walker

TOONDAH HARBOUR

CHAPTER 13
LIGHTING ASSESSMENT AND STRATEGY

saunders havill group

13. Lighting Assessment and Strategy

13.1. Introduction

Lighting technical studies were completed by Simpson Engineering Group (SEG) and included as Appendix 2-K. Details of the key personnel involved in the study are provided in Appendix 1-F.

The scope for lighting investigations included:

- Review of the existing lighting at Toondah Harbour and surrounds;
- Proposed goals for light spill accordance with community expectations and ecological requirements;
- Outline of the strategy for lighting associated with the Project, including required characteristics for lighting sources; and
- Assessment of the effects of lighting on the surrounding environment, including key ecological receptors.

This report does not assess lighting impacts on terrestrial ecology, marine ecology or migratory shorebirds These impacts are addressed in Chapters 15, 16 and 17 of the EIS respectively.

13.1.1 Lighting Criteria and Objectives

13.1.1.1 *Redland City Council*

RCC currently implements *Redland City Plan 2018*, which includes benchmark Performance Outcomes and Acceptable Outcomes for lighting associated with development, street and path lighting, construction management.

13.1.1.2 *Australian Standard 4282 – Control of the Obtrusive Effects of Outdoor Lighting*

The Australian Standard 4282 "Control of the obtrusive effects of outdoor lighting" (AS4282:2019) outlines recommended values for light for the control of obtrusive light. It recommends lighting limits for residential properties in different light zones. The AS4282 also defines procedures for 'Assessment of Lighting' and provides general limits/goals for design. Economic Development Queensland refers to AS 4282 in *PDA guideline 14: environmental values and sustainable resource use* when considering impacts of artificial lighting in PDAs. These limits are to be used for construction and operational phase to reduce the potential for impacts. The lighting design goals address light spill, avoidance of direct view of bright luminaires and changes in luminance due to signage and trees moving across bright lights. These have been nominated to protect the maintenance of amenity and protect environmental integrity, refer to Table 13-1.

Table 13-1: AS 4282 Lighting Design Goals.

Light Parameter	**Recommended Maximum Value**
Illuminance in vertical plane at functional boundaries	1 lx
Luminous intensity emitted by luminaires	500 cd
Threshold increment	20% based on adaptation luminance (L_{ad}) of 0.1 cd/m
Sky Glow	Upward light ratio 0.01

13.1.1.3 *National Light Pollution Guidelines for Wildlife*

In January 2020, the Australian Government Department of the Environment and Energy issued the *National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds*. The Guidelines provide theoretical, technical and practical information required to assess if artificial lighting is likely to affect wildlife and the management tools to minimise and mitigate that affect. These techniques can be applied regardless of scale, from small, domestic projects to large-scale industrial developments.

The guideline recommends best practice light design to be applied to all outdoor lighting. If there is important habitat for threatened or listed species within 20 km of the new lighting, the guideline also recommends an environmental impact assessment is carried out to assess potential impacts of the artificial light on wildlife.

This study addresses lighting design and models the effects of the lighting from the Project on the surrounding environment. The model outputs have been utilised by other EIS studies to assess impacts of lighting on wildlife such as migratory birds (Chapter 17) and marine fauna (Chapter 16).

13.1.2 Activities that May Result in Impacts

Project activities with the potential to impact on existing lighting include:

- A general increase in ambient light from urban areas (building, parkland, etc) and the upgraded ferry terminal including associated retail and commercial uses; and
- Short term increases in artificial lighting around the temporary unloading dock and other activities during construction.

13.2. Assessment Methodology

13.2.1 Existing Light levels

A survey of the existing public lighting levels was conducted in the public areas surrounding Toondah Harbour. The survey was carried out during the new moon and with scattered cloud cover. The measurement of lighting levels was conducted at the port and roads near Toondah Harbour.

Areas of the port including Emmett Drive, the public boat ramp and three public car parks as well as Middle St were surveyed to provide good coverage. To measure the greater subject area, the measurement rig was attached to a vehicle and driven slowly around the greater area. The sites covered by this method include parts of Shore Street East, North Street, Shore Street North, Paxton Street, William Street, Wharf Street, Passage Street, Queen Street and Longland Street.

The discrete location-based measurements were plotted and applied to a 2 x 2 m grid across the subject site. Where measurements were not available on the grid an estimation of the light level was performed using a modified Inverse Square Law for point sources. These estimations were verified against actual measurements and found to be accurate.

13.2.2 Conceptual Lighting Model

The lighting model of the site was developed using Agi32. Agi32 has two calculation methods comprising direct calculation and full radiosity. Direct calculation considers only direct light from luminaires to calculation points and the results can be contoured. This method is mostly used for external lighting as site lighting, roadway and sports applications. Full 3D modelling is permitted including screening effects. The full radiosity method includes both direct and reflected light. Full Radiosity Method is required when photo-realistic rendering is desired. Due to the rigorous nature of interrelated lighting calculations and the extended computational time it is more usual to adopt this method for internal lighting rather than external lighting investigations.

The supplied 3D CAD model of the site and the buildings is highly detailed with a polygon count well in excess of the file size limits of the Agi32 lighting model. The model included a large number of surfaces inside buildings which do not have any relevance for an external lighting assessment. Hence, the original 3D CAD design was significantly simplified for the purposes of modelling due to these considerations. Notwithstanding, while the lighting model has reduced the complexity of the buildings and the landform, it includes all street and park lighting potentially visible from Moreton Bay. Figure 13-1 shows the luminaire locations.

Since the main impact considered in this assessment is light spill onto Moreton Bay, the model has included greater detail for the buildings likely to be visible from Moreton Bay. Additionally, public parks are visible from Moreton Bay and hence the illumination of the public areas has been included. The only public road which is likely to be visible from Moreton Bay is in the northeast precinct. The lighting of the parkland has focussed on providing higher levels of illumination of the hardstand areas and permitted lower levels of illumination of the grassed areas.).

Buildings are included in the lighting model at the height indicated in the 3D CAD models. These have been entered (for most buildings) as large flat surfaces comprising rendered concrete. The illumination of these building is mostly from streetlights and reflections from various surfaces. During the assessment process it was found that higher levels of reflected light occurred from concrete facades than from glass facades. Glass facades allowed light to penetrate the building interior and made the building appear dark. Hence it has been found flat surfaces comprising rendered concrete provided greater brightness environmentally and it is considered that this is equivalent to buildings with curtains or blinds covering glass windows.

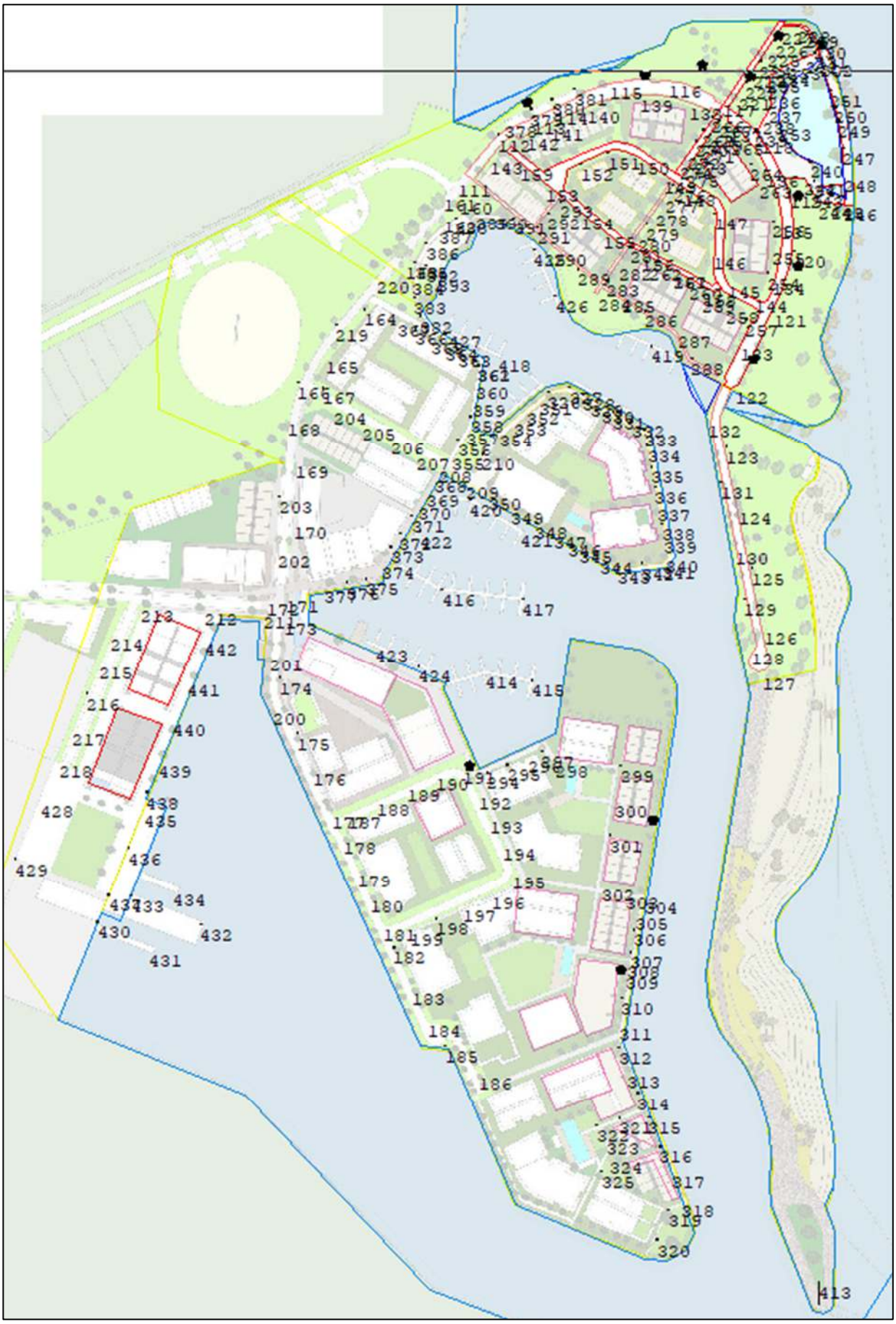

Figure 13-1: Luminaire Locations.

13.3. Construction and Operational Phase Lighting Design

The *National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds* highlights numerous references including Australian Standard AS/NZS4282:2019: Control of the obtrusive effects of outdoor lighting, since it recognises the impact of artificial light on biota. Both AS 4282 and the National Light Pollution Guidelines for Wildlife have been considered in the lighting design for the Project.

The selection of luminaires can have a significant effect on the ability to control light that is emitted outside the Project footprint. It is important that the selected luminaires for this Project (during construction phase and operations phase) have a light distribution that is appropriate not only for the lighting task but also to minimise obtrusive light. As a general principal, a lighting installation that controls obtrusive light will also be generally more efficient at the lighting task.

The proposed lighting during construction and operational phases will have luminaire design which directs light downwards and not horizontally or vertically (i.e., Designs B and D in Figure 13-2)

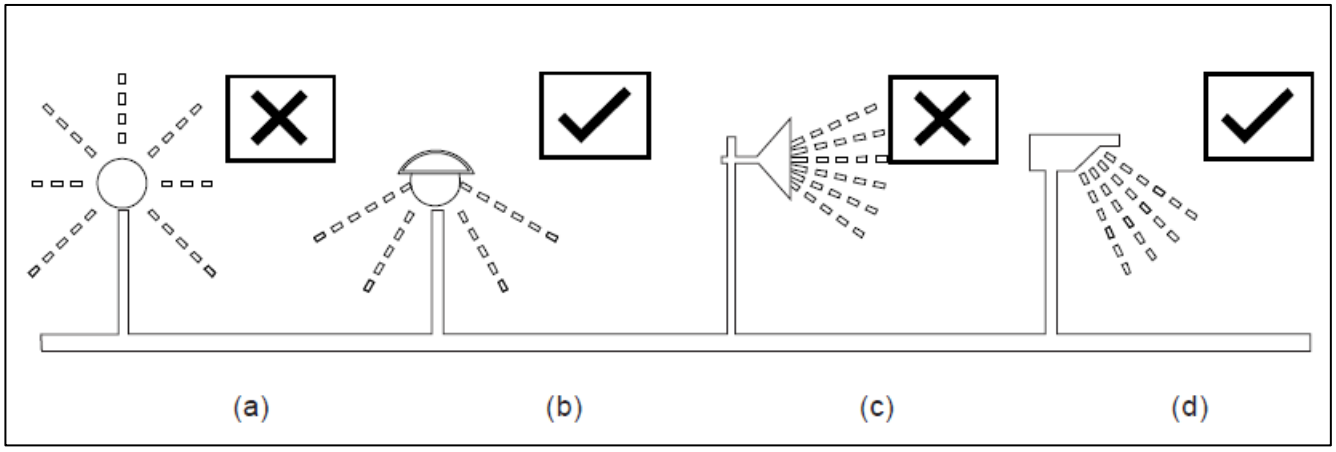

Figure 13-2: Simplified Lighting Types and their Ability to Control Environmentally Obtrusive Light (AS4282:2019).

It is considered important to avoid light spill onto Moreton Bay. Luminaires that are elevated (such as streetlamps) may be visible from Moreton Bay. These luminaires will have inherent screens to minimise or avoid visibility of the luminaire at water level at distances of 500 m from the shoreline. Typical designs for these locations comprise designs C and D in Figure 13-3.

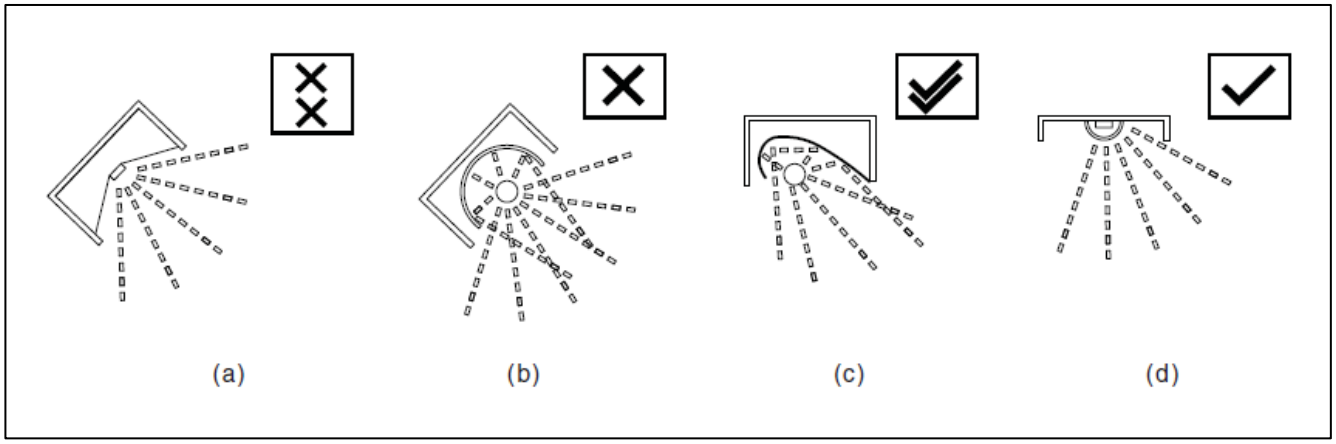

Figure 13-3: Luminaire Design and their Ability to Control Environmentally Obtrusive Light (AS4282:2019).

The future residential towers will not feature large prominent illuminated areas on vertical surfaces. Rather illumination will mostly be directed downwards onto footpaths and other public areas. Light spill onto Moreton Bay and into the sky (Figure 13-4 A and C) will be largely avoided and comply with Council guidelines for public areas.

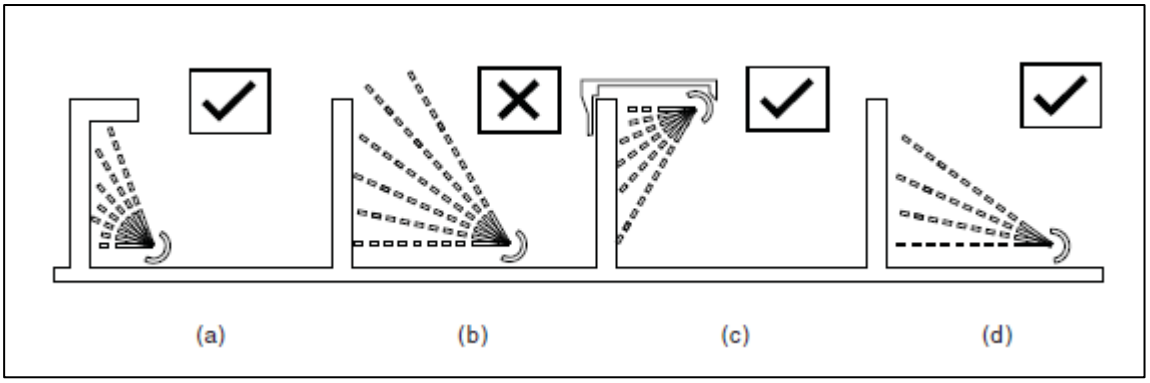

Figure 13-4: Luminaire Design to Avoid Skyward Illumination and Control Environmentally Obtrusive Light (AS4282:2019).

13.3.1 Conceptual Lighting Discussion and Design Intent

Lighting for the Project has been designed to be a low impact design and suitable for a site of high ecological sensitivity. The luminaires selected for the public areas are all Dark Sky Compliant LED lights with a colour temperature of 2700 K. These are "amber" lights which are specifically designed to protect marine and avian life from the adverse aspects of urban lighting.

The philosophy adopted for the lighting plan is low, long and shielded. Specifically fixtures will be mounted as **low** as possible. Low mounted fixtures provide more light directly on the ground where it is needed for human safety. This also reduces the potential of a light source or lamp from being directly visible at distance. The Project will use **long** wavelength (greater than 560 nm AND absent wavelengths below 560 nm) light sources such as amber, orange, or red LEDs, without the use of filters, gels, or lenses. Using long wavelength light sources is less disruptive to marine turtles than white or multi-colored lights. The luminaire should meet or exceed full cutoff. This is defined as no light emitting above a 90-degree plane. The fixture must be shielded so that the lamp or glowing lens is not directly visible when looking towards the fixture at a large distance, i.e. 100^{+} m.

13.3.2 Luminaires Selections

The lighting plan has adopted two types of luminaires RFL540-SEL LED for street lighting and PTY424 LED for park lighting (Figure 13-5). These are dark sky compliant and available with amber color temperature. Alternatives to these luminaires may be used, but they must meet the criteria to be dark sky compliant.

RFL540-SE LED

111-1075

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Description

IP66, Class I. IK07. Marine-grade, die-cast aluminium alloy. 5CE superior corrosion protection including PCS hardware. Non-reflecting safety glass lens, hinged. Silicone CCG® Controlled Compression

Beam Type	rectangular, 'side throw' [R65]
Light Source	LED-36/72W / 700 mA - 2700 K
CRI	80

PTY424 LED

114-9774

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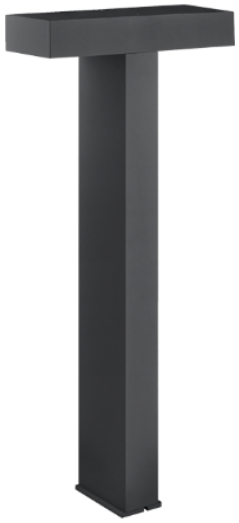


Description

IP66/IP67. Class I. IK10. Marine-grade, all-aluminium construction. Pole section features galvanised steel reinforcement core. 5CE superior corrosion protection including PCS hardware. RFC™

Beam Type	asymmetric, side-throw [S70/S70]
Light Source	LED-2x6/36W / 1050 mA - 2700 K
CRI	80

Figure 13-5: Example Luminaire Selections.

13.4. Existing Values

Onground monitoring of existing light sources found the ground level horizontal plane light level from streetlamps on roads and car parks adjacent to the site. These measurements and contours exclude the effects of screening and shadows from terrain, vegetation and buildings that are present on the site. The effect of these would further reduce the extent of the lighting exposure.

Whist there are other sources of light from residential and commercial sites, it was found that these are predominantly designed to provide light for tasks in dwellings, advertisement and architectural feature lighting; none of these types of lights were measurable at street level during this assessment. Over the subject site, there are no other potential sources of light. Figure 13-6 shows the area around the existing ferry terminal and Figure 13-7 shows the road to the north of the subject area.

The measurements show that the existing ferry terminal and car park is covered with extensive flood lighting. The current design of the lighting and luminaires does not result in a significant spill into the water or into surrounding property. Additionally, the measurements show that there is very little illumination of GJ Walter Park and the streets that surround the park.

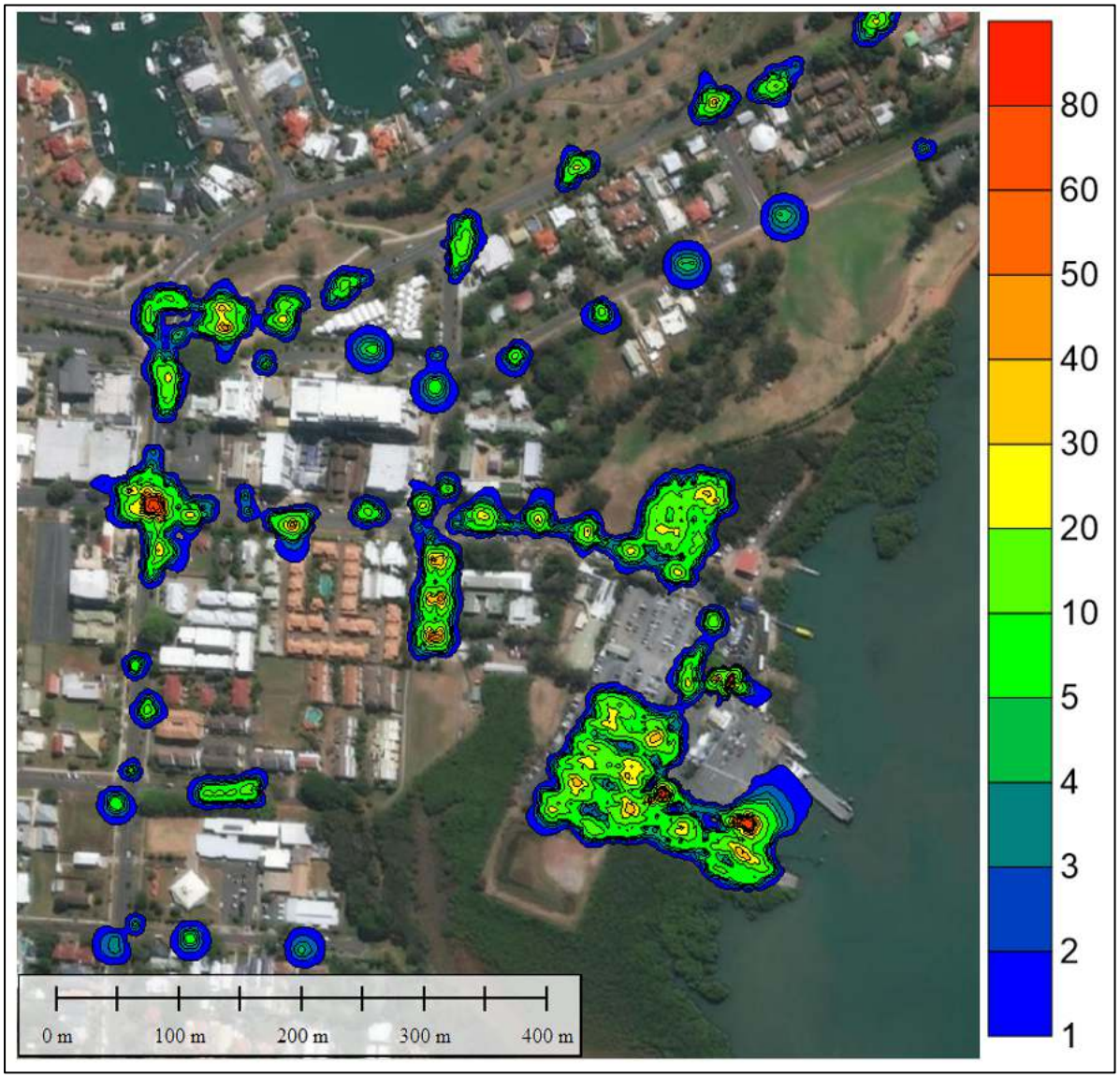


Figure 13-6: Toondah harbour and Surrounds – Measurements in Lx on a Horizontal Plane.

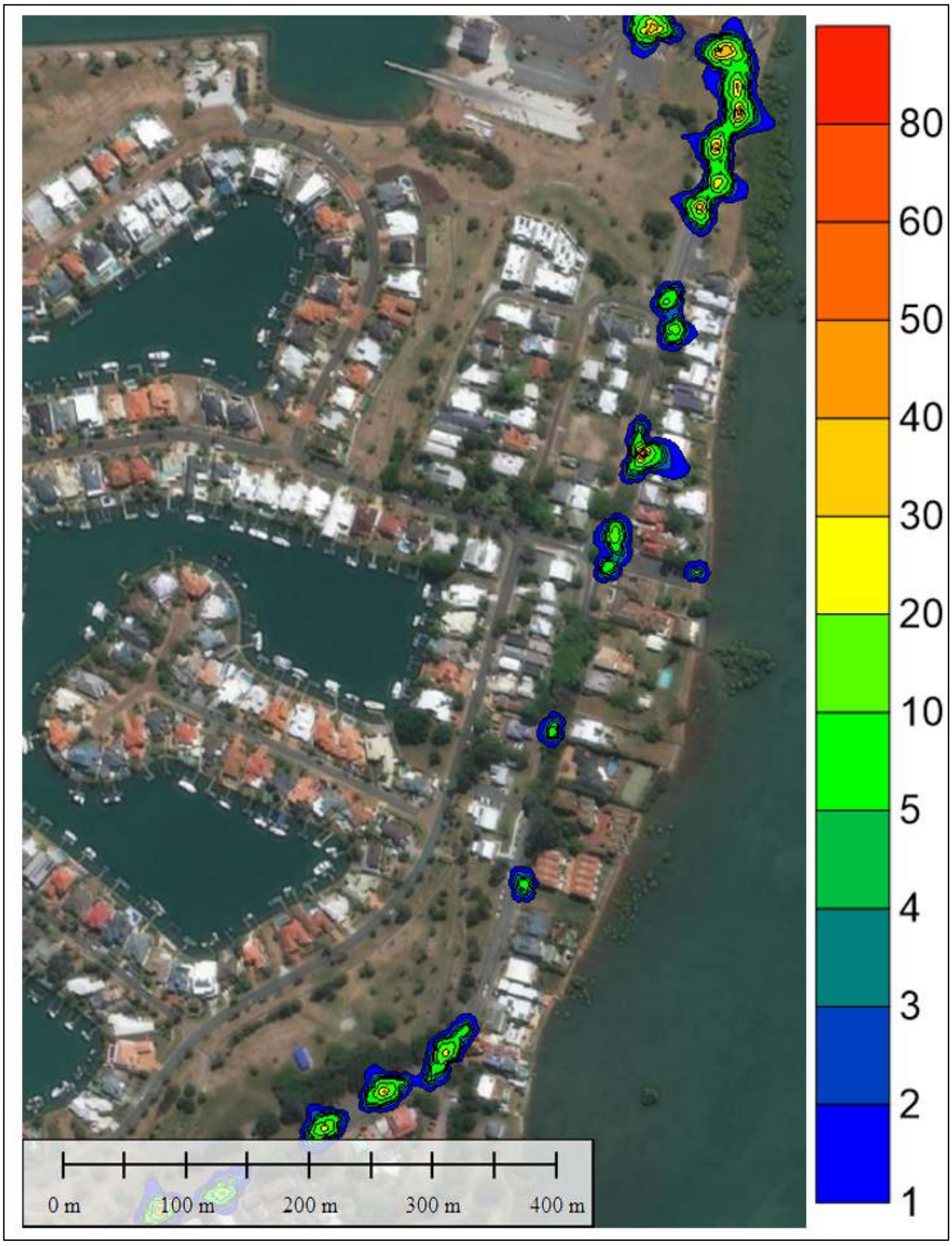


Figure 13-7: Roads North of Toondah Harbour – Measurements in Lx on a Horizontal Plane.

A clean photograph of the existing Toondah Harbour is shown on Plate 13-1 with comments identifying specific light sources included on the same photo as Plate 13-2. The view is from a location south of Cassim Island within the Fison Channel. The dominant lights are associated with spotlights and flood lights on the ferries and the harbour buildings. The existing residential units in Wharf Street do not have any visible lighting, however at least two residential floors are visible from this location. The construction crane is at the location of a new multistorey building, which also is visible from this location. It is noted that there is not any illumination of the construction site and building.

Plate 13-1: Toondah Harbour from Fison Channel South of Cassim Island

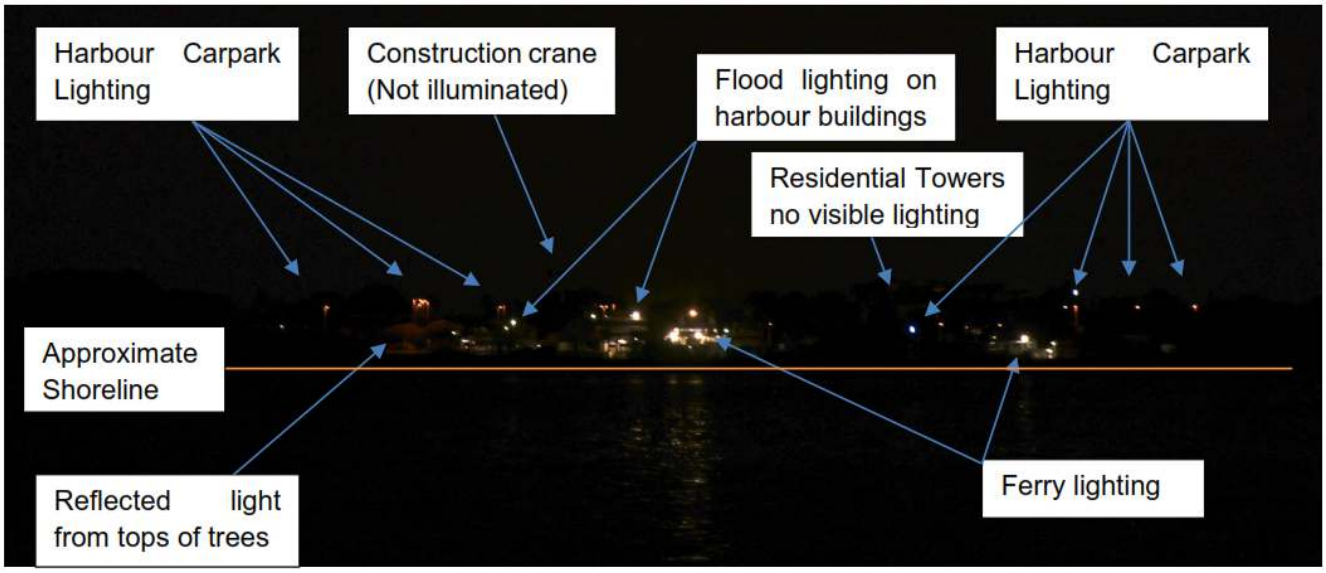


Plate 13-2: Toondah Harbour from Fison Channel South of Cassim Island with Comments

13.5. Potential Impacts – Conceptual Lighting Model

13.5.1 Illumination Levels

The modelled illumination levels (Lx) at ground level for the Project are shown in Figure 13-8. A 5 m grid spacing has been adopted to calculate the lighting levels. The contours show that directly under a streetlamp the illumination level is approximately 20 Lx to 30 Lx, while under the park lights the illumination level is greater than 50 Lux (but of a much smaller area).

It should be noted the lighting illumination is more uniform than that measured around the subject site with the maximum street lighting being similar.

Since the model has adopted "Dark Sky Compliant" luminaires, the illumination level quickly reduces to 1 Lux within the boundaries of the site. Apart from minor illumination of the marina water, there is no light spill onto adjacent mudflats, nor into the water.

13.5.2 Rendered Views

The rendered view from directly above the site (an aerial view) is contained in Figure 13-9. Renders of the development are presented from several viewpoints (refer to Figure 13-10) including:

- View 1 - 400 m northeast of the Project footprint (Figure 13-11 to Figure 13-13);
- View 2 - 100 m south of Cassim Island and 300 m from the navigation beacon for the marina entrance (Figure 13-14 to Figure 13-16);
- View 3 - Nandeebie Claypan, excluding screening effect of mangroves (Figure 13-17 to Figure 13-19);
- View 4 – Fison Channel entrance (Figure 13-20);
- View 5 - Cassim Island (Figure 13-21 and Figure 13-22);
- View 6 - Oyster Point (Figure 13-23);
- View 7 - Offshore Sandbank (due east of Cassim Island, excludes screening effect of Cassim Island) (Figure 13-24); and
- View 8 - Location 150 m northeast of the site (Figure 13-25).

Human eyesight field of view is approximately 135°. For birds and wildlife, the field of view is much greater. In this instance the field of view for the renders has been limited to a maximum of 30° to avoid distortion (or fish-eye) effects associated with perspective views. All renders are perspectives from an elevation of 2 m above the water. Figure 13-25 represents a location on mudflats close to the perimeter of the site. This nearfield render demonstrates the screening of the more distant buildings by the closer buildings. Additionally, vegetation provides effective screening of the closest building. The model includes a small number of trees with a comparatively open canopy. The screening effect of vegetation will be significantly enhanced by increasing the number of trees and providing trees with a dense canopy. The marina navigation beacon atop the rock wall east of the entrance channel has been included in the model and is visible from the arc from the west, south and east.

The renders demonstrate that none of the luminaires are visible beyond the site, with the exception of the marina navigation beacon. This ensures the site will not have any direct glare from the luminaires.

The main aspects are reflected light from vertical surfaces (and or) illumination from within buildings. Generally, it is found occupiers of dwellings limit the use of lighting to occupied rooms and balcony lights are only on when the balcony is in use. Finally, east facing windows usually have curtains drawn during the evening to avoid early morning sun waking the occupants. Consequently, the model is considered to be representative of typical lighting usage for the site.

Figure 13-8: Predicted Lighting Levels for The Entire Site (Lx).

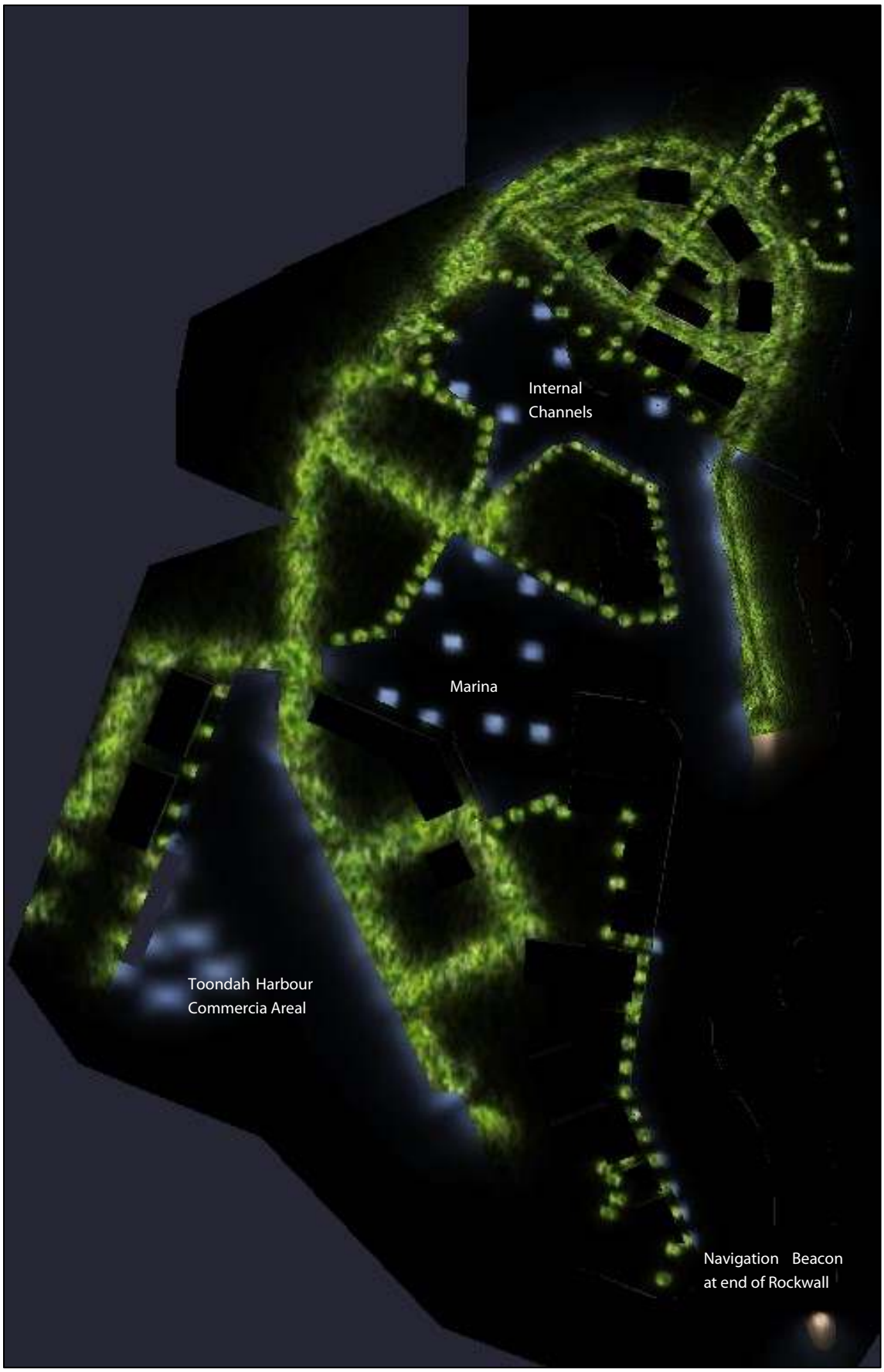
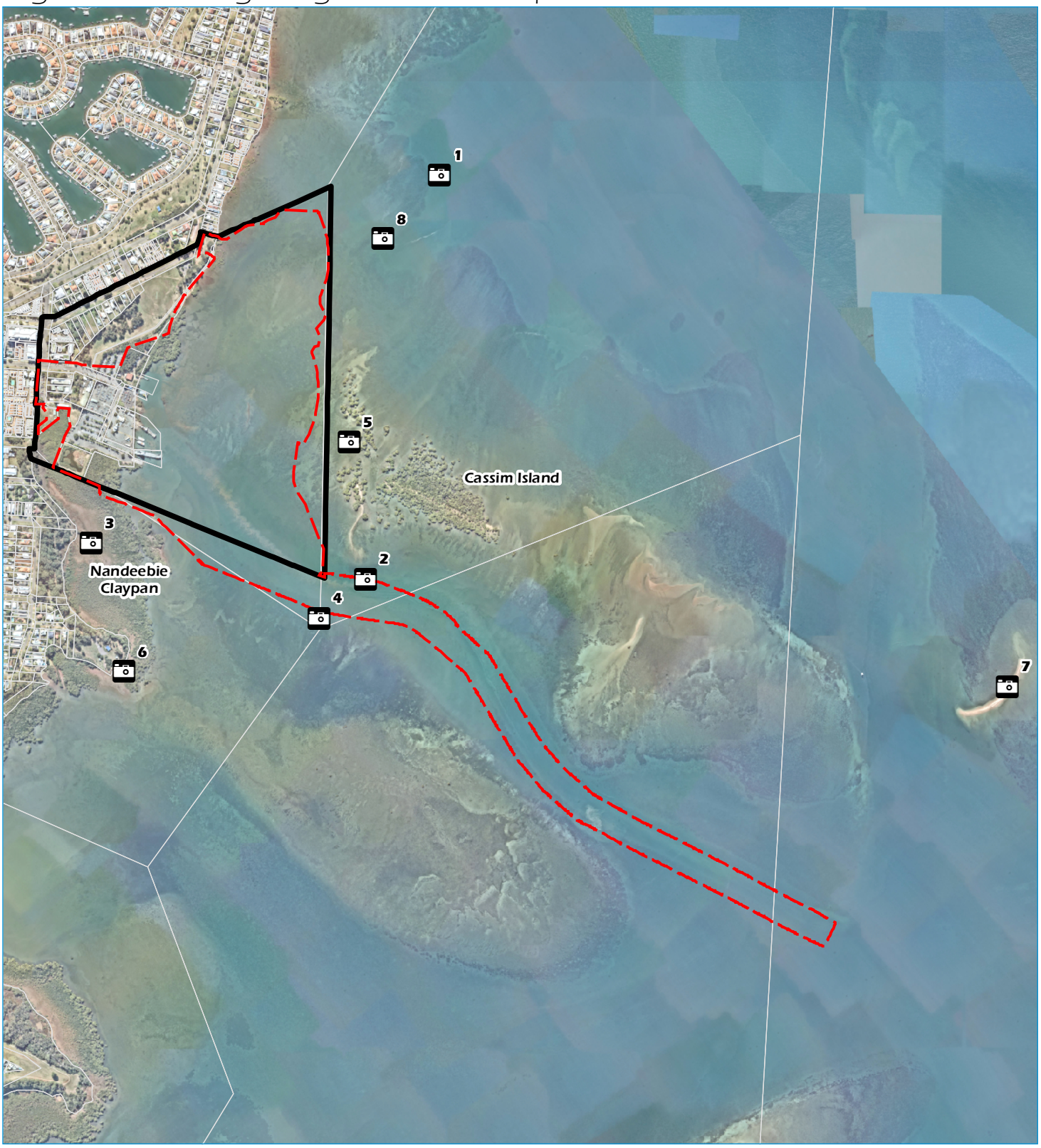


Figure 13-9: Aerial Render View of the Toondah Harbour Project.

Figure 13-10: Lighting Render Viewpoints



Legend

- Toondah Harbour PDA
- Qld DCDB
- Project area/footprint
- Lighting Render Viewpoints

Toondah Harbour EIS

TOONDAH HARBOUR

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N

0 100 200 300 400 m

GDA 1994 MGA zone 56

Scale (A4): 1:16,000

Layer Source: © State of Queensland Datasets (Department of Resources 2022), Aerial (Nearmap 2020)

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FILE REF. 9858 Figure 13 10 Lighting Render Viewpoints B

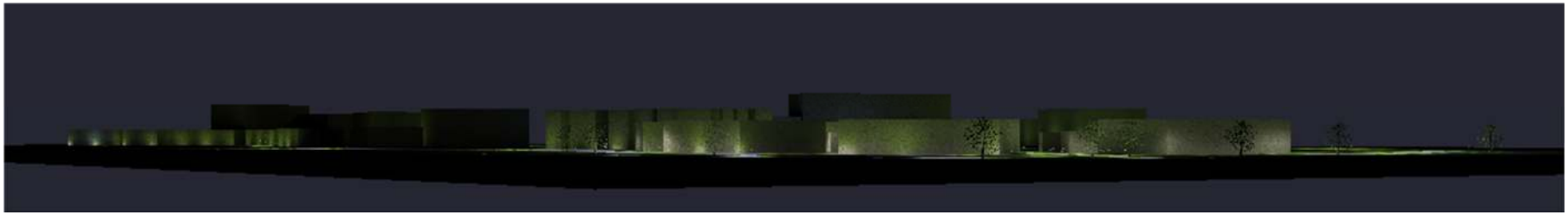

Figure 13-11: NE Location, 400 m Site 30° Field of View.

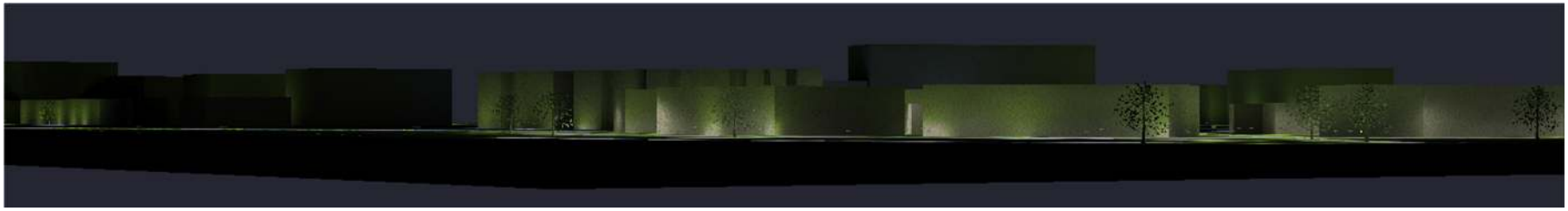

Figure 13-12: NE Location, 400 m from Site 15° Field of View.

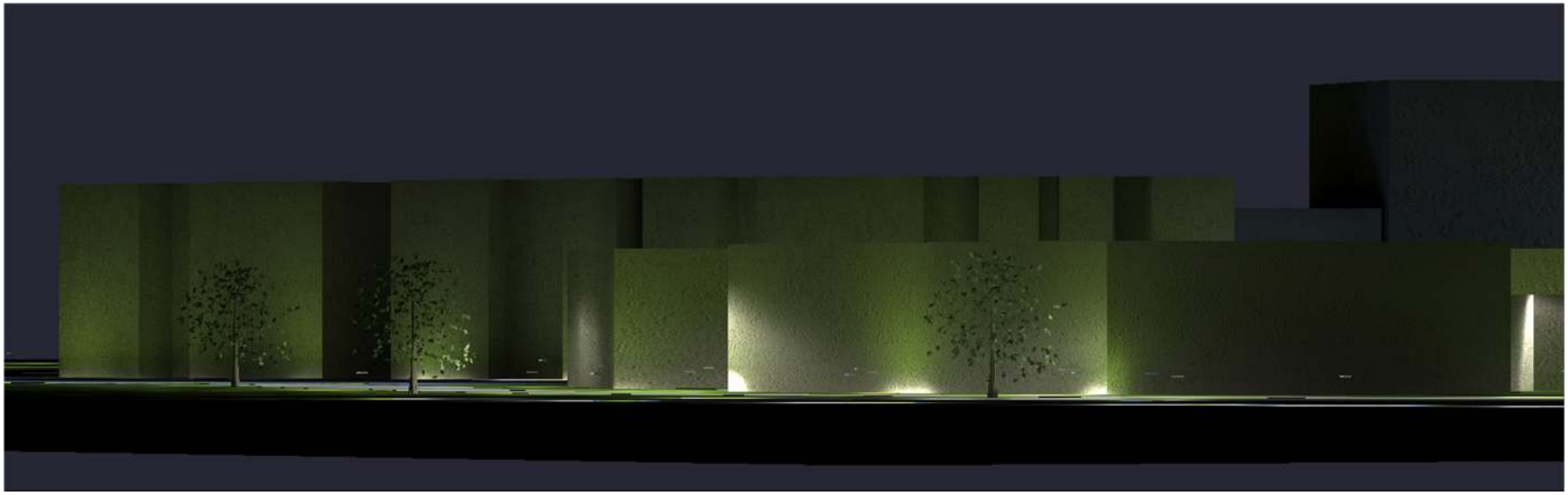

Figure 13-13: NE Location, 400 m from Site 5° Field of View.

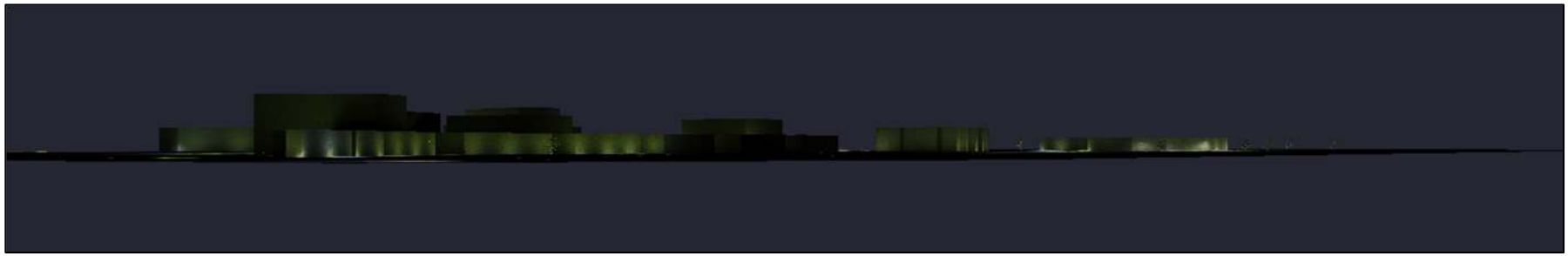

Figure 13-14: 100 m South of Cassim Island Site 30° Field of View.

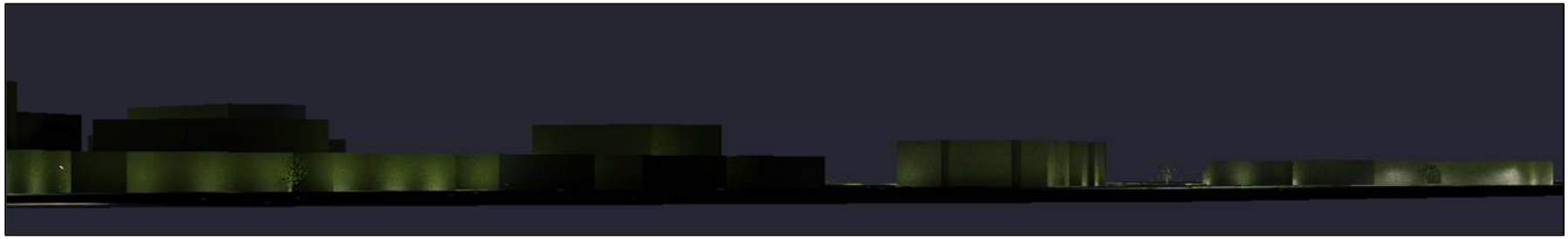

Figure 13-15: 100 m South of Cassim Island Site 15° Field of View.

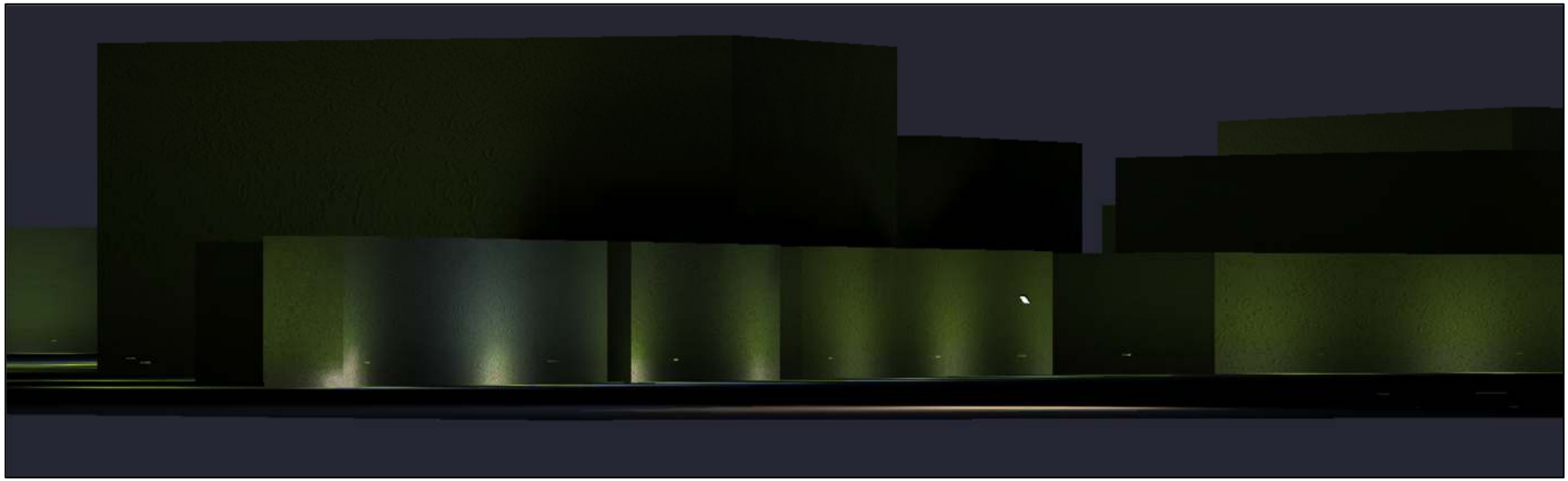

Figure 13-16: 100 m South of Cassim Island Site 5° Field of View (Showing Navigation Beacon).

Figure 13-17: Nandeebie Claypan (Excludes Screening Effect of Mangroves) Site 30° Field of View.

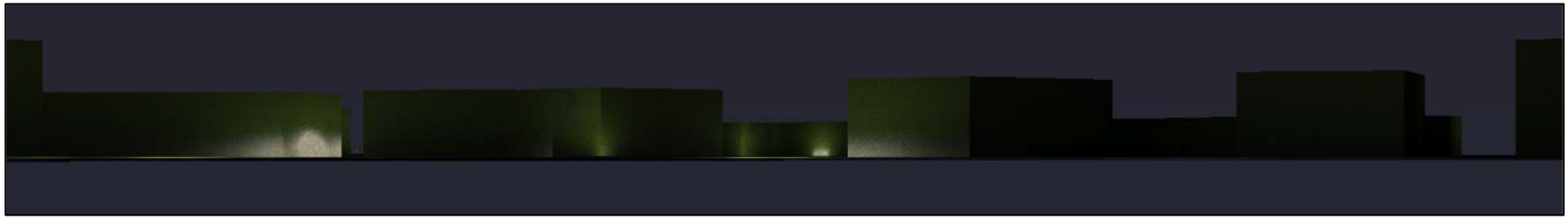

Figure 13-18: Nandeebie Claypan (Excludes Screening Effect of Mangroves) Site 15° Field of View.

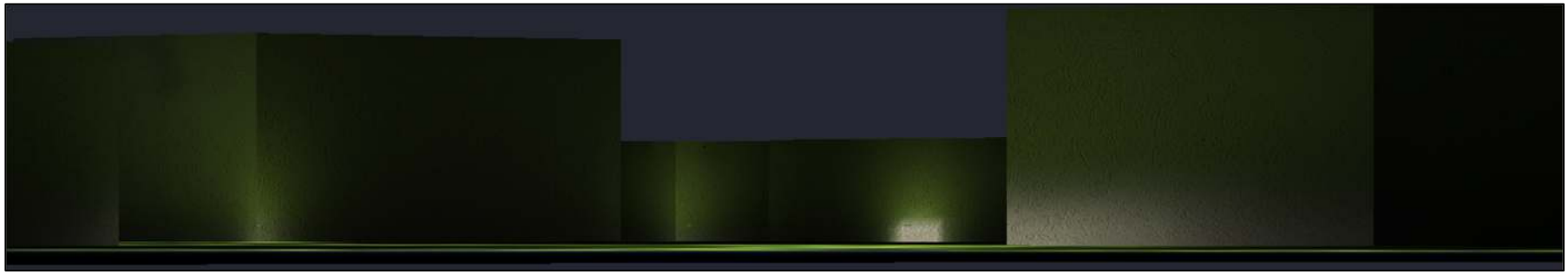

Figure 13-19: Nandeebie Claypan (Excludes Screening Effect of Mangroves) Site 5° Field of View.

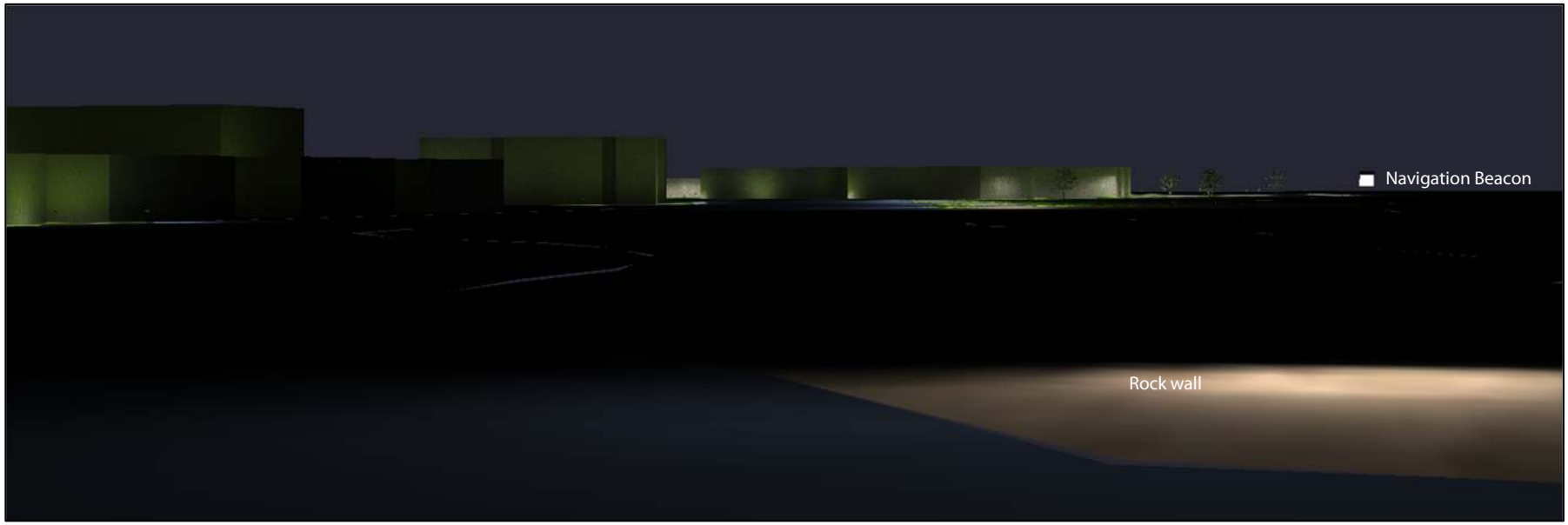

Figure 13-20: Marina Navigation Channel Entrance Site 30° Field of View.

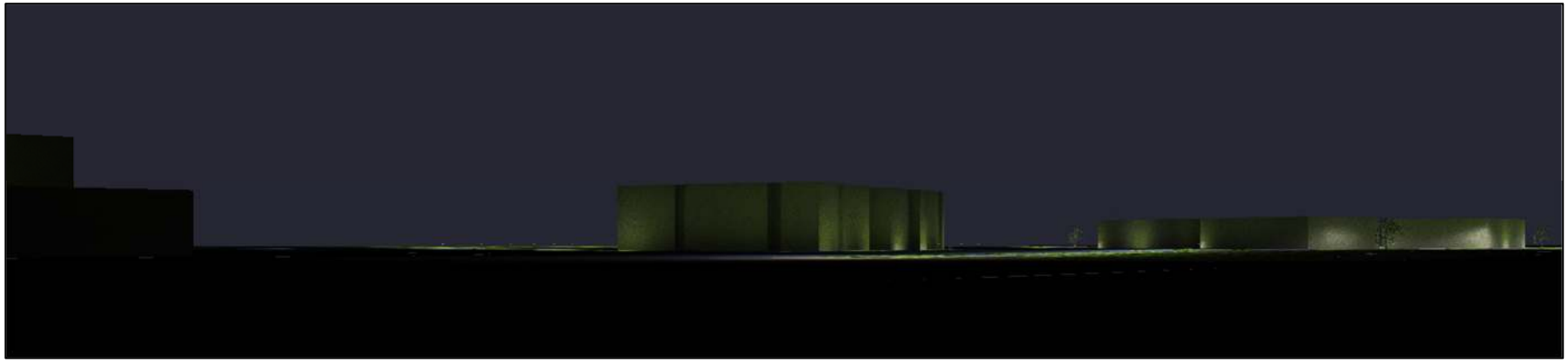

Figure 13-21: Cassim Island Looking North 30° Field of View.

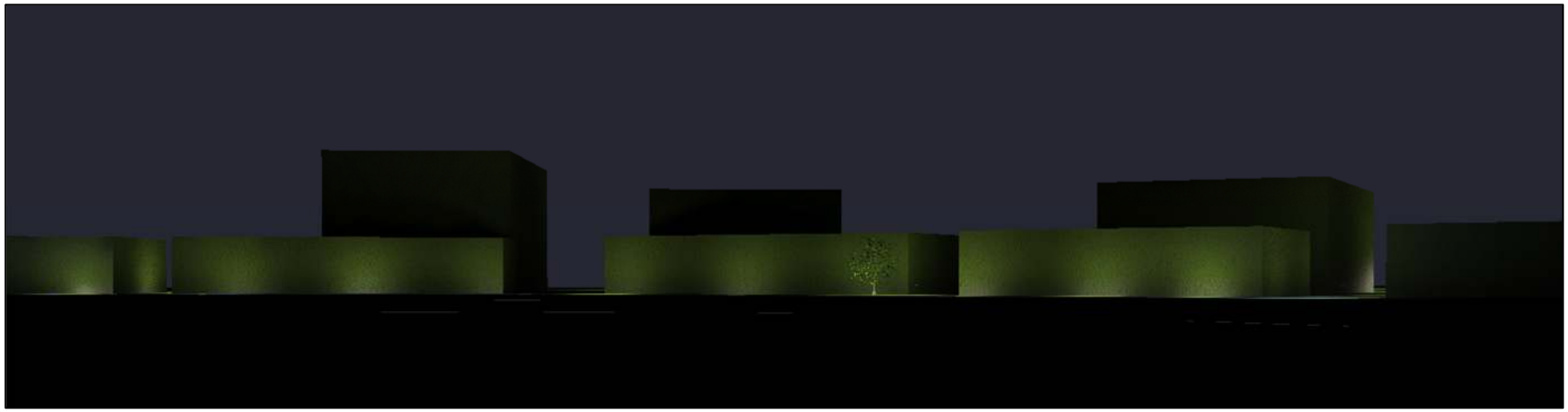

Figure 13-22: Cassim Island Looking Southwest 30° Field of View.

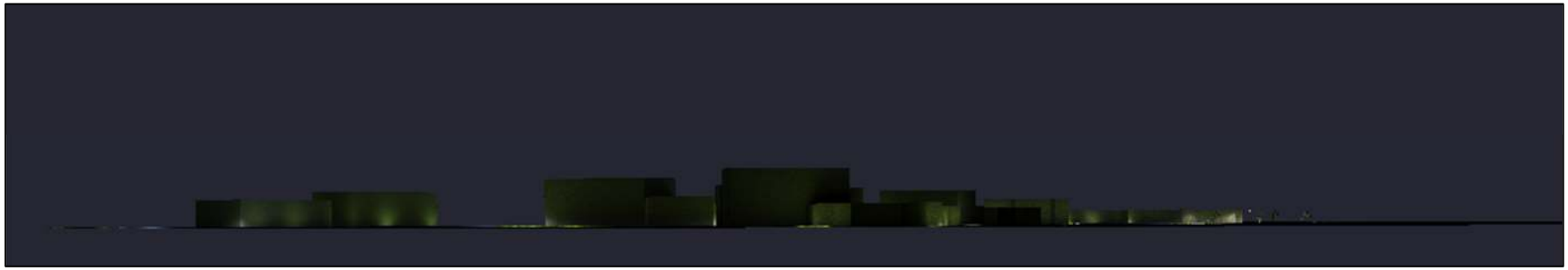

Figure 13-23: Oyster Point Looking North 30° Field of View.

Figure 13-24: Sandbank 1.5 km from Site Looking West 30° Field of View.

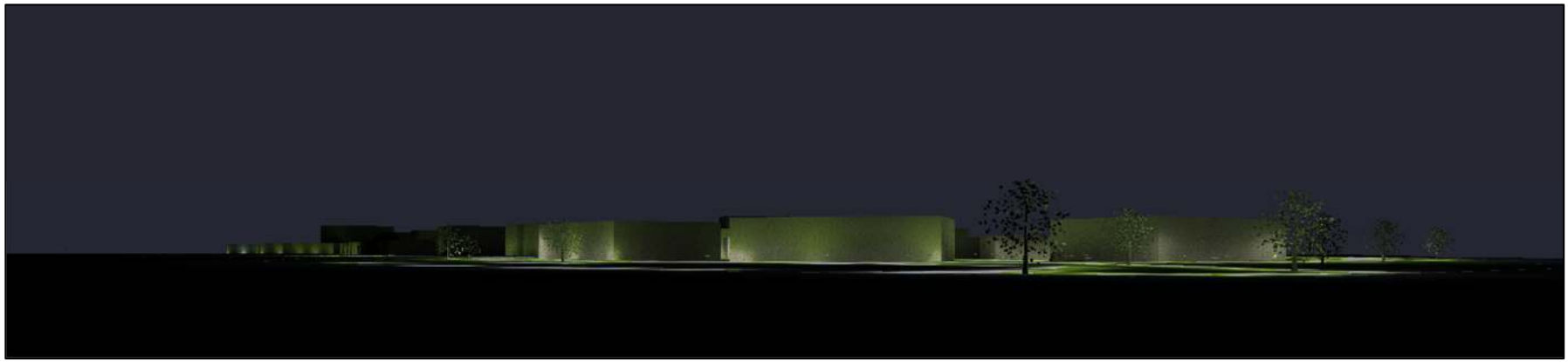

Figure 13-25: NE of site (150 m) Looking SW 30° Field of View

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13.6. Adaptive Management and Monitoring Measures

Management measures for construction and operational lighting are generally associated with selection of luminaires and design of lighting fixtures. Modelling has demonstrated that, apart from areas immediately below street luminaires and the security lighting in the public car parks, the lighting levels for the Project footprint and surrounds is very low. Outside of target areas, light levels are well below 1 Lux and there is minimal light spill onto Moreton Bay. The extensive areas of vegetation provide effective screens for lighting spill. Generally, the lighting in public areas and on most private property is directed downwards with minimal skyward lighting losses. Management measures are listed in Table 13-2. Management measures address light sources and spill outside of target areas. Measures specific to marine fauna and migratory shorebirds are addressed in Chapters 16 and 17 respectively.

A conceptual design has been outlined with the lighting designed to:

- Comply with AS 4282 - Control of the obtrusive effects of outdoor lighting and the National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds and migratory shorebirds;
- Maintain or reduce lighting exposure onto Moreton Bay;
- Avoid wasteful illumination into the sky;
- Avoid excessively bright points of light when viewed from Moreton Bay, all existing residential areas and from public areas;
- Avoid illumination of large vertical surfaces visible from Moreton Bay and from existing residential areas; and
- Support vegetation to assist with screening ground level visibility and avoid light spill onto surrounding areas.

Table 13-2: Lighting Management Measures

Potential Impacts	Mitigation Measure	Desired outcomes and effectiveness
Short term increases in artificial lighting around the temporary unloading dock and other activities during construction.	▪ Lighting design to adhere to AS 4282 - Control of the obtrusive effects of outdoor lighting and the National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds and migratory shorebirds. ▪ Light downwards and not horizontally or vertically. ▪ Avoid excessively bright points of light being directed towards Moreton Bay. ▪ Temporary fencing to be placed around the work compounds where lighting may affect sensitive receptors.	▪ No long-term disturbance to marine or terrestrial fauna as a result of lighting. ▪ Modelling has shown that lighting design in accordance with AS 4282 - Control of the obtrusive effects of outdoor lighting and the National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds and migratory shorebirds will minimise spill outside of target areas to less than 1 Lux, therefore management measures proposed are considered highly effective.
Increase in ambient light from urban areas (building, parkland, etc) and the upgraded ferry terminal including associated retail and commercial uses.	▪ Lighting design to be adhere to AS 4282 - Control of the obtrusive effects of outdoor lighting and the National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds and migratory shorebirds. ▪ Luminaires selected for street and park lighting are to be dark sky compliant. ▪ Light downwards and not horizontally or vertically.	▪ No long-term disturbance to marine or terrestrial fauna as a result of lighting. ▪ Modelling has shown that lighting design in accordance with AS 4282 - Control of the obtrusive effects of outdoor lighting and the National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds and migratory shorebirds will minimise spill outside of target areas to less than 1 Lux, therefore management measures proposed are considered highly effective.

Potential Impacts	Mitigation Measure	Desired outcomes and effectiveness
	▪ Avoid excessively bright points of light being directed towards Moreton Bay. ▪ Avoid illumination of large vertical surfaces visible from Moreton Bay. ▪ Park and open space planting planning to assist with screening ground level visibility and avoid light spill onto surround areas.	

13.7. Residual Risk of Impact

The risk of significant residual impacts to the lighting environment have been assessed following the methodology outlined in Chapter 6 of the EIS. The risk of significant residual impacts to environmental values such as terrestrial and marine flora and fauna and migratory shorebirds has been addressed in Chapters 15, 16 and 17 respectively. Risk of impacts from lighting to ecological sensors is considered low if managed appropriately (Table 13-3).

Table 13-3: Lighting Risk Assessment of Key Activities.

Activity	Initial risk assessment					Mitigated risk assessment				
	Scale	**Duration**	**Impact**	**Likelihood**	**Risk**	**Scale**	**Duration**	**Impact**	**Likelihood**	**Residual risk**
Increases in artificial lighting around the temporary unloading dock and other activities during construction	Local	Short	Low	Possible	**Low**	Site	Short	Low	Not Likely	**Low**
Increase in ambient light from urban areas (building, parkland, etc) and the upgraded ferry terminal including associated retail and commercial uses	Local	Permanent	High	Possible	**High**	Site	Permanent	Medium	Not Likely	**Low**