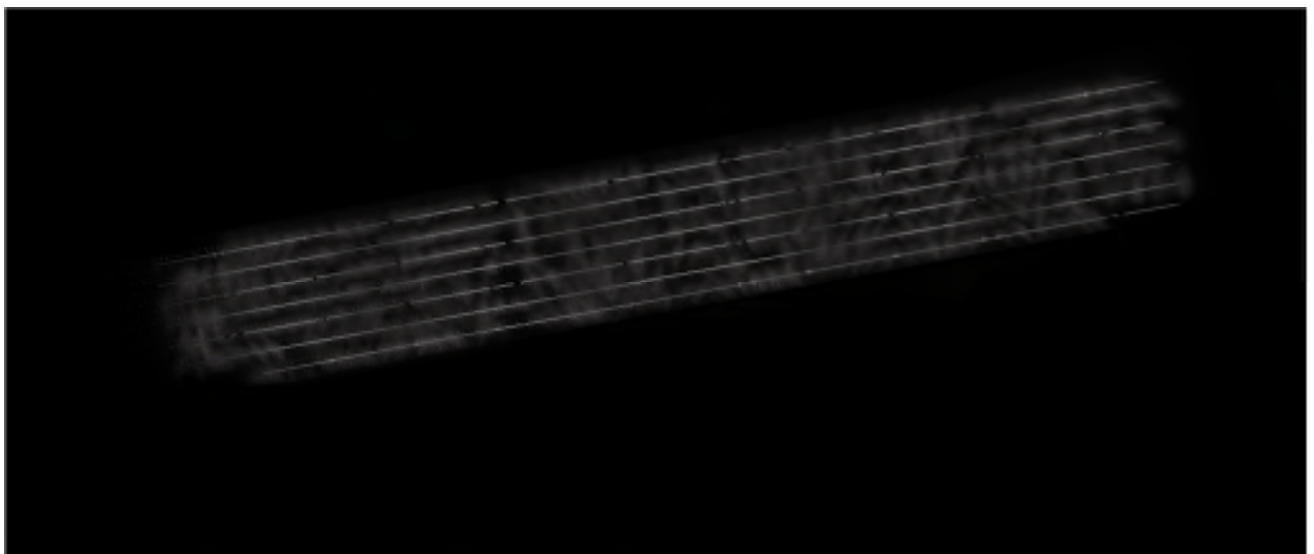
Order No. : TRK-1200-630N-MT
Luminaire name : Trackline TRK-1200-630N-MT
Equipment : 1 x LED 8.4 W / 633 lm
Maintenance factor : 0.89

The graphics on the previous page show an average illumination across the sidings of 7lx but most of the site is in complete darkness, as can be observed from the mass of black colour within the measurement field. The maximum illuminance is observed directly below a bollard light source, adjacent to a large concrete pad, and is 121lx. These 'hot spots' demonstrate the effect of light reflecting from concrete surfaces and steel rails between fittings.

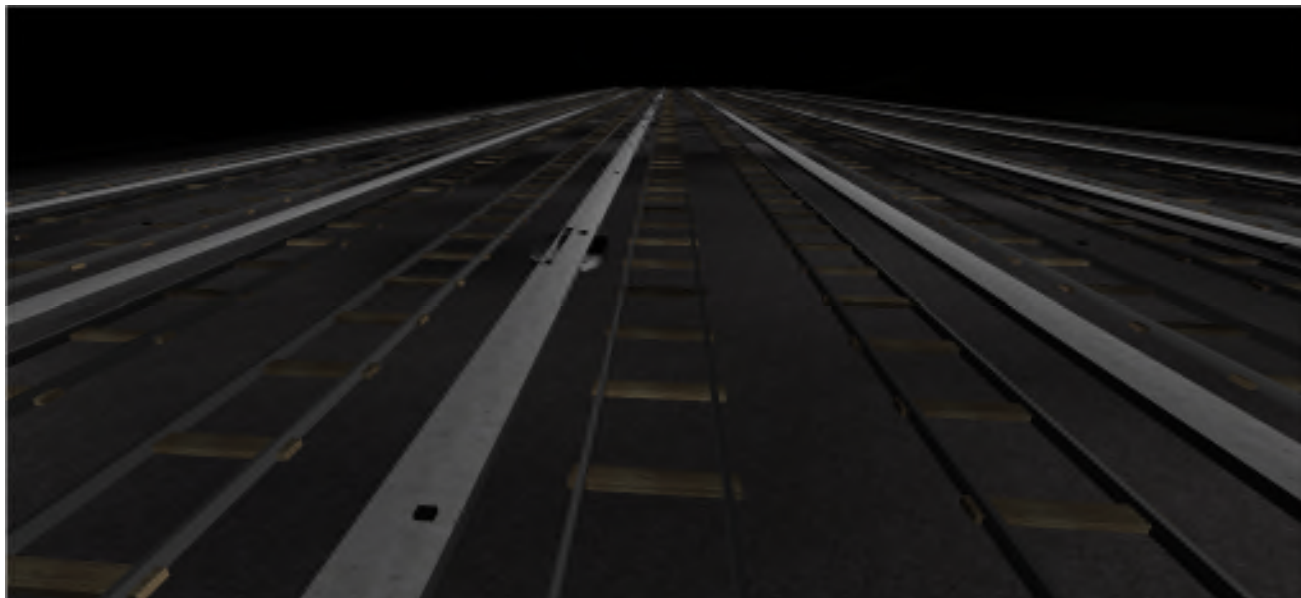
The sidings are all de-populated and all walkways have been illuminated with the entire 387 luminaires, to demonstrate a worst-case lighting scenario. The image directly below is to allow readers to orient themselves prior to observing the same image with zero natural light and purely illuminated with artificial light from the trackside bollards.



The image below is representative of the worst-case scenario, viewed from above, with all the bollards illuminated with an open field of distribution:



The view looking down Path 3, can be seen overleaf. You can clearly make out the empty tracks and the pathways, but you cannot observe any sky glow from within the design software, nor can you see any terrain in the background, proving that light spill is at zero, well within the boundary limits. This is verified in the lighting calculation results where the entire boundary returns 0lx on the **All Tracks** measuring plane.



The table below shows the Inverted Sky Glow Plane results, with a maximum illuminance of 3.11lx and an average of 1.09lx - 20m above the tracks.

General

Calculation algorithm used
Maintenance factor

low indirect fraction
see luminaires / maintenance plan

Total luminous flux
Total power
Total power per area (684048.62 m²)

244971 lm
3250.8 W
0.00 W/m²

Illuminance

Average illuminance
Minimum illuminance
Maximum illuminance
Uniformity U_o
Diversity U_d

E _m	1.09 lx
E _{min}	0.03 lx
E _{max}	3.11 lx
E _{min} /E _m	1:36.4 (0.03)
E _{min} /E _{max}	1:104 (0.01)

Type No.\Make

1 387 x

**Designplan**

Order No. : TRK-1200-630N-MT
Luminaire name : Trackline TRK-1200-630N-MT
Equipment : 1 x LED 8.4 W / 633 lm
Maintenance factor : 0.89



For later comparisons, Path 3 has an average illuminance of 25lx with the peak illuminance at 105lx at a point immediately below a bollard light source. Other paths have similar results, but Path 3 has been chosen for the typical scenario comparison calculations, as a mid-located track with the potential for multiple carriages and open trackside.

General

Calculation algorithm used
Maintenance factor

low indirect fraction
see luminaires / maintenance plan

Total luminous flux
Total power
Total power per area (684048.62 m²)

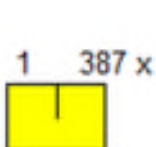
244971 lm
3250.8 W
0.00 W/m²

Illuminance

Average illuminance
Minimum illuminance
Maximum illuminance
Uniformity U₀
Diversity U_d

Em	25 lx
E _{min}	0 lx
E _{max}	105 lx
E _{min} /E _m	1:1200 (0)
E _{min} /E _{max}	1:5150 (0)

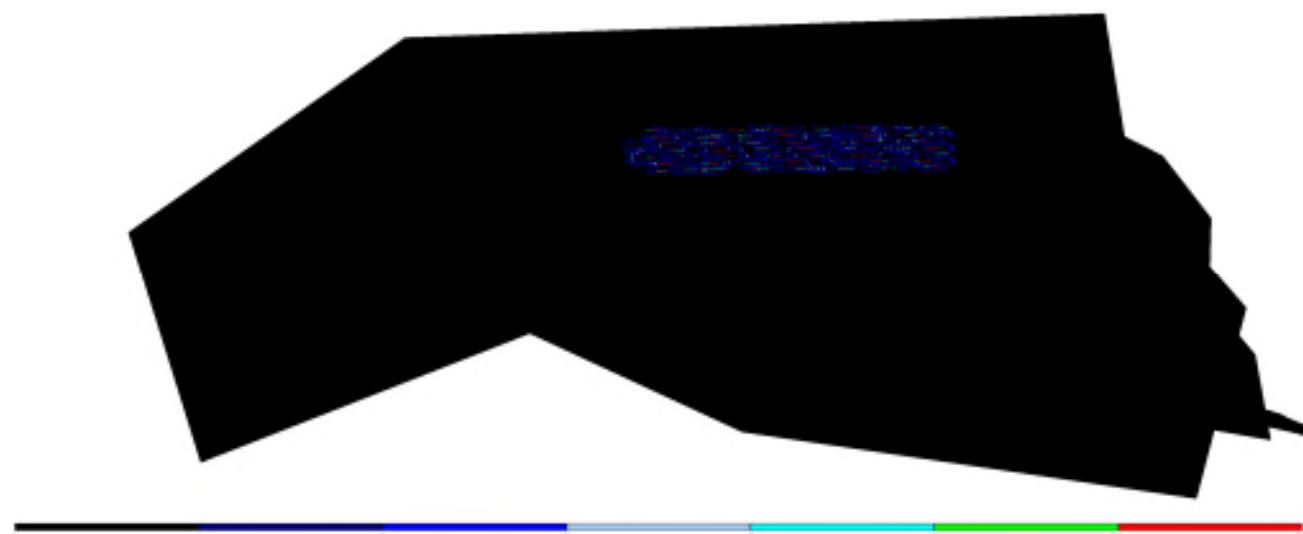
Type No.\Make



Designplan

Order No. : TRK-1200-630N-MT
Luminaire name : Trackline TRK-1200-630N-MT
Equipment : 1 x LED 8.4 W / 633 lm
Maintenance factor : 0.89

The best way to demonstrate the lack of light spill is to show the pseudo colour 3D view, where anything lit below 1lx is coloured black - the scale of illuminance is shown at the bottom of the graphic:

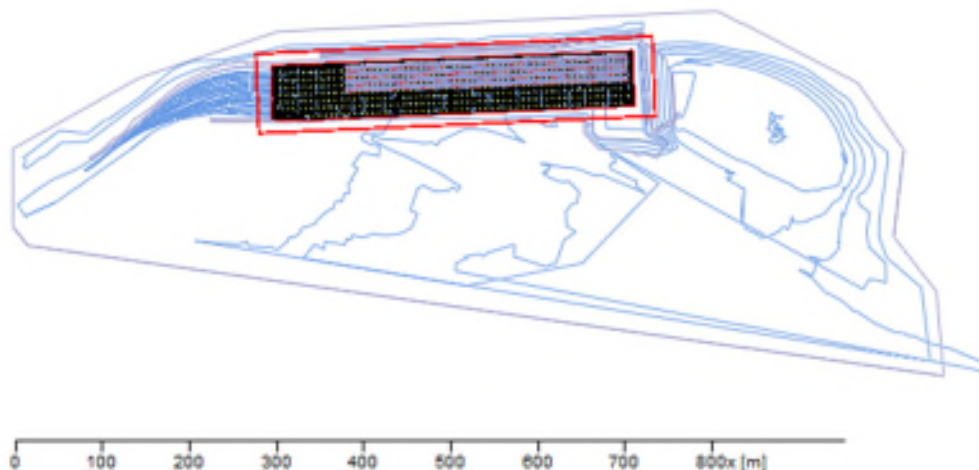


The light spill, even in this adverse case, still doesn't reach the drainage ditches or the grassy embankments.

2ii. - Typical application scenario where only limited walkway lights are ON

The bollard lighting should only be activated when required by engineers walking a pathway. The reason for walking this pathway is to access or inspect rolling stock. Once an engineer enters the area and activates a walkway sector they will walk along the designated route until they reach the 2nd switching point. They will continue, if necessary, along that route until they reach the third switching point. St that time, the first time-lag switch will have timed out and the first sector of bollards would be turned off. Therefore, in a typical scenario, we would expect there to be rolling stock on at least one track and not more than 40 bollards illuminated.

The summary results for this typical scenario can be seen below and is indicative of the expected operation of the site. The full results can be seen in the lighting report for this scenario.



General

Calculation algorithm used	low indirect fraction
Maintenance factor	see luminaires / maintenance plan
Total luminous flux	22788 lm
Total power	302.4 W
Total power per area (684048.62 m ²)	0.00 W/m ²

Illuminance

Average illuminance	Em	1 lx
Minimum illuminance	Emin	0 lx
Maximum illuminance	Emax	114 lx
Uniformity Uo	Emin/Em	1:-- (---)
Diversity Ud	Emin/Emax	1:-- (---)

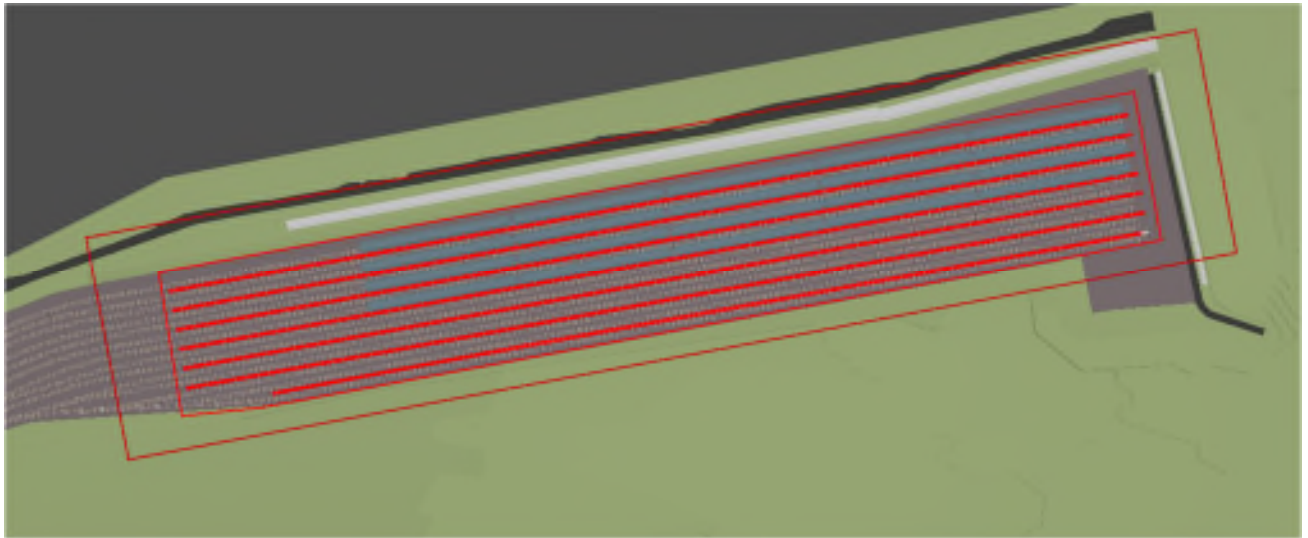
Type No. Make

1	36 x	Designplan
		Order No. : TRK-1200-630N-MT
		Luminaire name : Trackline TRK-1200-630N-MT
		Equipment : 1 x LED 8.4 W / 633 lm
		Maintenance factor : 0.89

The sidings have been populated with a number of carriages and walkway 3 has been illuminated to demonstrate a typical operational scenario.

The average illumination has fallen to 1lx because most of the site is in darkness. The maximum illumination is now 114lx because this is the light from other bollards, in adjacent rows, has been blocked by the train carriages but also has more localised inter-reflecting onto the measuring plane from those same carriages.

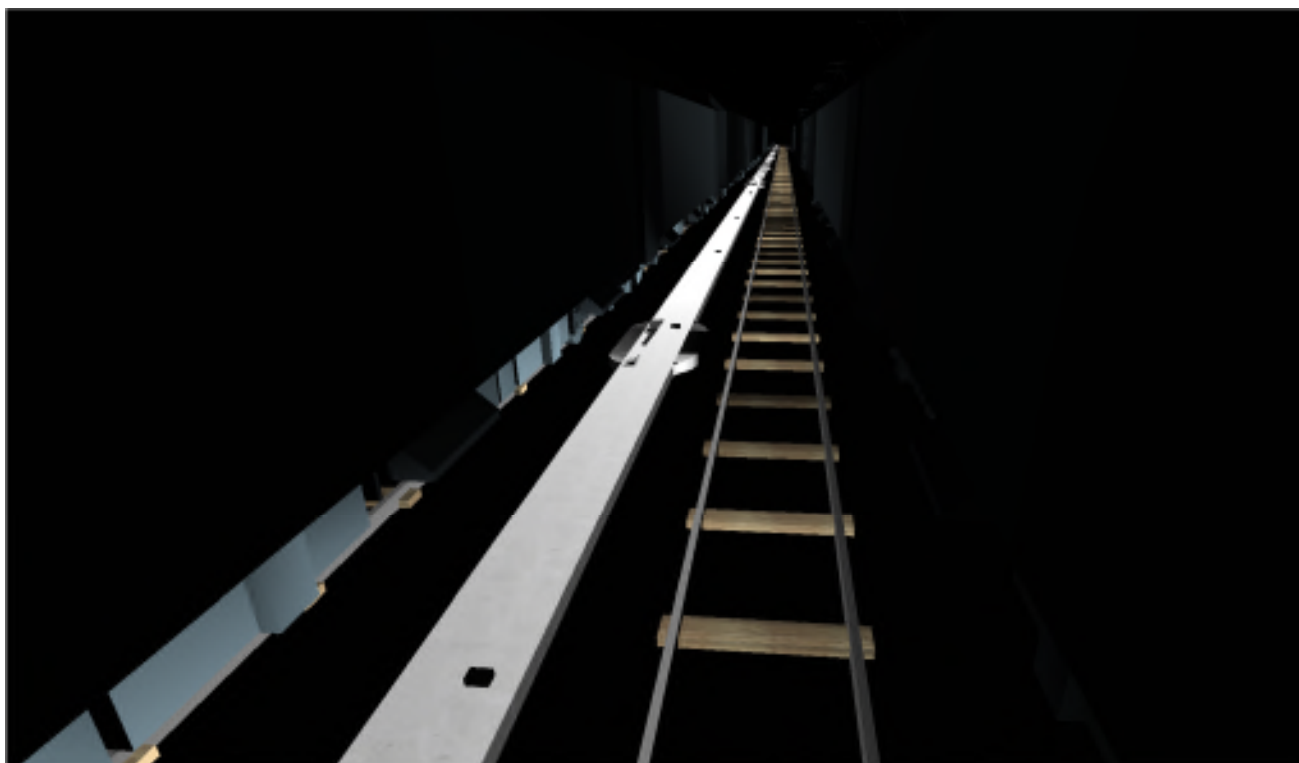
The image directly below is to allow readers to orient themselves prior to observing the same image with zero natural light and purely illuminated with artificial light from the selected bollards.



The image below is representative of a typical scenario, viewed from above:



The view looking down the illuminated Path 3, can be seen overleaf. You can clearly make out the train carriages, the empty tracks and the pathway but you cannot observe any sky glow from within the design software.



The table below shows the Inverted Sky Glow Plane results, with a maximum illuminance of 0.88lx and an average of 0.04lx - 20m above the tracks.

General

Calculation algorithm used
Maintenance factor

low indirect fraction
see luminaires / maintenance plan

Total luminous flux
Total power
Total power per area (684048.62 m²)

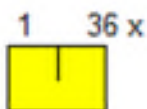
22788 lm
302.4 W
0.00 W/m²

Illuminance

Average illuminance
Minimum illuminance
Maximum illuminance
Uniformity U₀
Diversity U_d

Em	0.04 lx
E _{min}	0 lx
E _{max}	0.88 lx
E _{min} /E _m	1:--- (---)
E _{min} /E _{max}	1:--- (---)

Type No.\Make



Designplan

Order No. : TRK-1200-630N-MT
Luminaire name : Trackline TRK-1200-630N-MT
Equipment : 1 x LED 8.4 W / 633 lm
Maintenance factor : 0.89



Path 3 now has an average illuminance of 16lx with the far end reaching 0lx, as the lights have been turned off at the one end of the walkway; again, inter-reflections between the coaches and ground have increased the localised ground level illumination to a peak 105lx at a point immediately below a bollard light source.

General

Calculation algorithm used	low indirect fraction
Maintenance factor	see luminaires / maintenance plan
Total luminous flux	22788 lm
Total power	302.4 W
Total power per area (684048.62 m ²)	0.00 W/m ²

Illuminance

Average illuminance	Em	16 lx
Minimum illuminance	Emin	0 lx
Maximum illuminance	Emax	105 lx
Uniformity Uo	Emin/Em	1:--- (---)
Diversity Ud	Emin/Emax	1:--- (---)

Type No.\Make

	Designplan		
	Order No.	:	TRK-1200-630N-MT
	Luminaire name	:	Trackline TRK-1200-630N-MT
	Equipment	:	1 x LED 8.4 W / 633 lm
	Maintenance factor	:	0.89

All other paths are at 0lx average and a 0.02lx maximum is observed on Path 2, clearly demonstrating zero horizontal light spill.

General

Calculation algorithm used	low indirect fraction
Maintenance factor	see luminaires / maintenance plan
Total luminous flux	22788 lm
Total power	302.4 W
Total power per area (684048.62 m ²)	0.00 W/m ²

Illuminance

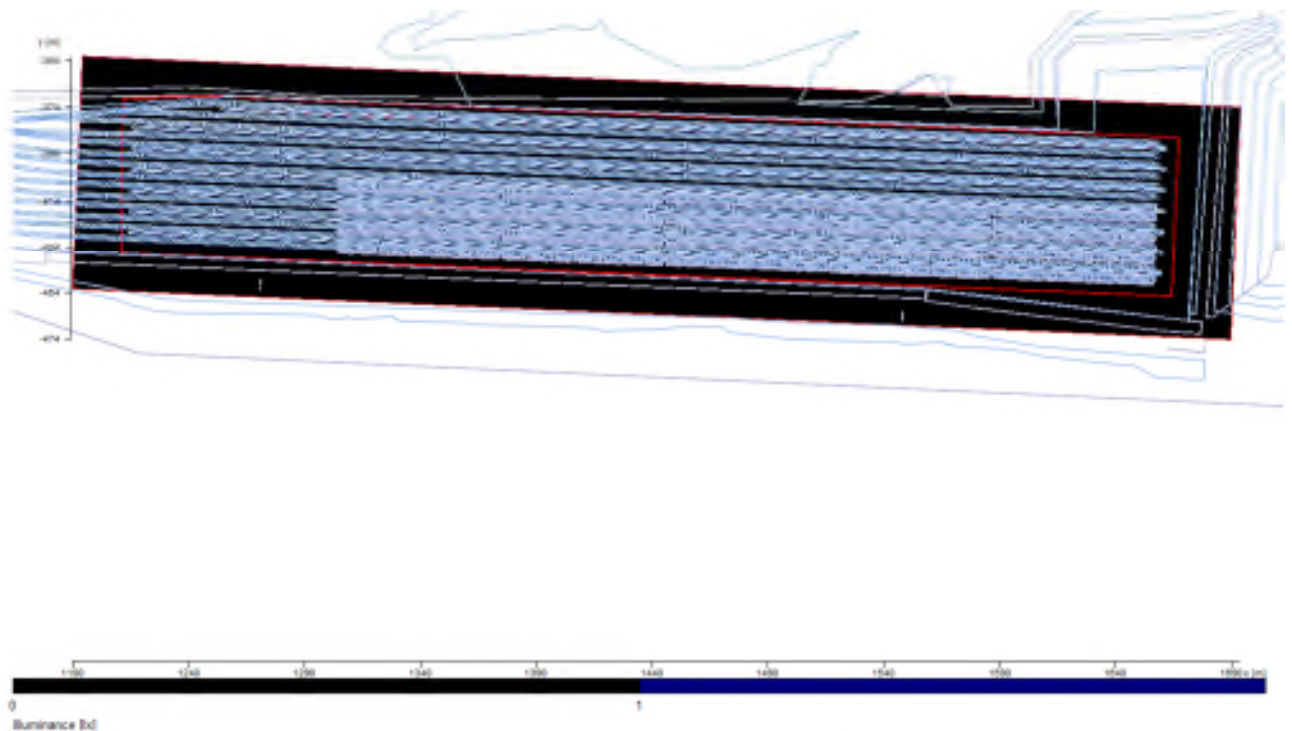
Average illuminance	Em	0 lx
Minimum illuminance	Emin	0 lx
Maximum illuminance	Emax	0.02 lx
Uniformity Uo	Emin/Em	1:--- (---)
Diversity Ud	Emin/Emax	1:--- (---)

2iii. - Potential impact on neighbouring areas and compliance with the Dark Skies initiative

When illuminating any space, there is likely to be light spill. This has to be minimised for all sorts of reasons starting with light pollution control and ending up with energy saving as another environmental factor, amongst many others.

The upward illumination, measured across an area of 500m x 100m, at 20m above the tracks is 0.04lx on average during operation of a typical expected scenario; this further creates a maximum spot illuminance on the same plane of 0.88lx. To put this into perspective, the average illuminance across the ½km wide plane is less than the effect of moonlight on a dark night and just 40% of moonlight on an average typical UK clear night sky.

The intensity of moonlight varies greatly depending on its phase, but even the full Moon typically provides between 0.05 - 0.1 lux illumination. When the full Moon is at perigee and viewed around upper culmination from the tropics, the illuminance can reach up to 0.32 lux.



As can be seen from the above graphic, the illuminance across the entire plane is less than 1lx ; with the average illumination less than 5/100 of a lux whilst the pathway is lit to an average of 16lx with a scotopic uniformity of 1:6.5.

The Sky Glow plane was set to 20m above the tracks because this has been deemed as a reasonable height which may be observed from the boundaries of the site, given the topography of the development and its location to nearby roads and structures. The impact on wildlife and the wider local community will be minimal if anything at all should be kept to a minimum with the careful selection of light source, optics and by the use of lighting controls.

Summary

In summary, there were three primary lighting requirements that needed satisfying:

1. Lights to provide illumination along the walkways between rail tracks, primarily for engineer footfall. Task lighting will also be required for performing inspections and manual tasks. These lights would be temporary in nature with a huge emphasis on health and safety in the workplace and therefore are exempt from any required calculations, as would be any temporary safety lighting.
2. Minimal light spill
3. Reduced impact on Brecon Beacons National Park Trust land and locale.

The design has been completed using the following luminaires:

- 387 no. **TRK-1200-630N-MT** LED 1.2m Bollards - 4000°K

All mounted on ground anchored posts, with the luminaire height at 1.2m above ground level to create a safe environment for staff and a suitable environment for the local wildlife. These lights have been specifically selected because they have been designed exclusively for trackside applications and the datasheet has been provided as evidence of the photometry also used in the lighting calculations.

By optimising optics to limit wasted light and light spill, overcoming the risks of light pollution and the dangers of glare to passing pedestrians and train divers, the proposed solution answers most possible environmental concerns but it is the fact that these lights minimise the use of the energy, meaning the environmental impact is significantly reduced and the risk to staff on GCRE-PH1 from lighting issues is low.

The CAD drawings accompanying this report, combined with the two lighting reports and the engineering drawings from Arcadis, (ref: GCRE001-ARC-XX-SS-DR-EE-00063) demonstrate the locations of each bollard, the effect it has on illuminating the overall ground space, specifically walkways and rail tracks, as well as the surrounding areas: all are within the parameters required for a minimal environmental impact and Dark Skies compliant installation.

Even with the Sky Glow measurement plane above the height of the Eastern embankment, the minimal light observed on that plane and the zero light falling on the surrounding landscape permits the assumption that landscape and environmental impact on are negated and the lighting will be not be of detriment to the local fauna, flora or residents alike.

In final summation, all required design criteria and the planning conditions are deemed to have been fulfilled.



Neil Tomkinson
Director
Lumen Designers Ltd



APPENDIX A

Designplan Trackside

Luminaire Datasheet

**designplan**
LIGHTING

TRACKLINE



IP 66

IP 65

150 JOULES = IK 16

**Sectors**Transport**Finishes**

TITANIUM

Trackline vandal resistant bollard is designed specifically for railways sidings in two different heights.

- Spacings up to 11.6 metres (1200mm version at 0.1 uniformity).
- Complies with London Underground and Network Rail uniformity and illuminance specifications (refer to table below).
- Double insulated control gear to protect against internal faults.
- Supplied with two internal M5 studs for equipotential bonding.
- Specially sourced optics ensure zero upward light and wide distribution.
- Easily maintained through access hatch and removeable gear tray in head.
- Robust heavy gauge construction, finished in titanium polyester powder coat.
- Fully IP rated head (IP65 and IP66).
- Impact resistance rating of IK16 (150 joules).
- Horizontal load tested up to 1.5kN/m.
- Supplied with internal plywood board for installation of junction box or fused cutout.
- Root mount and base plate with external bonding stud available as options

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Incorporated Number: 9862082. Registered Office: Meryll House, 57 Worcester Road, Bromsgrove. B61 7DN



- Available with twin-head.

Technical Information

LED, Clear Diffuser	Temp	Height	Load	Lum/lm	Efficacy	CRI	Weight	HT
TRK-1000-350N-MT	4000K	1000mm	4.5W	345 lm	76 lm/W	CRI>80	15.5kg	HT40°
TRK-1200-350N-MT	4000K	1200mm	4.5W	345 lm	76 lm/W	CRI>80	16.5kg	HT40°
TRK-1200-630N-MT	4000K	1200mm	8.4W	633 lm	76 lm/W	CRI>80	16.5kg	HT40°
Emergency Output	4000K	-	379 lm	-	-	-	-	

Twin-head

LED, Clear Diffuser	Temp	Height	Load	Lum/lm	Efficacy	CRI	Weight
TRKD-1000-700N-MT	4000K	1000mm	9.5W	713 lm	75 lm/W	CRI>80	16kg
TRKD-1200-700N-MT	4000K	1200mm	9.5W	713 lm	75 lm/W	CRI>80	17kg

HT Applies for standard version. For any options please check with technical sales.

Trackline Bollard contains a light source of energy efficiency class D.

Trackline LED Lifetime $L_{80B_{10}} > 100,000h$ at 25°C ambient.

Trackline Driver Lifetime up to 100,000h at 25°C ambient.

Uniformity and Spacings

Output (lms)	Height (mm)	Lux level	Uniformity	Spacing (m)
345	1000	10	0.13	8.6
345	1000	11.2	0.25	7
633	1200	11.1	0.1	11.6
633	1200	16.6	0.25	8.3

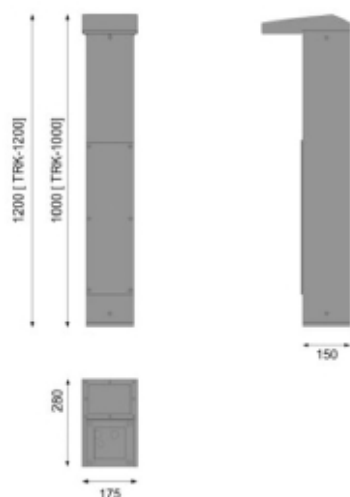
For lighting calculations utilising the double-sided Trackline version, please use 2 x single Trackline LDT files back-to-back.

Fitting Options

Integral 3-hour duration emergency	add suffix -E3
Self test 3-hour duration emergency	add suffix -ES



DALI 3-hour duration emergency	add suffix -ED
DALI dimming/monitoring	add suffix -DA
Baseplate with external earth termination lug	add suffix -B1
Root mounting bracket	add suffix -TRK-ROOT



- B1 Option

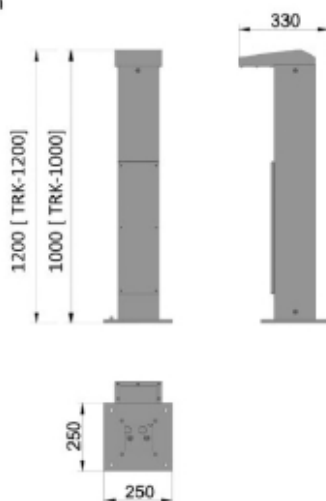


IP 66

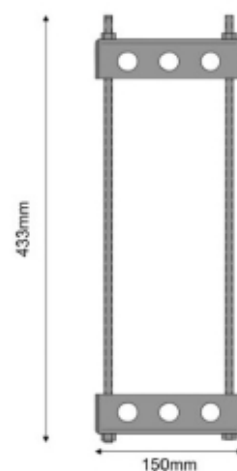
IP 65

150 JOULES = IK 16

- B1 Option

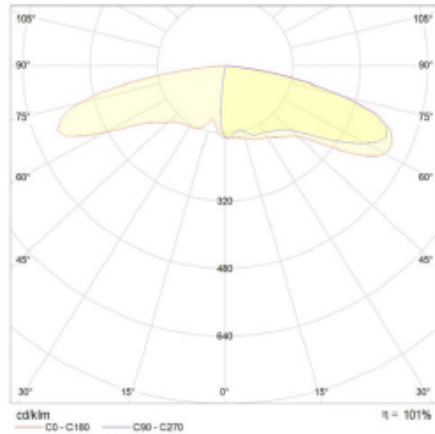


Root Mounting Bracket





Trackline



designplan
LIGHTING

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