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Boskalis Cambridge Gulf: Sand Production Vessel Light Modelling and Impact Assessment

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SUMMARY OF OVERALL FINDINGS

Artificial light modelling of the proposed Sand Production Vessel (SPV) operations indicated low levels of observed light emissions from all five marine turtle nesting beaches in the Cambridge Gulf (CG) area. Initial contour modelling confirmed key OFOV FME Impact Level boundaries at 1.6 km (Impact Level 3), 4.2 km (Impact Level 2) and 4.2 km (Impact Level 1).

Panoramic modelling from each nesting beach showed a further reduction in the brightness (OFOV FME) observed due to the incorporation of topography into the model. From all nesting beaches excluding Barnett Point and Cape Domett Small Beach, topography in the direction of the POA provides substantial shielding. The OFOV FME values for each nesting beach all fell into the N/A Impact Level range (<0.01), with exception to Barnett Point which recorded 0.055 OFOV FME (Impact level 1).

Overall, no significant impacts from the SPV's lights on nesting adult or hatchling Flatback Turtles in the CG area are predicted.

1. INTRODUCTION AND BACKGROUND

Boskalis Australia Pty Ltd (BKA) is proposing to develop a marine sand-sourcing and export operation in Cambridge Gulf (CG) near Wyndham in the north-east of Western Australia (WA). The proposed operation will use a single Sand Production Vessel (SPV) based on the design principles of a large Trailing Suction Hopper Dredge (TSHD) vessel, with a single suction arm and drag-head.

BKA has self-referred the proposal to the WA Environmental Protection Authority (EPA) under Section 38 of the *WA Environmental Protection Act 1986* (EP Act) in September 2024, and to the Commonwealth under the *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act) in January 2025.

There are five flatback turtle (*Natator depressus*) nesting sites located in the general CG area, as shown in **Figure 2** and described in **Section 3.2**. The Seaward Beach at Cape Domett is globally significant with an annual nester abundance in the order of several thousand individuals (Whiting et al. 2008).

The EPA has decided to assess the proposal under the EP Act, based on the referral reports submitted by BKA, with an additional Request for Information (RFI) including the SPV light modelling that is the subject of this report, as described in **Section 2**.

To address the EPA request, BKA engaged Nocterra to undertake the technical study and impact assessment as presented in this report.

2. STUDY OBJECTIVES AND TASKS

The overall objective of the study is to address the EPA's request which states:

“Undertake an evaluation of impacts from artificial light originating from the proposed SPV, and include discussion in the report of the results in the context of the proposal that includes an assessment of:

- Predicted impacts which are informed by realistic light emission scenarios given the likely marine fauna (Flatback Turtle) presence, the likely behaviours they are undertaking, the vessel light source characteristics and the natural darkness of the area.*
- The importance of the Cambridge Gulf area for Flatback Turtle nesting and appropriate mitigation measures for operations during night-time hours during peak turtle nesting periods (August – September).*
- The mitigation and monitoring commitments that provide confidence that artificial light impacts will be managed appropriately.*

The artificial light impact assessment must be consistent with the National Light Pollution Guidelines for Wildlife (DCCEEW 2023).”

To achieve this objective, the assessment was undertaken in accordance with the following tasks:

- Task 1: Natural Darkness:** Perform a Desktop assessment of the existing light environment within the CG area.
- Task 2: Light Modelling:** Model the light emissions from the proposed SPV (using methods that are accepted by the WA EPA and DCCEEW).
- Task 3: Impact Assessment:** Use the modelled light emissions from Task 2 to assess potential light impacts on nesting and hatching flatback turtles at each of the five nesting sites in the CG area from relevant SPV locations.
- Task 4: Findings & Recommendations:** Present the findings of Tasks 1 to 3 including summarising the assessment of potential impacts and make recommendations on any additional mitigation and monitoring measures that might be required.

3. TARGET SPECIES & LIFE STAGE

3.1 Scope

3.1.1. Species

While the CG region supports a significant population of flatback turtles, green turtles (*Chelonia mydas*) have also been recorded nesting at Cape Domett, albeit at very low levels with only 12 records documented over seven nesting seasons (Price & Raaymakers 2024). Given the minimal and infrequent nature of this activity, green turtles are not considered further

in this impact assessment. The assessment therefore focuses solely on the flatback turtle species within the CG region, as agreed between BKA and the WA Department of Water and Environmental Regulation (DWER) EPA-Services during scoping of this study.

3.1.2. Life Stage

This impact assessment specifically focuses on the influence of artificial light from the SPV on marine turtle behaviour. Accordingly, only life stages during which adult female and hatchling turtles are engaged in behaviour at their nesting habitat are within scope, as there is a known pathway for potential impact (as per DCCEEW 2023).

Activities involving adult and juvenile turtles in offshore waters, including inter-nesting, foraging, and migration, are considered out of scope, as artificial light is not known to influence these behaviours and no established pathway for impact exists.

Although artificial light has the potential to influence the immediate offshore dispersal of hatchling turtles from the nesting habitat (Wilson et al. 2018), the strong tidal currents recorded within the CG region (>2 m/s; Boskalis Australia 2024) are expected to transport hatchlings away from the area and restricts hatchlings from actively swimming in the direction of the SPV. As such, this phase is also excluded from the scope of this impact assessment.

3.2 General Species Description

The flatback turtle is endemic to northern Australian waters with sightings reported in south-eastern Indonesia and Papua New Guinea, and is listed as Vulnerable under the WA *Biodiversity Conservation 2016 Act* (BC Act), Vulnerable and Migratory under the EPBC Act, and as Data Deficient on the IUCN Red List.

Adult flatback turtles are known to utilise nesting habitat on sandy beaches, with the Cape Domett Seaward Beach located outside of CG being the most significant (Whiting et al. 2008; Price & Raaymakers 2024). The *Recovery Plan for Marine Turtles in Australia 2017 – 2027* (Commonwealth of Australia 2017) identifies this nesting habitat as critical for the survival of the species within the CG region. Furthermore, a Biologically Important Area (BIA), which is a spatially defined area where aggregations of individuals of a species are known to display biologically important behaviour, has been designated by DCCEEW for flatback turtles onshore nesting habitat at Cape Domett (Commonwealth of Australia 2012).

The nesting population within this region forms part of the Joseph Bonaparte Gulf (JBG) genetic stock (Fitzsimmons et al. 2020), for which the overall population trend remains unknown (Commonwealth of Australia 2017).

3.3 Nesting Habitat and Activity within Cambridge Gulf Region

Flatback turtle nesting activity has been documented at four sandy beach habitats located on seaward coasts outside of CG, these being, from east to west, the Cape Domett Seaward Beach (east of Cape Domett), Cape Domett Small beach at the tip of Cape Domett, Turtle Bay on Lacrosse Island and Turtle Beach West (west of Cape Dussejour). A fifth nesting site at

Barnett Point inside CG has also been identified, where nesting activity occurs on sand cheniers located behind mangroves (**Figure 2**; Price & Raaymakers 2024; Whiting et al. 2008).

Nesting activity monitoring in the CG region has primarily focused on the Cape Domett Seaward Beach, where the Department of Biodiversity, Conservation, and Attractions (DBCA) has conducted a long-term monitoring program since 2012. This program involves overnight track counts conducted during the peak nesting season, typically spanning 13 to 14 nights each season (Price & Raaymakers 2024). From 2013 to 2022, the mean number of overnight tracks recorded per season was 48.7 ± 12.3 (range = 27.4 – 63.4, $n = 10$). Earlier survey work conducted between April 2006 and March 2007 involved four- to five-day monitoring sessions every seven weeks (Whiting et al. 2008). These surveys recorded a peak nester abundance of 71 to 74 turtles per night and estimated an annual nesting population of 3,250 individuals (95 % CI = 1431 – 7757), establishing Cape Domett Seaward Beach as one of the largest known flatback turtle nesting populations.

In a regional aerial survey conducted in July 2023, Price & Raaymakers (2024) recorded low levels of flatback turtle nesting activity at Cape Domett Small Beach (7 nests) and Turtle Bay on Lacrosse Island (6 nests). A higher level of nesting activity was also recorded at Turtle Beach West, west of Cape Dussejour (28 nests), and at Barnett Point (13 nests). No nesting activity was detected at sandy habitat on the western side of CG, the northern coast of Adolphus Island, or east of Cape Domett.

With regards to sea-finding behaviour at these nesting habitats, there is no known available data on the orientation of adult turtles following their departure from the nesting site or hatchling flatback turtles following emergence onto the sand surface.

3.4 Seasonality Factors and Sensitive Periods for Target Species

Flatback turtles within the JBG genetic stock exhibit year-round nesting, with a peak during the winter months of August and September (Commonwealth of Australia 2017; Limpus 2004; Whiting et al. 2008). Hatching also occurs at beach habitat throughout the year, and while there is no defined seasonal peak (Commonwealth of Australia 2017) it is likely to occur approximately 45 to 50 days after the peak in nesting i.e. September to October.

3.5 Influence of Artificial Light on Behaviour

3.5.1. Nesting Adult Turtles

Adult female marine turtles return to land, predominantly at night, to nest; relying on visual cues to select, and orient on, sandy nesting beaches. Artificial lighting on or near beaches has been shown to disrupt nesting behaviour (see Witherington & Martin 2003 for review) and beaches with nearby high-intensity artificial light, such as urban developments, roadways, and piers, often have lower densities of nesting females compared to beaches with less development (Salmon 2003; Hu et al. 2018).

In addition to potential impacts to nesting females prior to or during nesting, artificial light also has the potential to impact post-nesting behaviour (Hodge et al. 2007). On completion of laying, nesting females are thought to use light cues to return to open ocean, orientating

towards the brightest light (Witherington & Martin 2003). However, observations of nesting females and emerging hatchlings at the same beach showed that females were disorientated much less frequently than hatchlings (Witherington 1992), indicating that nesting females are less vulnerable to impacts of artificial light on sea-finding behaviour post-nesting than as hatchlings.

3.5.2. Hatchling Turtles

Artificial lights interfere with natural light levels and silhouettes disrupting onshore hatchling sea finding behaviour (Witherington & Martin 2003; Pendoley & Kamrowski 2015; Kamrowski et al. 2014). Hatchlings may become disorientated, crawling in circuitous paths, or misorientated, where they move in the wrong direction, possibly as a result of being attracted to artificial lights (Witherington & Martin 2003; Lohmann et al. 1997; Salmon 2003). On land, movement of hatchlings in a direction other than the sea often leads to death from predation, exhaustion, or dehydration (Witherington & Martin 2003).

Hatchling orientation can be disrupted by light produced at distances of up to 18 km from the nesting beach (Kamrowski et al. 2014), although the degree of impact is influenced by a number of factors, including: light intensity, visibility (a function of lamp orientation and shielding), spectral power distribution (wavelength and colour), atmospheric scattering, cloud reflectance, spatial extent of sky glow, duration of exposure, horizon elevation, lunar phase, and geographical screening.

4. DESCRIPTION OF PROPOSED OPERATION

Key factors relating to the proposed operations, and relevant to the assessment of impacts from artificial light include:

- **Project lifespan:** Up to 15 years from commencement of operations.
- **Single vessel:** The proposed operation will involve a SPV based generally on the design of a large TSHD. While the design is conceptual, indicative specifications are an overall length of 350 m, breadth of 62 m, and a draft of ~19 m.
- **Fully marine-based operation:** The proposal does not involve the construction and operation of any landside or nearshore facilities, with the SPV undertaking all operational activities.
- **Marine area:** The proposed operational area (POA) is located in the central part of the main body of CG where there is a significant seabed sand resource, covering an area of ~100 km².
- **Schedule:** The SPV will self-load sand in CG for one to two days every two weeks. It will then travel to the sand delivery port in Asia and return to CG two weeks later to repeat the cycle. This means that the SPV will only operate in CG for 52 days per year, with zero presence and therefore zero light source for 86 % of the time throughout the project lifetime.

- **Footprint each loading cycle:** During each one to two-day sand loading cycle, the SPV will work over an area of $\sim 0.5 \text{ km}^2$ within the POA, with a drag head width of $\sim 6 \text{ m}$.

5. STUDY METHODS

5.1 Task 1: Natural Darkness

A desktop review of available data on the CG region was performed to determine existing light levels. This review utilised publicly available Visual Infrared Imaging Radiometer Suite (VIIRS) Satellite to understand the extent and location of regional light sources (**Figure 3**). Additional observations on navigation lights and cargo vessel routes were provided by EcoStrategic Consultants.

5.2 Task 2: Light Modelling

Nocterra have developed software that integrates with the publicly available ILLUMINA model to predict the visibility and intensity of a particular light source at specific viewpoints. ILLUMINA is an academic model developed by Dr. Martin Aube and is designed to simulate the effect of various atmospheric factors on night-time light emissions from a precise inventory of lighting fixtures (Aube et al. 2020). Multiple lighting parameters can feed into the model, including location, height, spectral output, and shielding. It can also take into account topography and surface reflectance, and proposed structures that may block the visibility of lighting.

The model natively outputs in radiance units (watts per square metre per steradian; $\text{w/m}^2/\text{sr}$) but can be converted to Visual Magnitudes (Vmag) or Full Moon Equivalents (FME) depending on which is most relevant for the receptors being assessed.

This light modelling methodology has been applied across multiple projects and is considered consistent with approaches accepted by both the WA EPA and DCCEEW.

5.2.1. Lighting Inventory

A lighting inventory of the SPV was generated using engineering drawings and specification sheets provided by BKA, as contained in **Appendix B**. A summary of the lighting inventory is provided in **Table 1**.

Table 1: Lighting inventory of the Sand Production Vessel.

Model	Power (W)	Power (lumens)	CCT (K)	Count (No. of lights)	Lumen output total
Glamox MIRS67-600(M) G2 1500 HF Amber TW M20 FR/PC	25	1,540	1800	124	190,960
Glamox RLX D FL 160W100-277VACD wide 830 3XEABKX	160	14,893	3000	15	223,395
Glamox RLX D FL 240W100-277VACD Wide 830 3XEABKX	240	21,204	3000	11	233,244

The external SPV lighting consisted of three distinct light types, one amber (1800K) linear LED, and two 3000K floodlights (**Table 1**). The SPV has a total external luminaire count of 150, and a total power output of 647,599 lumens.

The lights are spaced near-homogenously across the main deck of the SPV, with a small area of concentrated lighting at the rear between the fuel tanks. The precise location of each light was determined by cross referencing the supplied engineering drawings and specification sheets. The height (AMSL) of each light was determined using a vessel draft of 19 m, and by placing linear and floodlights 3 m and 5 m above the specified deck heights respectively. The lights ranged from 32.5 – 52 m AMSL.

5.2.2. Units of Measurement

For the purpose of assessing potential impacts to flatback turtles, modelling results were converted from the native unit of measurement (radiance) into orientation field-of-view full moon equivalents (OFOV FME). This unit compares the average brightness within a turtle's field-of-view (considered 180° x 30°; Witherington 1992) centred on the brightest pixel to that of the same field-of-view oriented toward a full moon at 45° elevation (**Figure 1**). The relative number of "full moons" within a turtle's FOV was used to perform a high-level assessment on the likelihood of impacts to a marine turtle (**Table 2**).

Note: The scale in **Figure 1** and **Figure 5** is a false-colour map and presents results in log radiance as the model computes radiance down to negligible values (on orders of magnitude of 10^{-10}). The figures communicate quantitative results and are not a visual representation of what light would be seen by a human or turtle receptor.

Table 2: Orientation field-of-view full moon equivalents (OFOV FME) impact categories and their explanation.

Impact category	OFOV FME	Impact category explanation
0	< 0.1	Brightness visible to a marine turtle's field-of-view is less than 10 % of a full moon, behavioural impacts to marine turtles are unlikely.
1	0.1 – 1.0	Brightness visible to a marine turtle's field-of-view is between 10 % and 100 % of a full moon, behavioural impacts to marine turtles are possible.
2	> 1.0	Brightness visible to a marine turtle's field-of-view is greater than 100 % of a full moon, behavioural impacts to marine turtles are likely.

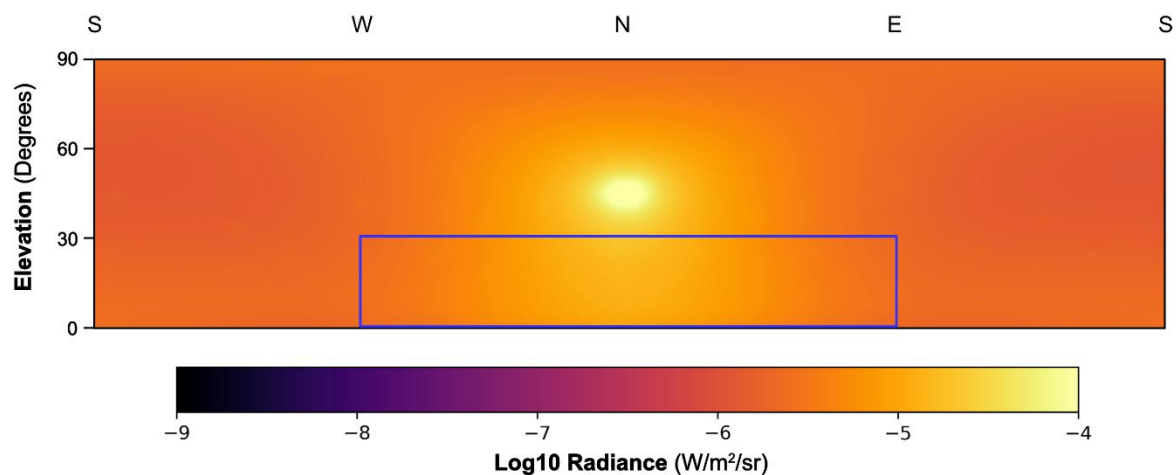


Figure 1: OFOV FME model output. OFOV region is within the blue rectangle (180° x 30°).

5.2.3. Contour Modelling

To determine the maximum extent of visible light from the SPV and the potential overlap with sensitive habitat, preliminary contour modelling was undertaken. This model incorporates a set of evenly spaced viewpoints directed towards the SPV to determine the decrease in brightness over distance. The contour was placed at the edge of the POA boundary to determine if impact boundaries overlap with flatback turtle nesting habitat.

The outputs provide a 'worst case' spatial representation of light emissions and inform selection of appropriate locations for more detailed panoramic modelling. The contour modelling did not consider topography or geo-screening (assumes a completely 'flat' environment), and calculated a OFOV FME value for the set of evenly spaced viewpoints.

5.2.4. Panoramic Modelling

Five modelling viewpoints were selected based on the presence / density of flatback turtle nesting activity within the CG region and the potential visibility of light emissions from the SPV, as determined by the contour modelling. These included Seaward and Small beaches at Cape Domett, Turtle Beach West (west of Cape Dussejour), Barnett Point, and Turtle Bay on Lacrosse Island.

At each location, panoramic modelling of the SPV was undertaken to estimate the visibility of light across a 360° horizontal by 90° vertical field-of-view. Panoramas provide a complete hemispherical view of the SPV light source and account for topography, allowing for accurate metric calculations and a more informed assessment of potential lighting impacts to marine turtles.

5.2.4.1. SPV Locations and Modelling Scenarios

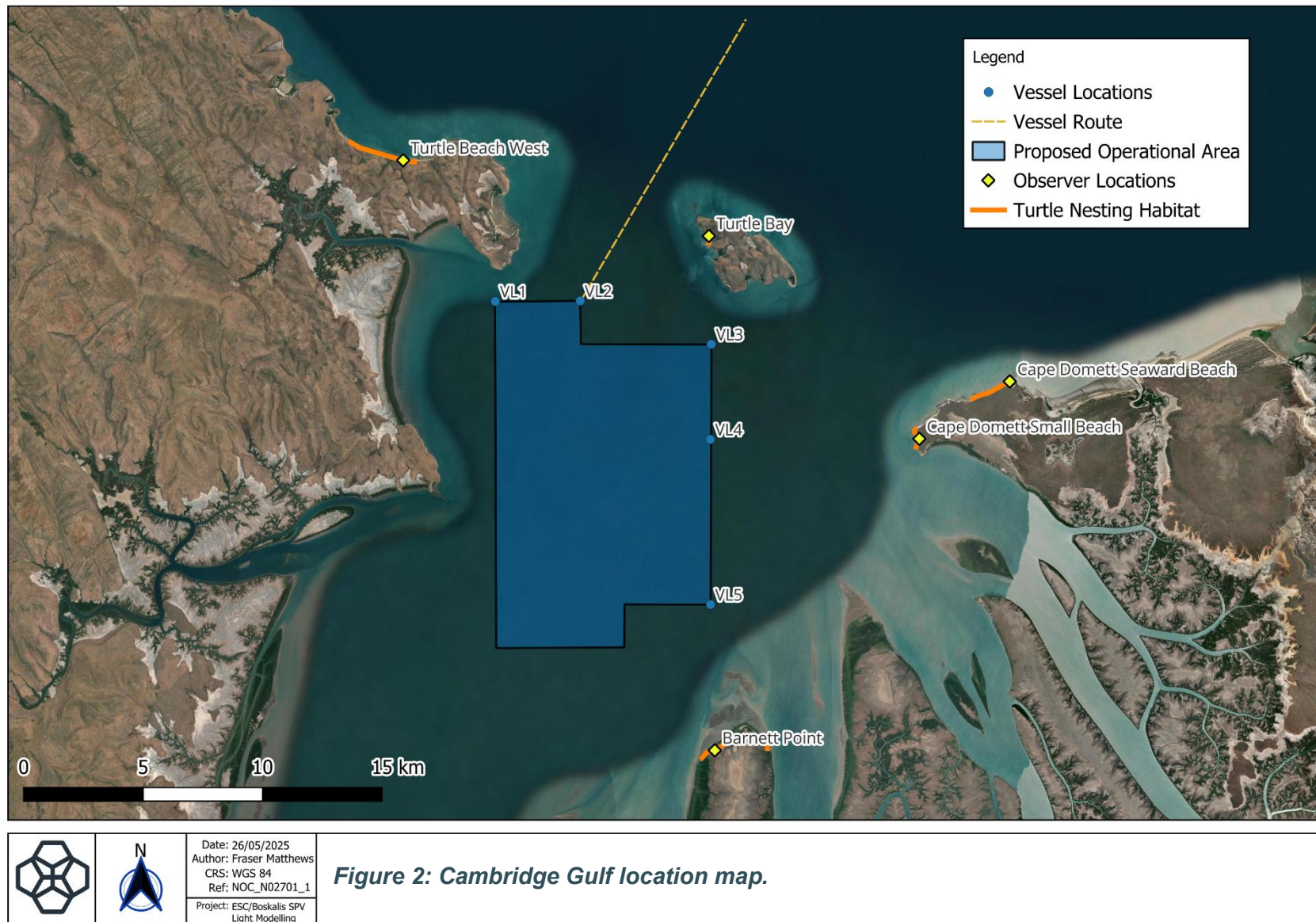
Five relevant SPV locations along the POA boundary were selected for panoramic modelling. These were selected based on their proximity and bearing to the nesting beaches, and the visibility of light emissions from the SPV at each location. The combination of one vessel location modelled from one viewpoint constitutes a single modelling scenario.

In reality the SPV will mainly operate well inside the POA and will only spend small amounts of time at the POA boundary when turning. Modelling at locations on the POA boundary therefore represents 'worst case' scenarios in terms of impact assessment at the receiving beaches.

Panoramic modelling scenarios were ultimately determined as follows (**Figure 2**):

1. Turtle Beach West, west of Cape Dussejour: VL1
2. Turtle Bay, Lacrosse Island: VL2
3. Turtle Bay, Lacrosse Island: VL3
4. Cape Domett Seaward Beach: VL3
5. Cape Domett Small Beach: VL4
6. Barnett Point: VL5

This approach provided a relevant set of panoramic results to inform the impact assessment. For each SPV location (modelling scenario), the lighting inventory remained the same, with exception to the latitude and longitude of each light.



5.2.5. Data Analysis

For each panoramic viewpoint, a set of metrics were calculated including:

1. **OFOV FME Brightness:** The average intensity across a 180° x 30° field-of-view centred on the brightest pixel. This represents a turtle hatchlings field-of-view and is used to assess the Impact Levels in **Table 2**.
2. **All-Sky Brightness:** The average intensity across all pixels in the entire panorama (360° x 90°).
3. **Zenith Brightness:** The average intensity across all pixels in a 30° field-of-view directly above the viewpoint.
4. **Horizon Brightness:** The average intensity across all pixels in a 30° field-of-view directly above the horizon.

Metrics 2 - 4 are provided in **Appendix A** as they do not directly inform the impact assessment to marine turtles, however may be useful for future comparisons with any monitoring data captured.

5.2.6. Model Assumptions and Limitations

The following assumptions apply to the artificial light modelling:

- The vessel lighting specifications were accurate and representative of the proposed operational lighting onboard the SPV.
- A completely dark background sky brightness was chosen due to represent the natural darkness of the CG region.
- Weather conditions and natural light (clouds, sun, moon, stars) were intentionally excluded from the model.
- The panoramic view considered each viewpoint to be at ground-level to represent a marine turtle receptor.
- The ILLUMINA model has only had limited ground-truthing completed and is still in active development, with regular improvements and adjustments being made. Future model results may not be directly comparable.
- Contour modelling is an assumed 'worst case' scenario and does not take into account topography / geo-screening.
- The model outputs in absolute radiance units, which represent light equally across the entire visible spectrum. Most receptors have sensitivities to different wavelengths, or cannot detect all wavelengths. Therefore, these units represent a 'worst case' scenario where light will be visible at maximum sensitivity across the whole spectrum.
- The proposed operational area will remain consistent with the area provided by BKA.

5.3 Task 3: Impact Assessment

This assessment adopts a source–pathway–receptor framework to evaluate the potential impact of artificial light on marine turtles when present at the nesting habitat. This involved identifying the artificial light source(s) (i.e. SPV), the mechanisms by which light may be visible at selected sensitive nesting habitats through modelling (the pathway), the natural location-specific factors that may reduce the likelihood of an impact from artificial light occurring, the life stages of marine turtles that may be influenced (the receptor i.e. adult and hatchling flatback turtles on the beach), and the scale at which the impact may occur (i.e. at an individual hatched nest/adult turtle level and population level).

Given that BKA has already committed to best-practice lighting management measures to for the SPV, the potential for impacts of artificial light on marine turtles have been assessed from a residual risk perspective only.

5.3.1. Hatchling Turtles

The impact assessment was undertaken using a likelihood and consequence matrix shown in **Table 3**, with category definitions based on potential impacts at the individual hatched nest level. Where the individual-level assessment resulted in a high overall impact rating, it was deemed to have the potential to affect the broader population. In such cases, a population-level assessment was triggered, incorporating factors such as the project's duration relative to the species' generation length, as well as the current size and conservation status of the nesting population present at the habitat.

Predicting the likelihood of artificial light impacting a hatchling turtle's sea-finding behaviour following their emergence from a nest is inherently complex due to the wide range of biological and physical factors that influence how they perceive and respond to visible light. These factors can act independently or in combination, further complicating assessment of potential impact.

For this assessment, several location-specific natural factors were also considered when evaluating the likelihood of impact from the SPV:

- **Backshore environment:** The topography and vegetation within the backshore environment i.e. the area immediately inland of the point of hatchling emergence, can create a darkened landward silhouette that serves as a key visual cue for hatchlings to orient away from during sea-finding (Limpus 1971; Salmon et al. 1992, Salmon & Witherington 1995). Variability in dune height, slope, and vegetation cover can influence the strength and reliability of this natural cue, potentially diminishing the relative influence of visible artificial light.
- **Direction of light source:** The direction of an artificial light source relative to the hatchling's emergence point may affect its potential to disrupt sea-finding. For instance, a light source located offshore may reinforce the correct seaward direction to a hatchling, potentially reducing disorientation. Conversely, a light source situated adjacent to or behind the nesting beach may attract hatchlings inland or alongshore, increasing the risk of misorientation or delay in ocean entry.

Note that other natural and project-related factors, such as shielding provided by localised topography, the hatchling's field-of-view, the extent of visible artificial light along and above the horizon, and the intensity of the light source, are incorporated into the assessment through the location-specific panoramic modelling outputs.

5.3.2. Adult Turtles

The assessment for adult turtles initially considered impact at an individual level during their nesting activity and sea-finding following departure from the nesting site, using the matrix and definitions in **Table 3**. The likelihood of impact was primarily determined by the direction of the light source relative to the nesting site (as per the hatchling assessment in **Section 5.3.1**) and the outputs from the location-specific panoramic modelling, including any shielding, the extent of visible light along and above the horizon, and the light intensity.

If the individual-level assessment indicated a high overall impact rating, it was deemed to have the potential to affect the broader population. In such cases, a population-level assessment was initiated as described in **Section 5.3.1**.

Table 3: Risk assessment matrix and corresponding likelihood/consequence definitions for impacts of artificial light on hatchling/adult turtles at the individual level.

		Consequence			
		Insignificant	Minor	Major	Severe
Likelihood	Unlikely	Low	Low	Moderate	Moderate
	Possible	Low	Moderate	Moderate	High
	Likely	Moderate	Moderate	High	High
	Almost Certain	Moderate	High	High	High

Definitions	
Likelihood	<i>What is the likelihood of Project-related light sources influencing the behaviour of hatchling/adult turtles?</i>
Unlikely	Expected to occur once over the Project life.
Possible	Expected to occur once each season.
Likely	Expected to occur many times in each season.
Almost Certain	Expected to occur the majority of the time each season.

Consequence	Life phase	<i>What is the consequence of Project-related light sources influencing behaviour?</i>
Insignificant	Hatchling	Time spent crawling and energy expenditure may increase. All hatchlings from a hatched nest may still reach the ocean.
	Adult	No deterrence from nesting at a beach. Time spent crawling and energy expenditure may increase. All adults may still reach the ocean.
Minor	Hatchling	Moderate increase in time spent crawling and energy expenditure, possibly reducing fitness. Some hatchlings from a hatched nest may not reach the ocean.
	Adult	A turtle may emerge and abort their nesting activity. Moderate increase in time spent crawling and energy expenditure, possibly reducing fitness. All adults may still reach the ocean.
Major	Hatchling	Large increase in time spent crawling and energy expenditure, reducing fitness. Many hatchlings from a hatched nest may not reach the ocean.
	Adult	Some turtles may avoid sections of the beach for nesting. Large increase in time spent crawling and energy expenditure, possibly reducing fitness. An adult may reach the ocean after prolonged exposure on the habitat or not at all.
Severe	Hatchling	All hatchlings from a hatched nest may not reach the ocean.
	Adult	Adult turtles may be deterred from selecting the beach for nesting. An adult may not reach the ocean.

6. STUDY FINDINGS

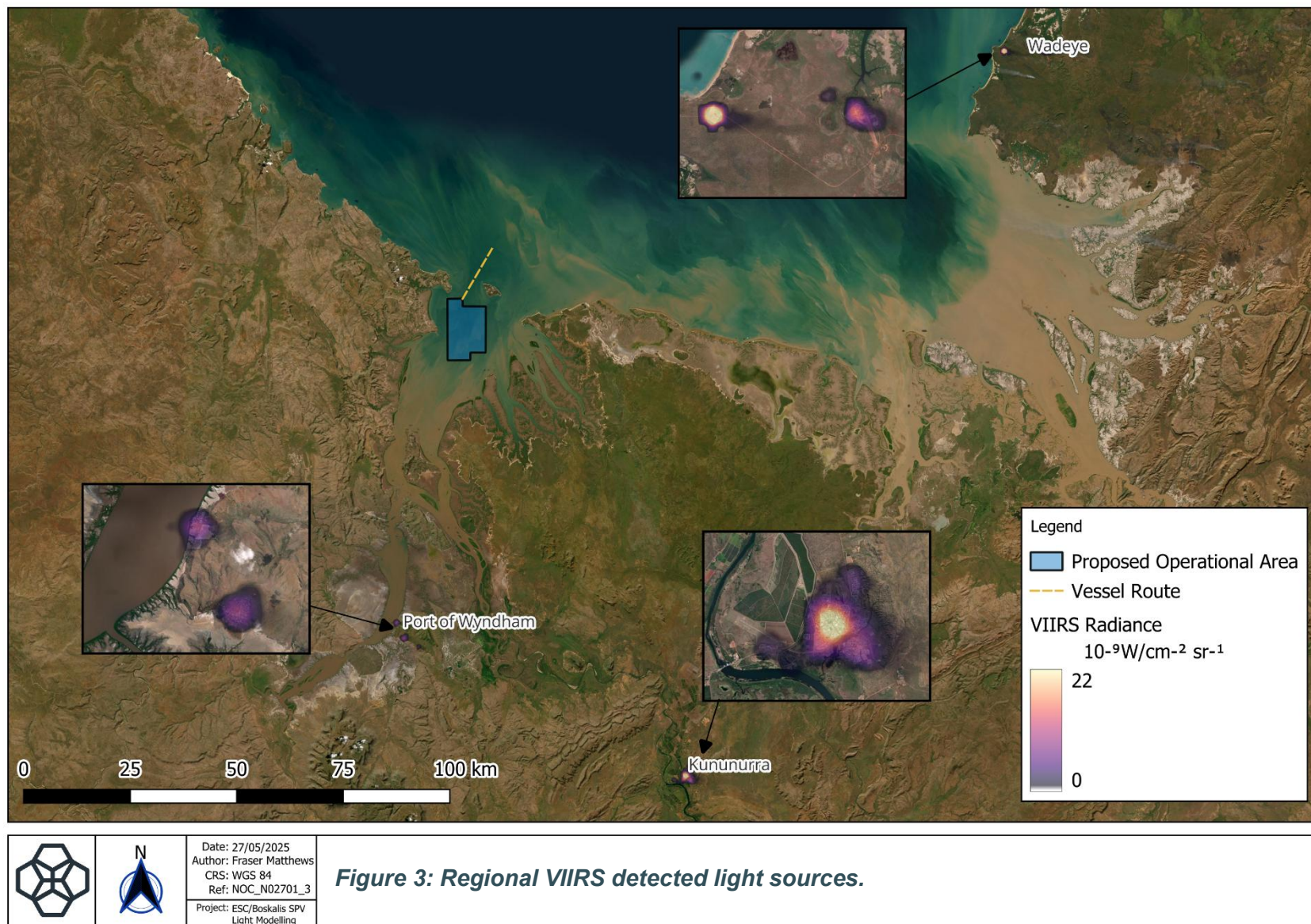
6.1 Task 1: Natural Darkness

The key sources of light in the region include:

- Aid to Navigation Light (Lacrosse Island): A flashing white navigation light located at the summit of Lacrosse Island (~113 m).
- Aid to Navigation Light (Nicholls Point): A flashing white light on the northern end of Adolphus Island.
- Cargo Ships: Vessels navigating through the CG to and from the Port of Wyndham, located ~80 km south of the main body of CG.

The Aid to Navigation (AtoN) lights and cargo ships were not detected in the VIIRS satellite data, however the Port of Wyndham, Kununurra, and Wadeye were detected as major light sources (**Figure 3**). These sources fall outside of the region of interest, and the domain of the modelling, and therefore are not considered necessary for inclusion in the model.

Due to the small number of fixed light sources (AtoN lights) in the region, and the infrequent and temporary presence of cargo vessels, a 'worst case' approach was taken for the light modelling, which assumes a naturally dark sky and models the SPV in isolation.



6.2 Task 2: Light Modelling

6.2.1. Contour Modelling

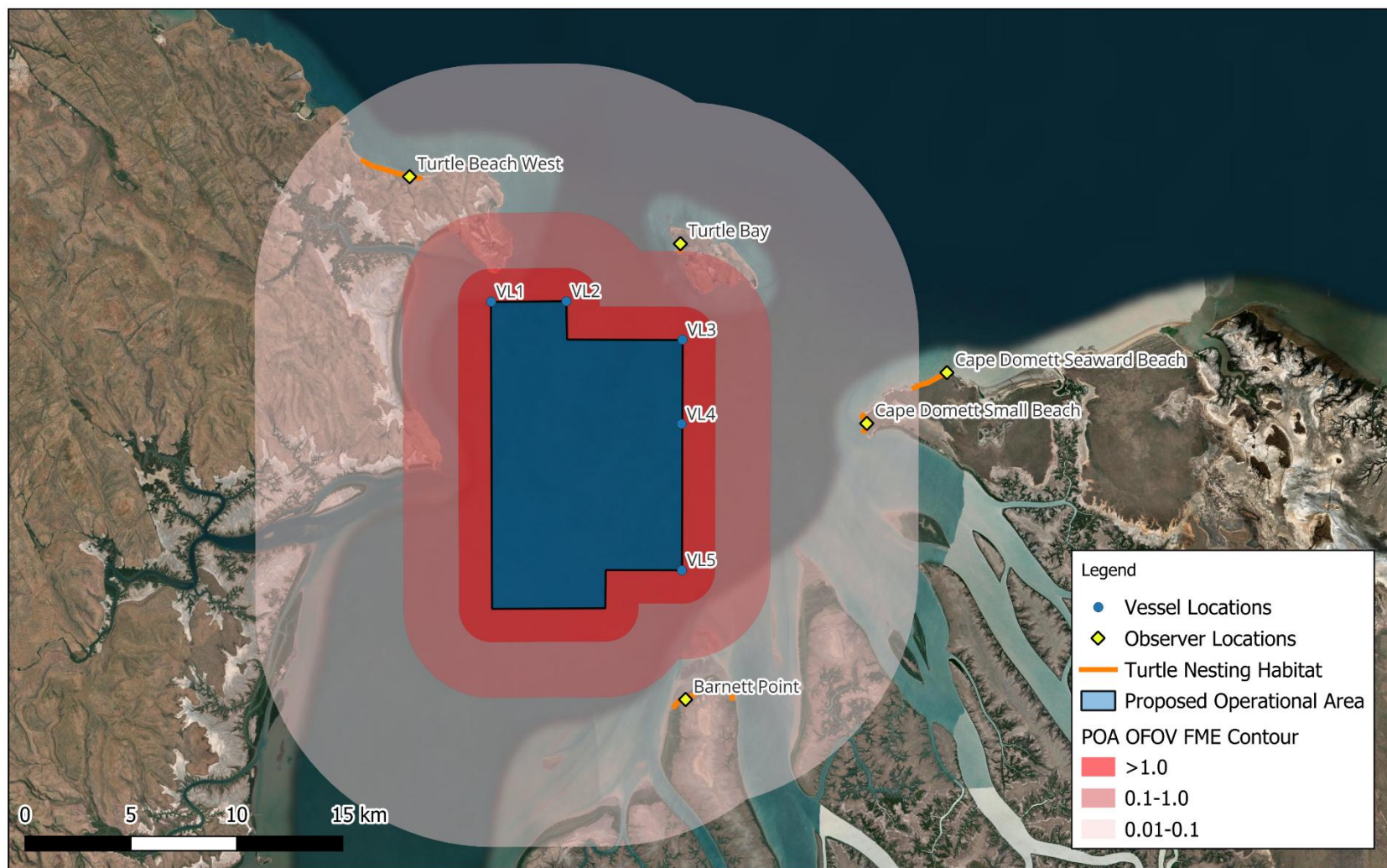
The results of the contour modelling, including the distances at which specific OFOV FME values are reached, are summarised in **Table 4** and presented in **Figure 4**.

Table 4: OFOV FME contour modelling results.

Impact level	OFOV FME	Minimum distance from POA boundary (m)
N/A	< 0.01	> 11,177
1	< 0.1	> 4,180
2	0.1 – 1.0	4,180 – 1,563
3	> 1.0	< 1,563

The OFOV FME contour from the edge of the proposed operational area (**Figure 4**) indicates that light levels within Impact Level 1 (< 0.1) extend onto all five nesting beaches. The < 0.1 OFOV FME boundary crosses over a small section of the western side of the Cape Domett Seaward Beach.

The boundary for Impact Level 2 extends ~4.2 km from the POA, intersecting a large section of Lacrosse Island to the north, and shallow waters adjacent to Barnett Point to the south. The Impact Level 3 (< 1.0 OFOV FME) boundary does not intersect any onshore habitat, excluding a small section of non-nesting habitat of Cape Dussejour (**Figure 4**).



Date: 26/05/2025
 Author: Fraser Matthews
 CRS: WGS 84
 Ref: NOC_N02701_2
 Project: ESC/Boskalis SPV
 Light Modelling

Figure 4: OFOV FME Contour of the Proposed Operational Area.

6.2.2. Panoramic Modelling

The results of the panoramic modelling are summarised in **Table 5**, and presented in **Figure 5**.

Table 5: OFOV FME panoramic modelling results.

Observer location	SPV location	OFOV FME	Impact Level
Cape Domett Small Beach	VL4	0.0022	N/A
Cape Domett Seaward Beach	VL3	0.0012	
Turtle Bay, Lacrosse Island	VL2	0.0040	
	VL3	0.0035	
Turtle Beach West (west of Cape Dussejour)	VL1	0.0007	1
Barnett Point	VL5	0.0550	

Observed OFOV FME brightness was highest at Barnett Point (0.055), followed by Turtle Bay on Lacrosse Island (0.004-VL2; 0.0035-VL3), Cape Domett Small Beach (0.0022), Cape Domett Seaward Beach (0.0012), and Turtle Beach West (0.0007; **Table 5**).

Barnett Point and Turtle Bay are the two closest nesting beaches to the POA, and therefore receive higher intensity light emissions from the modelled SPV. Barnett Point has an unobstructed view of the POA and records an OFOV FME brightness within Impact Level 1 (although there is screening by mangroves which is not accounted for in the model), whereas Turtle Bay is shielded by the topography of Lacrosse Island to the north, east, and south, resulting in a lower-level brightness (Impact Level N/A; **Table 5** and **Figure 5**).

The Cape Domett Small and Seaward beaches are approximately 8.5 km and 12.5 km from their respective modelled SPV locations. At these distances (and with the additional shielding of topography from Seaward Beach), observed radiance is minimal and falls into the N/A OFOV FME Impact Level.

Substantial shielding from localised topography between Turtle Beach West (west of Cape Dussejour) and the POA blocks any direct light from the SPV and the majority of the SPV sky glow (**Figure 5**). The small amount of observed radiance from Turtle Beach West can be considered inconsequential.

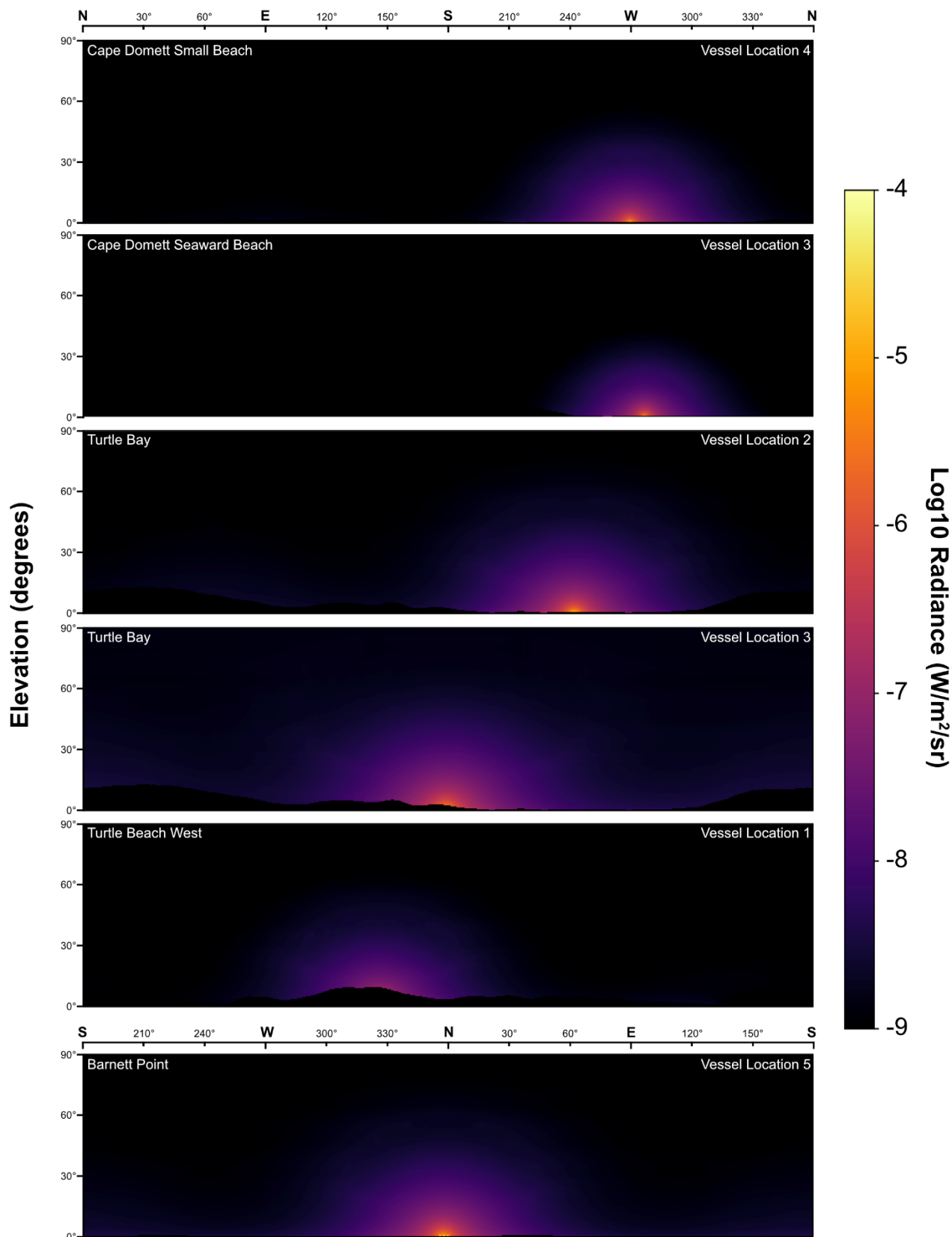


Figure 5: Light modelling outputs for all panoramic observer locations. Note that due to the orientation of the SPV at VL-5, the x-axis layout for Barnett Point differs from that of the other observer locations.

6.3 Task 3: Impact Assessment

Table 6: Summary of impact assessment outcomes for the Sand Production Vessel on hatchling flatback turtle sea-finding behaviour at each observer location. For likelihood and consequence definitions, refer to Table 3.

Observer location	SPV location	OFOV FME & Impact Level	Direction of SPV from location	Description of backshore environment	Impact assessment			
					Likelihood	Consequence	Residual risk	Justification
Cape Domett Small Beach	VL4	0.0022 N/A	Directly offshore in a westerly direction	Tall, vegetated, natural dune with rocks outcrops	Unlikely	Insignificant	Low	The offshore direction of the SPV, low OFOV FME, and presence of a tall dune which provides a cue for hatchlings to orient away from, minimises the likelihood of impact. Given the low intensity of the SPV light emissions, any impact is not expected to prevent hatchlings from reaching the ocean.
Cape Domett Seaward Beach	VL3	0.0012 N/A	Adjacent to the headland in a westerly direction	Tall, vegetated, natural dune with rocky outcrops	Unlikely	Insignificant	Low	The low OFOV FME, and presence of a tall dune which provides a cue for hatchlings to orient away from, minimises the likelihood of impact regardless of the adjacent direction of the SPV. Given the low intensity of the SPV light emissions, any impact is not expected to prevent hatchlings from reaching the ocean.
Turtle Bay, Lacrosse Island	VL2	0.0040 N/A	Directly offshore in a south westerly direction	Tall, vegetated, natural dune	Unlikely	Insignificant	Low	The offshore direction of the SPV, low OFOV FME, and presence of a tall dune which provides a cue for hatchlings to orient away from, minimises the likelihood of impact. Given the low intensity of the SPV light emissions, any impact is not expected to prevent hatchlings from reaching the ocean.
	VL3	0.0035 N/A	Adjacent to the headland in a southerly direction		Unlikely	Insignificant	Low	The low OFOV FME, and presence of a tall dune which provides a cue for hatchlings to orient away from, minimises the likelihood of impact regardless of the adjacent direction of the SPV. Given the low intensity of the SPV light emissions, any impact is not expected to prevent hatchlings from reaching the ocean.
Turtle Beach West (west of Cape Dussejour)	VL1	0.0007 N/A	Adjacent to the headland in a south-easterly direction	Low lying, vegetated, natural dune with tidal creek	Unlikely	Insignificant	Low	The low OFOV FME and high topography which shields any direct visibility of the SPV minimises the likelihood of impact regardless of the adjacent direction of the SPV and low-lying dune. Given the low intensity of the SPV light emissions, any impact is not expected to prevent hatchlings from reaching the ocean.
Barnett Point	VL5	0.0550 Impact Level 1	Directly offshore in a northly direction	No obvious dune with low-lying mangrove vegetation	Possible	Insignificant	Low	The likelihood of SPV lighting impacting hatchling behaviour is elevated due to the proximity and direction of the SPV, the associated OFOV FME value (Impact Level 1), and the absence of a tall dune at the beach for hatchlings to orient away from. Given the low intensity of the SPV light emissions, any impact is not expected to prevent hatchlings from reaching the ocean.

Table 7: Summary of impact assessment outcomes for the Sand Production Vessel on adult flatback turtle behaviour at each observer location. For likelihood and consequence definitions, refer to Table 3.

Observer location	SPV location	OFOV FME & Impact Level	Direction of SPV from location	Impact assessment			
				Likelihood	Consequence	Residual risk	Justification
Cape Domett Small Beach	VL4	0.0022 N/A	Directly offshore in a westerly direction	Unlikely	Insignificant	Low	The offshore direction of the SPV and low OFOV FME, minimises the likelihood of impact. Given the low intensity of the SPV light emissions, any influence is not expected to impact an adult turtle's selection of the habitat and return to the ocean.
Cape Domett Seaward Beach	VL3	0.0012 N/A	Adjacent to the headland in a westerly direction	Unlikely	Insignificant	Low	The low OFOV FME minimises the likelihood of impact regardless of the adjacent direction of the SPV. Given the low intensity of the SPV light emissions, any influence is not expected to impact selection of the habitat and an adult turtle's return to the ocean.
Turtle Bay, Lacrosse Island	VL2	0.0040 N/A	Directly offshore in a south westerly direction	Unlikely	Insignificant	Low	The offshore direction of the SPV and low OFOV FME, minimises the likelihood of impact. Given the low intensity of the SPV light emissions, any influence is not expected to impact an adult turtle's selection of the habitat and return to the ocean.
	VL3	0.0035 N/A	Adjacent to the headland in a southerly direction	Unlikely	Insignificant	Low	The low OFOV FME minimises the likelihood of impact regardless of the adjacent direction of the SPV. Given the low intensity of the SPV light emissions, any influence is not expected to impact an adult turtle's selection of the habitat and return to the ocean.
Turtle Beach West (west of Cape Dussejour)	VL1	0.0007 N/A	Adjacent to the headland in a south-easterly direction	Unlikely	Insignificant	Low	The low OFOV FME and high topography which shields any direct visibility of the SPV minimises the likelihood of impact regardless of the adjacent direction of the SPV. Given the low intensity of the SPV light emissions, any influence is not expected to impact an adult turtle's selection of the habitat and return to the ocean.
Barnett Point	VL5	0.0550 Impact Level 1	Directly offshore in a northy direction	Unlikely	Insignificant	Low	The offshore direction of the SPV and low OFOV FME, minimises the likelihood of impact. Given the low intensity of the SPV light emissions, any influence is not expected to impact an adult turtle's selection of the habitat and return to the ocean.

7. CONCLUSIONS AND RECOMMENDATIONS

Artificial light modelling of the proposed SPV operations indicated low levels of observed light emissions from all five marine turtle nesting beaches in the CG area. Initial contour modelling confirmed key OFOV FME Impact Level boundaries at 1.6 km (Impact Level 3), 4.2 km (Impact Level 2) and 4.2 km (Impact Level 1).

Panoramic modelling from each nesting beach showed a further reduction in the brightness (OFOV FME) observed due to the incorporation of topography into the model. From all nesting beaches excluding Barnett Point and Cape Domett Small Beach, topography in the direction of the POA provides substantial shielding. The OFOV FME values for each nesting beach all fell into the N/A Impact Level range (<0.01), with exception to Barnett Point which recorded 0.055 OFOV FME (Impact level 1).

The impact assessment for the SPV on hatchling orientation determined that the likelihood of impact was ‘unlikely’ at all nesting beaches, except Barnett Point. Due to its close proximity and direct line of sight to the SPV, Barnett Point was assessed as having a ‘possible’ likelihood of impact. However, the consequence of any potential impact on hatchling orientation at all beaches, including Barnett Point, was considered insignificant. Similarly, the assessment of potential impacts on adult turtle behaviour concluded that the likelihood of impact was ‘unlikely’ and the consequence ‘insignificant’ across all nesting beaches. As a result, the residual risk rating for both hatchling orientation and adult turtle behaviour was assessed as ‘low’ at all nesting beaches.

7.1 Vessel Lighting

The vessel lighting specifications and design principles outlined in documentation provided by BKA states that the following design and construction measures will be incorporated into the vessel design and operation:

- **“Keep lights ‘low’.** All lights will be fitted as close as possible to the SPV’s deck.
- **Keep lights ‘directed’.** Light-spill and sky-glow will be minimized by directing lights onto the areas where it is needed for safe operations. In example, the planned external lights have a light down distribution of 98% and the flood lights have a large beam angle which can minimize the projected area.
- **Keep lights ‘shielded’.** Where possible, shields and deflectors will be fitted to deck lights to minimize light spill and sky-glow.

In addition, the operational measure of ‘keep lights ‘off’ will be applied wherever possible. With crew safety having paramount priority, a selection of some deck lights may be switched off during sand loading operations in Cambridge Gulf to minimize the SPV’s light signature.”

These commitments, with additional consideration to the utilisation of Amber LED and 3000K luminaires, are aligned with the *National Light Pollution Guidelines for Wildlife* (DCCEEW 2023) Best Practise Lighting Design Principles. The implementation of these principles should

be evaluated often by vessel crew during the project lifespan to ensure consistency in minimising artificial light pollution from the POA.

7.2 Biological Monitoring

In line with the *National Light Pollution Guidelines for Wildlife* (DCCEEW 2023), the effectiveness of light mitigation and management measures should be evaluated through targeted biological monitoring. Given the outcomes of the impact assessment and their greater sensitivity to artificial light, hatchling turtles should be the focus of this monitoring.

Monitoring should involve measuring hatchling orientation by recording the direction and spread of their tracks, referred to as the nest fan, from the nest emergence point during a new moon phase. This should occur approximately 50 days after the peak of the adult nesting season i.e. in September or October. Key metrics include the spread and offset angles of the nest fan, which provide indicators of orientation success in terms of a hatchling finding the ocean.

Given the current absence of significant artificial light sources along the horizon in the CG region, hatchling orientation is expected to reflect natural, successful sea-finding behaviour. Therefore, baseline monitoring may not be required to evaluate the effectiveness of light mitigation and management measures in this case. Instead, targeted monitoring could be conducted during one or more seasons when the SPV is active within the POA to record any evidence of unsuccessful sea-finding at the habitat. This may be indicated by severe disorientation, defined in Salmon & Witherington (1995) and Witherington et al. (1996) as a nest fan spread angle exceeding 120° and offset angle exceeding 60°. Where required, these disorientation metrics could be incorporated into an Artificial Light Management Plan as trigger or threshold criteria, consistent with the *Instructions: How to Prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA 2024). Should these criteria be exceeded, appropriate adaptive management responses could then be implemented to reduce the likelihood of recurrence and ensure impacts remain within acceptable limits.

8. REFERENCES

Aube et al. (2020). Restoring the night sky darkness at Observatorio del Teide: First application of the model Illumina version 2.

Boskalis Australia Pty Ltd (2024). EPBC Referral Report No. 2 – Boskalis Cambridge Gulf: Setting and Existing Environment. Prepared for the Australian Government Department of Climate Change, Energy, the Environment and Water.

Commonwealth of Australia (2012). Marine bioregional plan for the North-west Marine Region prepared under the Environment Protection and Biodiversity Conservation Act 1999. Department of Sustainability, Environment, Water, Population and Communities.

Commonwealth of Australia (2017) Recovery Plan for Marine Turtles in Australia 2017 – 2027. Department of the Environment and Energy.

DCCEEW (2023) National Light Pollution Guidelines for Wildlife. May 2023. Available at: <https://www.dcceew.gov.au/environment/biodiversity/publications/national-light-pollution-guidelines-wildlife>.

EPA (2024) *Instructions: How to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans*. Available at: www.epa.wa.gov.au/sites/default/files/Forms_and_Templates/Preparing%20Environmental%20Protection%20Act%201986%20PIV%20environmental%20management%20plans.pdf

FitzSimmons, N.N., Pittard, S.D., McIntyre, N., Jensen, M.P., Guinea, M., Hamann, M., Kennett, R., Leis, B., Limpus, C.J., Limpus, D.J., McCann, M.J., MacDonald, A.J., McFarlane, G., Parmenter, C.J., Pendoley, K., Prince, R.T., Scheltinga, L., Theissinger, K., Tucker, A.D., Waayers, D., Whiting, A. & Whiting, S. (2020) Phylogeography, genetic stocks, and conservation implications for an Australian endemic marine turtle. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 30(3), 440–460.

Hodge, W., Limpus, C.J. & Smissen, P. (2007) Queensland turtle conservation project: Hummock Hill Island nesting turtle study December 2006 conservation technical and data report.

Hu, Z., Hu, H. & Huang, Y. (2018) Association between nighttime artificial light pollution and sea turtle nest density along Florida coast: A geospatial study using VIIRS remote sensing data. *Environmental Pollution*, 239, 30–42.

Kamrowski, R.L., Limpus, C., Pendoley, K. & Hamann, M. (2014) Influence of industrial light pollution on the sea-finding behaviour of flatback turtle hatchlings. *Wildlife Research*, 41 (5), 421–434.

Limpus, C.J. (1971) Sea turtle ocean finding behaviour. *Search*, 2, 385–387.

Limpus, C.J. (2004) A biological review of Australian marine turtles – Flatback Turtles, Queensland Environmental Protection Agency and the Department of the Environment and Heritage, Canberra.

Lohmann, K.J., Witherington B.E., Lohmann C.M.F. & Salmon M. (1997) Orientation, navigation, and natal beach homing in sea turtles, in *The Biology of Sea Turtles*. Volume I, P.L. Lutz and J.A. Musick, Editors., CRC Press: Washington D.C. p. 107-135.

Pendoley, K.L. & Kamrowski, R.L. (2015) Influence of horizon elevation on the sea-finding behaviour of hatchling flatback turtles exposed to artificial light-glow. *Marine Ecology Progress Series*, 529, 279–288.

Price, B. & Raaymakers, S. (2024) Analysis of Ten Years of Turtle Nesting Data from Cape Domett, Cambridge Gulf, Western Australia – 2013 to 2022 Inclusive. Report to the Western Australia Department of Biodiversity Conservation & Attractions and Boskalis Australia Pty Ltd, EcoStrategic Consultants, Cairns.

Salmon, M. (2003) Artificial night lighting and sea turtles. *Biologist*, 2003 (50), 163–168.

Salmon, M. & Witherington, B. (1995) Artificial lighting and seafinding by loggerhead hatchlings: Evidence for lunar modulation. *Copeia*, 1995, 931–938.

Salmon, M., Wyneken, J., Fritz, E. & Lucas, M. (1992) Seafinding by hatchling sea turtles: role of brightness, silhouette and beach slope as orientation cues. *Behaviour*, 122, 56–77.

Whiting, A., Thomson, A., Chaloupka, M. & Limpus, C. (2008) Seasonality, abundance and breeding biology of one of the largest populations of nesting flatback turtles, *Natator depressus*: Cape Domett, Western Australia. *Australian Journal of Zoology*, 2008(5), 297–303.

Wilson, P., Thums, M., Pattiaratchi, C., Meekan, M.G., Pendoley, K., Fisher, R. & Whiting, S. (2018) Artificial light disrupts the nearshore dispersal of neonate flatback turtles (*Natator depressus*). *Marine Ecology Progress Series*, 600, 179–192.

Witherington, B. (1992) Sea finding behaviour and the use of photic orientation cues by hatchling sea turtles. PhD dissertation, University of Florida, Gainesville.

Witherington, B.E., Crady, C. & Bolen, L. (1996) A “hatchling orientation index” for assessing orientation disruption from artificial lighting. Pp. 344-347 in J.A. Keinath, D.E. Bernard, J.A. Musick, and B.A. Bell, eds. *Proceedings of the Fifteenth Annual Symposium on Sea Turtle Biology and Conservation*. NOAA Technical Memorandum NMFS-SEFSC-387.

Witherington, B. & Martin, R.E. (2003) Understanding, Assessing, and Resolving Light-Pollution Problems on Sea Turtle Nesting Beaches. Florida Fish and Wildlife Conservation Commission FMRI Technical Report TR-2: Jensen Beach, Florida. p. 84.

APPENDIX A: PANORAMIC MODELLING RESULTS

Observer Location	Radiance (W/m ² /sr)		
	All-Sky	Horizon	Zenith
Barnett Point	6.90E-08	2.02E-07	9.73E-10
Small Beach, Cape Domett	3.30E-09	8.46E-09	4.60E-10
Seaward Beach, Cape Domett	1.71E-09	4.43E-09	2.17E-10
Turtle Bay	5.89E-09	1.50E-08	9.46E-10
	5.94E-09	1.38E-08	1.50E-09
Turtle Beach West	1.67E-09	3.08E-09	6.91E-10

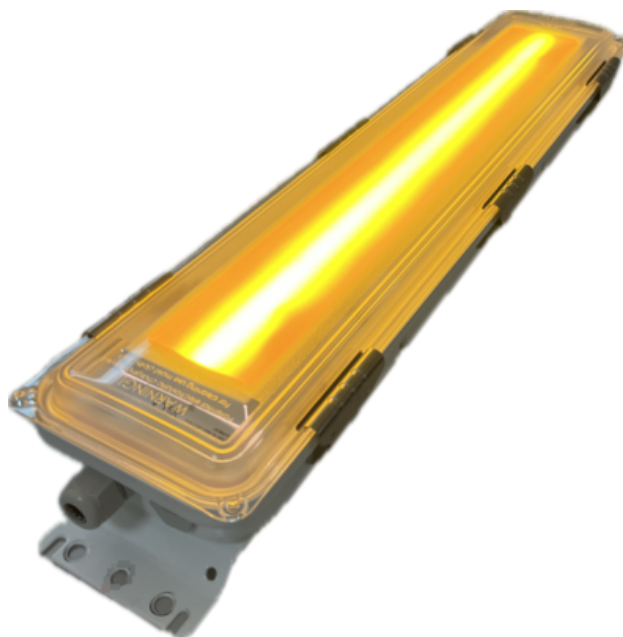
APPENDIX B : SPV LIGHT SPECIFICATIONS



MIRS67-600 (M) G2 1500 HF AMBER TW M20 FR/PC

Technical Wildlife friendly light is used on onshore, offshore and on marine installation where there is a requirement to avoid too much disturbances to the wildlife in the given area. Wildlife friendly light is also the same as turtle friendly light.

Item No.	MIR107493
GTIN	7054131074938
Stock status code	M

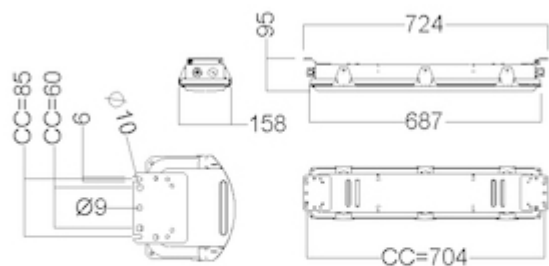


Technical specifications

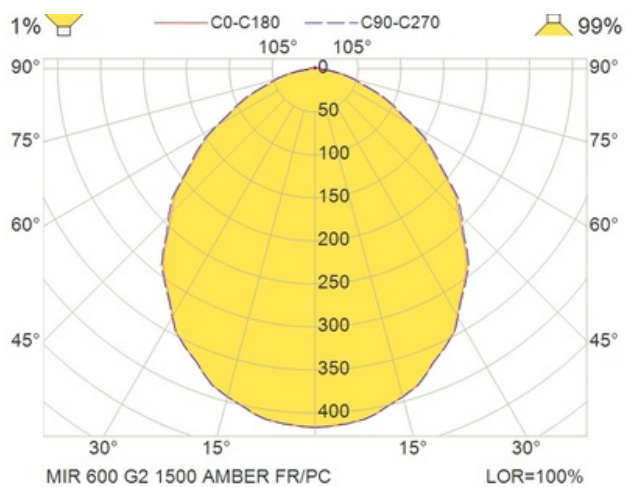
General	
Item Group	G10574-MIR S (M) G2
Mounting	
Product Mounting	Ceiling surface
Optic	
Optic Name	FR/PC - Frosted diffuser in polycarbonate
Diffuser Material	Polycarbonate
Optic main category	Diffuser
Certificates	
Marine Approved	true
Technical Data	
Corrosion class	CX

Light Technical Data	
Light source	LED
Lumen Out (lm)	1540
Number Of Light Source	1
Lumen Per Watt (lm/W)	61
Lamp Code Type	AMBER
Light Distribution Up %	2
Light Distribution Down %	98
Energy Class Light Source	C
Dimensions	
Item Net Weight (kg)	4.1768
Logistic Data	
Item Gross Weight (kg)	4.54

Illustrations



MULTI-600 G2





RLX D FL 160W100- 277VACD Wide 830 3XEABKX

RLX™ D LED FLOODLIGHT takes over the place of the traditional High Pressure Sodium and Halogen floodlights and are suitable for multiple areas of use. The RLX™ D is a powerful floodlight with proven endurance for harsh environments.

Item No.	LN1003762
GTIN	7072720011942
Stock status code	E



Technical specifications

General	
Item Group	PN0438-RLX D G3 FLOODLIGHT
Texts	
Remarks	Reserved for project: Tennet/Petrofac Custom components: 2x Gland M25 EExe dobb.comp ADE4F
Added information	Generation 3
Electrical Data	
EMC Category	EMC1 : EMC B – IEC 60533 Bridge and Open deck
Main Feed AC (V) Min	100
Main Feed AC (V) Max	277
Main Feed Frequency Min	50
Main Feed Frequency Max	60
Main Feed DC (V) Min	100
Main Feed DC (V) Max	300
Total Consumption (W)	160
Inrush current (A)	200
Number Of Luminaire MCB 10B	4
Number Of Luminaire MCB 10C	7
Number Of Luminaire MCB 16B	6
Number Of Luminaire MCB 16C	10
Power Factor	0.98

Optic	
Beam Angle (°)	110×45
Optic Name	Wide - Wide Beam 110×45
Diffuser Material	Glass
Certificates	
Certification	5 year warranty;DNV;RINA;UL;UL 1598 Wet Locations;UL1598/1598A Marine Listed
Marine Approved	true
Technical Data	
Minimum TA (°C)	-40
Maximum TA (°C)	55
IP classification	66/67
Corrosion class	C5-M
Light Technical Data	
Light source	LED
Lumen Out (lm)	14893
Number Of Light Source	1
Lumen Per Watt (lm/W)	93
Lamp colour temp (K)	3000
Colour Rendering Index	>80
MacAdam step	3
Light Source Included	true
Dimmable	true
Driver / Ballast	
Type of LED Driver	HFDa: Dimming Analogue 1-10V
Number of Driver	1

Lifetime

LED Lifetime L70B50 Ta45 (h)	100 000
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Housing

Body Material	Seawater-resistant aluminium
Treatment housing	Anodized
Body Colour	BL - Black
Main Body Colour Name	Graphite black
Main Body Colour Surface	Powder coated
Main Body Colour RAL code	RAL 9011
Mounting Bracket Material	Stainless steel AISI 316

Dimensions

Length (mm)	444
Width (mm)	143
Height (mm)	397
Item Net Weight (kg)	14.26

Termination

Termination	4×6+2×16+8×2.5mm ² Spring Cage
Maximum Core Diameter	6 mm ²
Minimum Core Diameter	0.5 mm ²

Cable Inlet

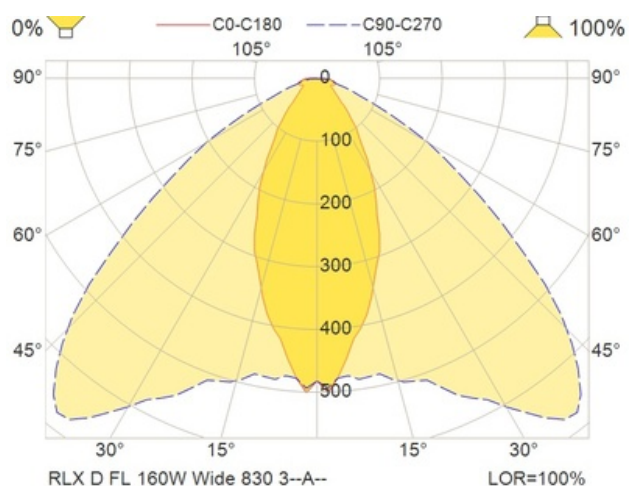
Cable Gland	M25-Nickel plated brass;M25 MCG - M25 Shielded
Number of Glands	2
Blinds	M20-Nickel plated brass
Number of Blinds	2
Max Cable Diameter (mm)	21
Min Cable Diameter (mm)	14

Logistic Data

Item Gross Weight (kg)	15.5
Min Storage Temp	-40
Max Storage Temp	55

Remarks

Reserved for project: Tennet/Petrofac Custom components: 2x Gland M25 EExe dobb.comp ADE4F

[illegible]



RLX D FL 240W100-277VACD Wide 830 3XEABKX

RLX™ D LED FLOODLIGHT takes over the place of the traditional High Pressure Sodium and Halogen floodlights and are suitable for multiple areas of use. The RLX™ D is a powerful floodlight with proven endurance for harsh environments.

Item No.	LN1003763
GTIN	7072720011959
Stock status code	E



Technical specifications

General	
Item Group	PN0438-RLX D G3 FLOODLIGHT
Texts	
Remarks	Reserved for project: Tennet/Petrofac Custom components: 2x Gland M25 EExe dobb.comp ADE4F
Added information	Generation 3
Electrical Data	
EMC Category	EMC1 : EMC B – IEC 60533 Bridge and Open deck
Main Feed AC (V) Min	100
Main Feed AC (V) Max	277
Main Feed Frequency Min	50
Main Feed Frequency Max	60
Main Feed DC (V) Min	100
Main Feed DC (V) Max	300
Total Consumption (W)	240
Inrush current (A)	200
Number Of Luminaire MCB 10B	4
Number Of Luminaire MCB 10C	7
Number Of Luminaire MCB 16B	6
Number Of Luminaire MCB 16C	10
Power Factor	0.98

Optic	
Beam Angle (°)	110×45
Optic Name	Wide - Wide Beam 110×45
Diffuser Material	Glass
Certificates	
Certification	5 year warranty;DNV;RINA;UL;UL 1598 Wet Locations;UL1598/1598A Marine Listed
Marine Approved	true
Technical Data	
Minimum TA (°C)	-40
Maximum TA (°C)	55
IP classification	66/67
Corrosion class	C5-M
Light Technical Data	
Light source	LED
Lumen Out (lm)	21204
Number Of Light Source	1
Lumen Per Watt (lm/W)	88
Lamp colour temp (K)	3000
Colour Rendering Index	>80
MacAdam step	3
Light Source Included	true
Dimmable	true
Driver / Ballast	
Type of LED Driver	HFDa: Dimming Analogue 1-10V
Number of Driver	1

Lifetime

LED Lifetime L70B50 Ta45 (h)	100 000
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Housing

Body Material	Seawater-resistant aluminium
Treatment housing	Anodized
Body Colour	BL - Black
Main Body Colour Name	Graphite black
Main Body Colour Surface	Powder coated
Main Body Colour RAL code	RAL 9011
Mounting Bracket Material	Stainless steel AISI 316

Dimensions

Length (mm)	444
Width (mm)	143
Height (mm)	397
Item Net Weight (kg)	14.26

Termination

Termination	4×6+2×16+8×2.5mm ² Spring Cage
Maximum Core Diameter	6 mm ²
Minimum Core Diameter	0.5 mm ²

Cable Inlet

Cable Gland	M25-Nickel plated brass;M25 MCG - M25 Shielded
Number of Glands	2
Blinds	M20-Nickel plated brass
Number of Blinds	2
Max Cable Diameter (mm)	21
Min Cable Diameter (mm)	14

Logistic Data

Item Gross Weight (kg)	15.5
Min Storage Temp	-40
Max Storage Temp	55

Remarks

Reserved for project: Tennet/Petrofac Custom components: 2x Gland M25 EExe dobb.comp ADE4F

Illustrations

