walker

TOONDAH HARBOUR

APPENDIX 2 - K

LIGHTING TECHNICAL REPORT

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Simpson Engineering Group

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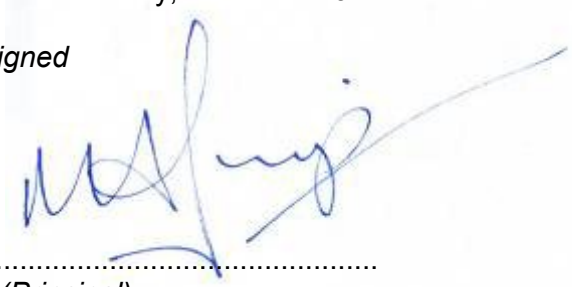

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Contents

1 Introduction

SEG Consulting Engineers has been retained by Walker Group Holdings to investigate lighting aspects associated with construction and operation of Toondah Harbour.

SEG has assessed environmental noise impacts from the construction and future proposed activities onto nearby noise sensitive receptors. The report presents the results of an investigation which includes:

- reviewed the existing environment,
- proposed goals in accordance with community expectations
- recommendations for lighting

This report does not assess lighting impacts on biota (the plant and animal life of a region). This will be addressed by others in the study team. However, this report describes the lighting intent for the development.

1.1 Project Description

The Site is located within the Toondah Harbour PDA at Middle Street, Cleveland. Cleveland is the civic, commercial and cultural hub of the Redland City local government area (LGA), and a principal regional activity centre under the South East Queensland Regional Plan.

Current uses of the terrestrial portion of the site include multiple ferry terminals and public boat ramp, extensive areas of surface car parking, an office complex, and a disused dredged material disposal pond.

The overwater areas are made up of a mix of tidal and intertidal habitats with the majority being intertidal mudflat but also include the existing wet berths, swing basin and public navigation channel.

The Toondah Harbour development area contains intertidal feeding habitat for a number of migratory shorebirds.

Refer to Figure 1 for the Toondah Harbour Master plan. The Masterplan shows a fully developed Toondah harbour which will comprise residential precincts, parks, a marina precinct, as well as a redeveloped harbour. Building works on the landform will occur progressively as sections are complete. The northern residential precinct will be completed after 2 to 4 years and the central residential precinct after 7 years. The southern section will require approximately 18 years from initial commencement before the new landform reaches practical completion.

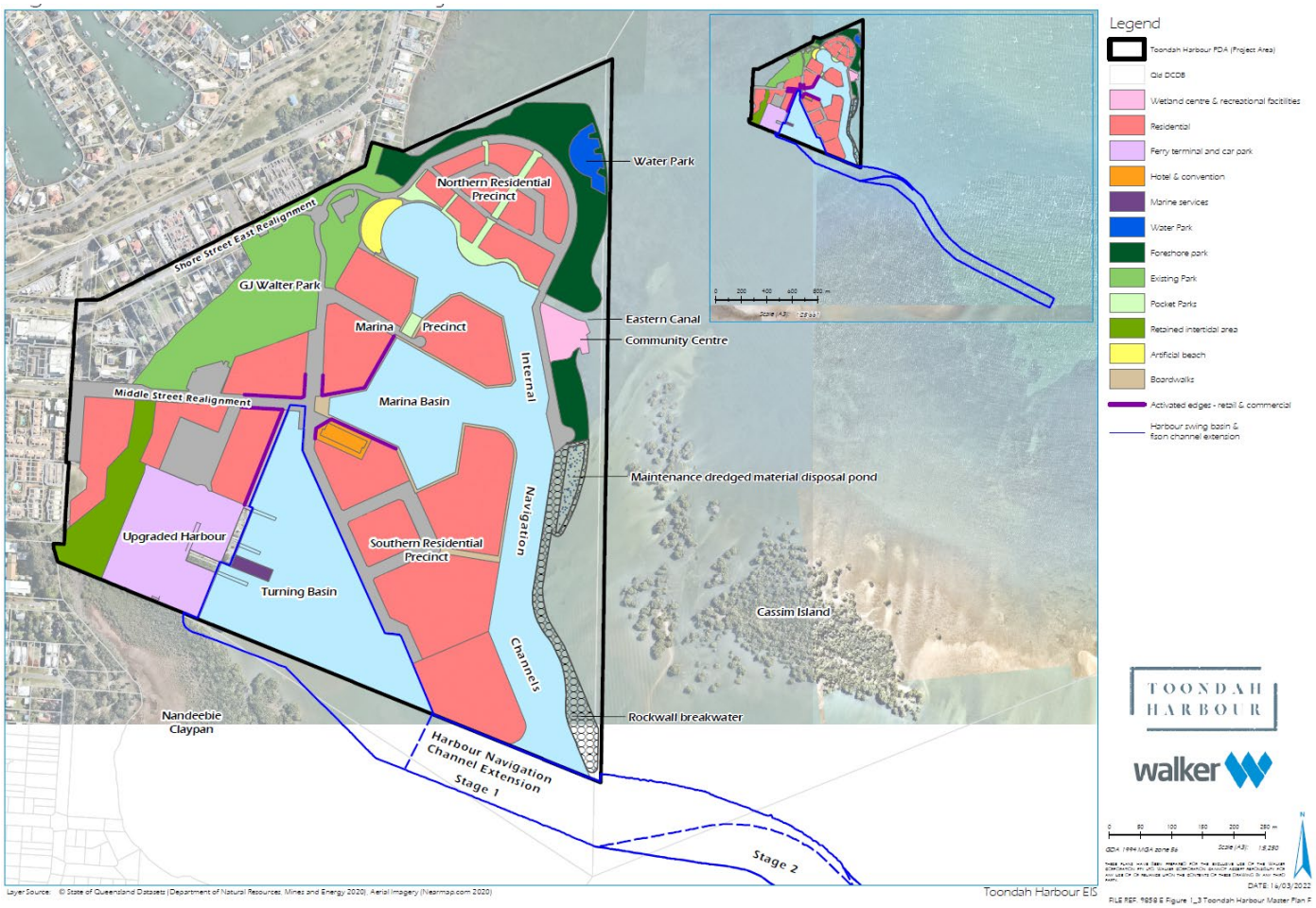


Figure 1: Toondah Harbour Project Master Plan

2 Existing Lighting Environment

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 the Toondah Harbour. A Lutron YK-2001LX Light Meter was mounted horizontally at the end of a survey pole. Collocated with the light meter sensor was a GPS/GLONASS receiver with 10Hz output and nominal accuracy around 1m. The light meter outputted Lux values once per second and this lighting level was logged with GPS location once per second.

Areas of the port including Emmet Drive, Toondah Harbour Boat Ramp and three public carparks 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 E, North Street, Shore Street N, Paxton Street, William Street, Wharf Street, Passage Street, Queen Street and Longland Street.

The discrete location-based measurements were plotted and applied to a 2m by 2m grid across the subject site. Where measurements were not available on the gird 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.

The resultant contours show the ground level horizontal plane light level from streetlamps on roads and carparks 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 such as Figure 1 shows the area around the port and Figure 2 shows the road to the north of the subject area.

The measurements demonstrate that the existing port environment and car park is covered with extensive flood lighting. The current design of the lightning 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.

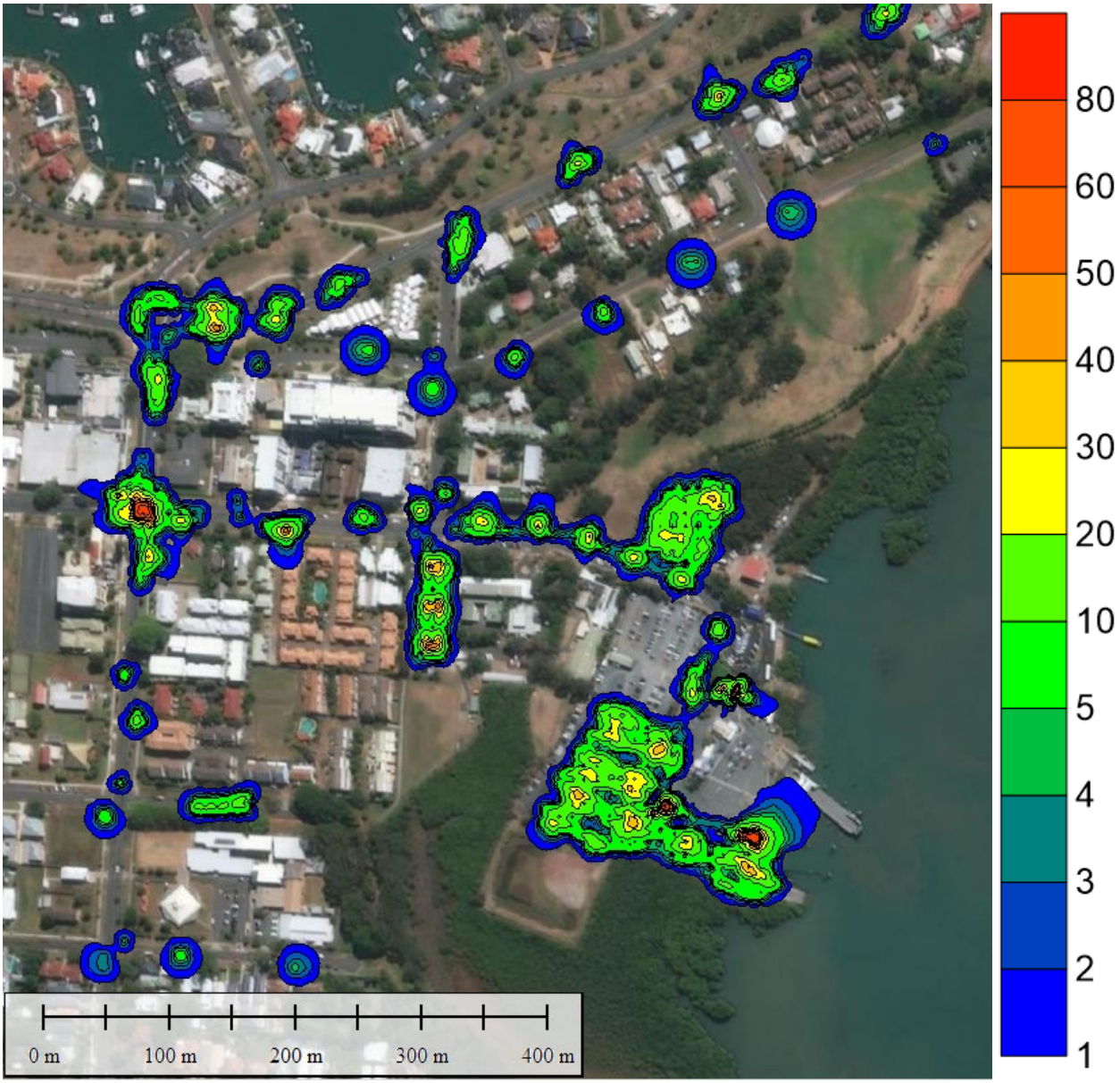


Figure 2:Port & Surrounds – Measurements in Lx on a horizontal plane

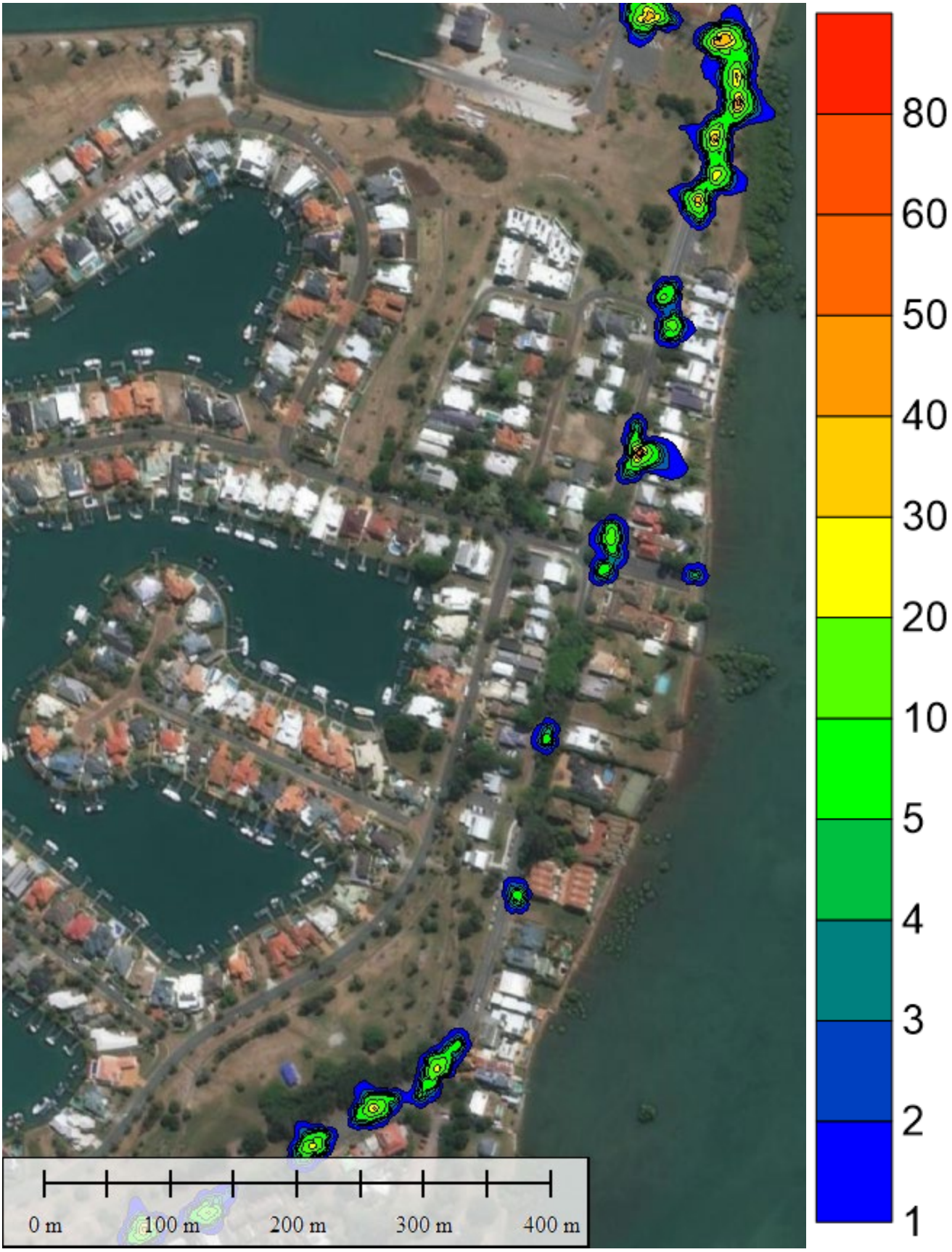
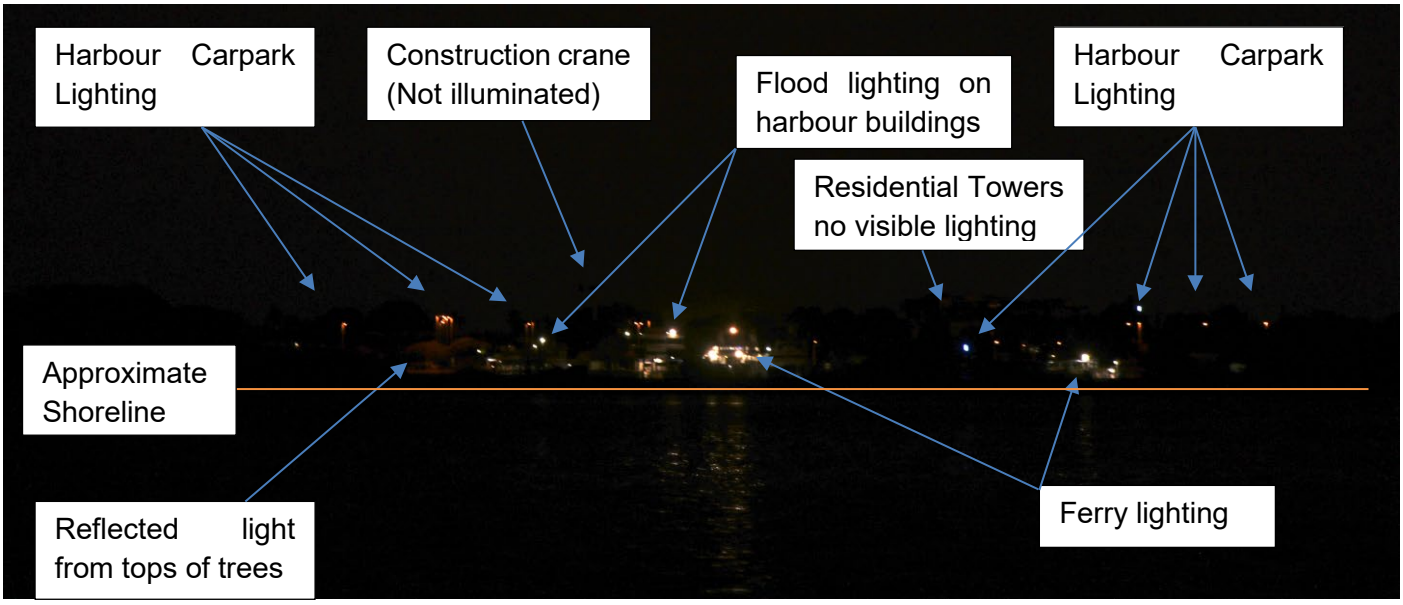


Figure 3: Northern Roads – Measurements in Lx on a horizontal plane

A photograph of the existing Toondah Harbour is contained in Photograph 1 and with comments in Photograph 2 . The view is from a location south of Cassim Island within the navigation channel, refer to Figure 4. The dominant lights are associated with spot lights 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 2 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.

Photograph 1: Toondah Harbour From Navigation Channel South of Cassim Island



Photograph 2: Toondah Harbour from Navigation Channel South of Cassim Island with Comments

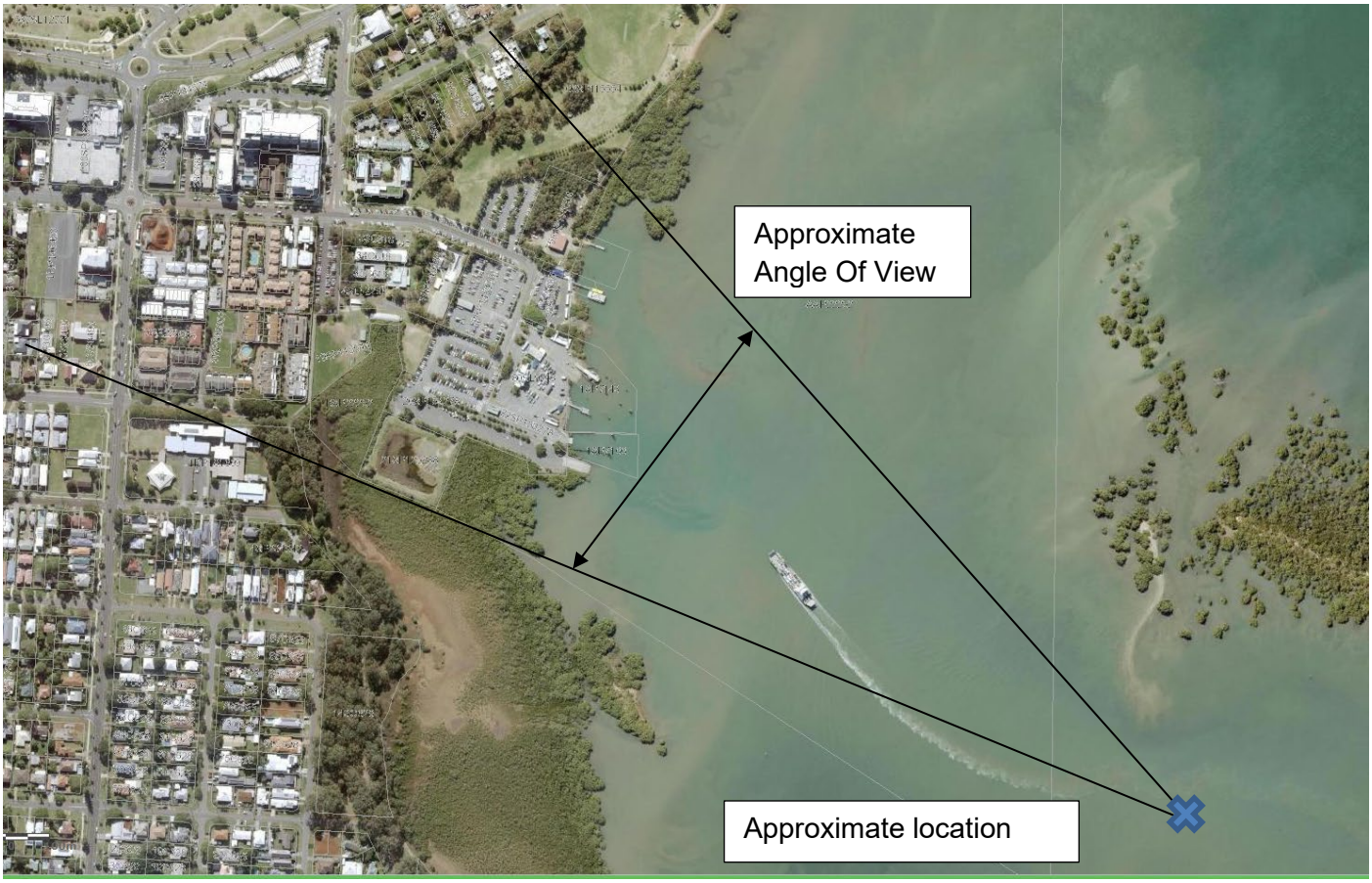


Figure 4: Approximate Location and Orientation of Night Photography

3 Lighting Criteria

3.1 Redlands City Council

Redlands City Council currently implements Redlands City Plan 2018. The residential properties surrounding the site are zoned a mix of low and medium density residential, neighbourhood and community facilities.

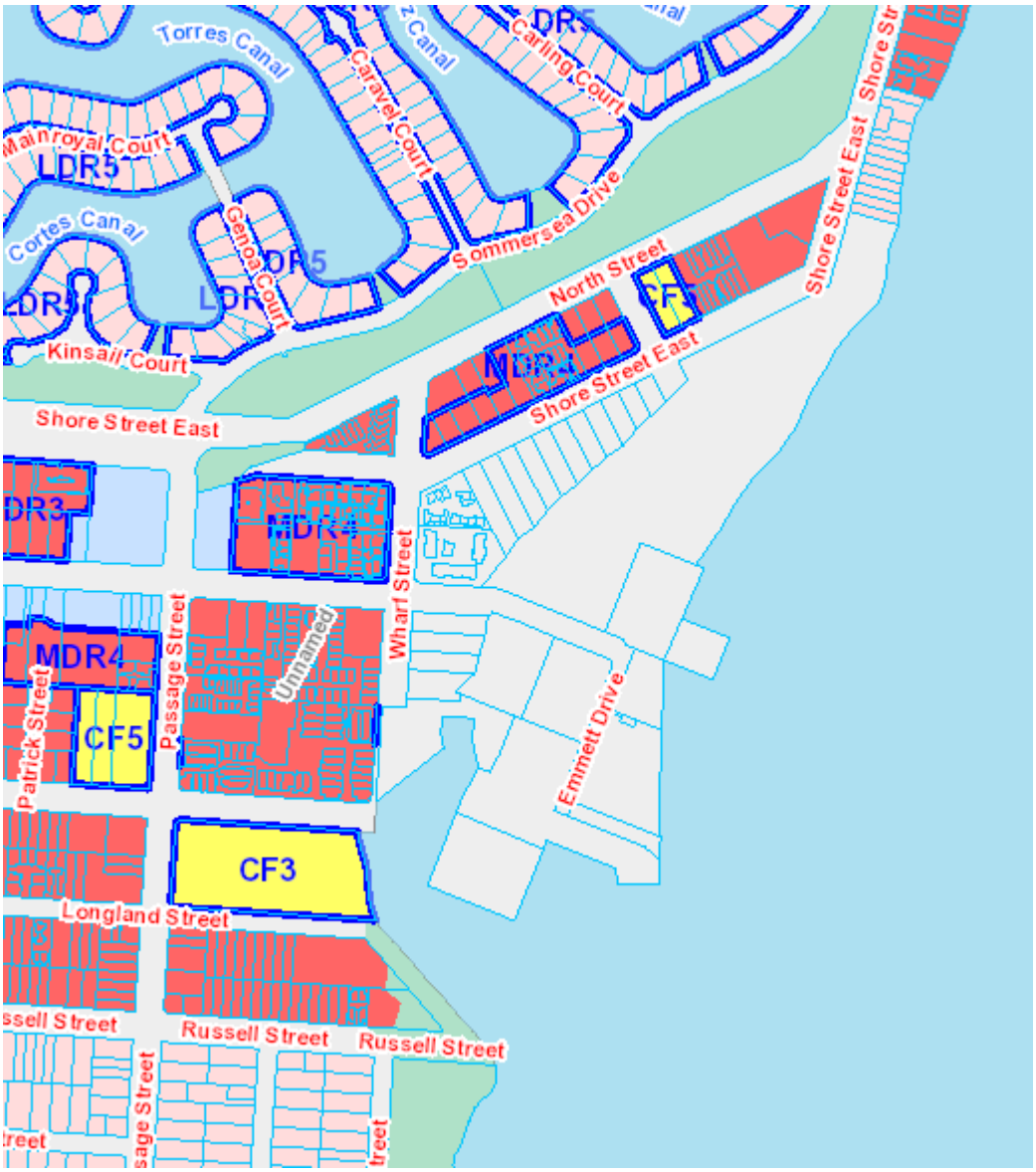


Figure 5: Zoning Information (Redlands City Council Red-e-Map)

Section *6.2.12.3 Recreation and open space zone code – Specific benchmarks for assessment* contains performance outcome PO11 for amenity.

PO11 Development minimises lighting, noise and other impacts on nearby sensitive land uses and habitat areas	No acceptable outcome is nominated.

Section 9.*3.2.3 Infrastructure works code – Specific benchmarks for assessment* contains a performance outcome for street and path lighting.

Table 1 Performance Outcome & Acceptable outcome for Lighting

Street and path lighting	
PO14 Street and path lighting is provided to enhance the safety of pedestrians, cyclists and road users.	**AO14.1** New public or private roads, pedestrian or cycle paths or public open space are provided with street and path lighting in accordance with AS1158 – Road Lighting (as amended) and Planning Scheme Policy 2 – Infrastructure works.
Construction Management	
Work is undertaken in a manner which does not cause unacceptable impacts on surrounding areas as a result of traffic, noise, lighting, waste material or other cause	No acceptable outcome is nominated. *Editor's note—The Planning Scheme Policy 2 –Infrastructure works contains guidance on what an appropriate construction management plan may contain*

Additionally, City Plan 2018 has two different benchmark performance outcomes and acceptable outcomes depending on the zoned area. Breaking his down into sections, the first zoned areas are:

- 6.2.6.3 Principal centre zone code – Specific benchmarks for assessment
- 6.2.7.3 Major centre zone code – Specific benchmarks for assessment
- 6.2.8.3 District centre zone code – Specific benchmarks for assessment
- 6.2.9.3 Local centre zone code – Specific benchmarks for assessment
- 6.2.10.3 Neighbourhood centre zone code – Specific benchmarks for assessment
- 6.2.11.3 Specialised centre zone code – Specific benchmarks for assessment
- 6.2.15.3 Low impact industry zone code – Specific benchmarks for assessment
- 6.2.16.3 Medium impact industry zone code – Specific benchmarks for assessment
- 6.2.17.3 Waterfront and marine industry zone code – Specific benchmarks for assessment
- 6.2.18.3 Mixed use zone code – Specific benchmarks for assessment

These zones have an amenity acceptable outcome that is dependent on the operating hours and is summarised in the excerpt from City Plan 2018 in Table 2.

Table 2: Excerpt from City Plan 2018 - Table 6.2.6.3.1

Amenity	
PO2 Development minimises impacts on the amenity of nearby land in a residential zone, having regard to noise, odour, vibration, air or light emissions.	**AO2.2** When measured from the windows of habitable rooms of the nearest dwelling, illumination does not exceed: (1) during opening hours: 25 lux; and (2) after opening hours, 4 lux. *Editor's note—For measurement guidance, refer to the Australian Standard for the Control of the Obtrusive Effects of Outdoor Lighting AS4282 – 1997.*

The second benchmark for is time dependent with a change of goal at 11pm and applies to developments zoned as:

- 6.2.19.3 Community facilities zone code – Specific benchmarks for assessment
- 6.2.20.3 Emerging community zone code – Specific benchmarks for assessment
- 6.2.21.3 Rural zone code – Specific benchmarks for assessment

From this the acceptable outcome that is dependent on time of day hours and is summarised in the excerpt from City Plan 2018 in Table 3.

Table 3: Excerpt from City Plan 2018 - Table 6.2.19.3.1

Amenity	
PO2 Development minimises impacts on the amenity of nearby land in a residential zone, having regard to noise, odour, vibration, air or light emissions.	**AO2.2** When measured from the windows of habitable rooms of the nearest dwelling, illumination does not exceed: (1) before 11pm: 25 lx; and (2) after opening hours, 4 lx. *Editor's note—For measurement guidance, refer to the Australian Standard for the Control of the Obtrusive Effects of Outdoor Lighting AS4282 – 1997.*

3.2 AS 4282 – Control of the obtrusive effects of outdoor lighting

Redlands City Council refers to AS4282 – 1997 for measurement guidance. It has subsequently been updated in 2019. Australian Standard AS 4282 Control of the obtrusive effects of outdoor lighting (AS4282) outlines recommended values for light for the control of obtrusive light. The lighting terms has been included in Appendix A: Lighting Definitions.

The standard also recommends lighting limits where residential properties are in low to high brightness environmental zones. It is likely that sections of North St and properties that abut this would be classified as

medium district brightness but the dwellings facing Moreton Bay and Moreton Bay would be in a Dark environmental zone.

AS4282 Defines procedures for Assessment of Lighting. As no design for lighting is available at this stage, general limits/goals for design are specified. These limits are to be used for construction and operational phase to reduce the potential 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.

Table 4: 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

3.3 National Light Pollution Guidelines for Wildlife

In Jan 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 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 and marine fauna.

4 Construction Phase and Operational Phase Lighting Design Intent

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 boundary. It is important that the selected luminaires for this project (during construction phase and operation phase) has 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 control obtrusive light well 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 6.

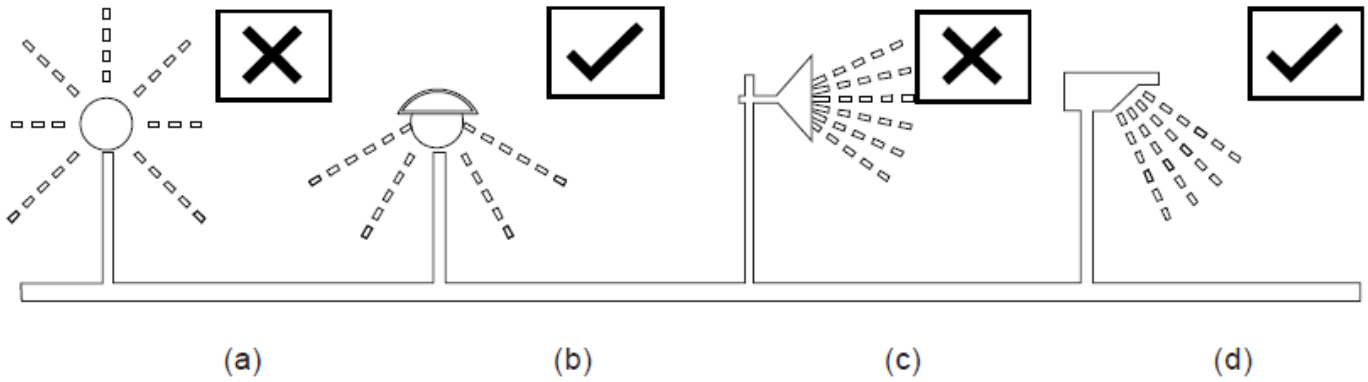


Figure 6: Simplified Lighting Types and Their Ability to Control Environmentally Obtrusive Light (AS4282:2019)

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 500m from the shore line. Typical designs for these locations comprise designs C and D in Figure 7.

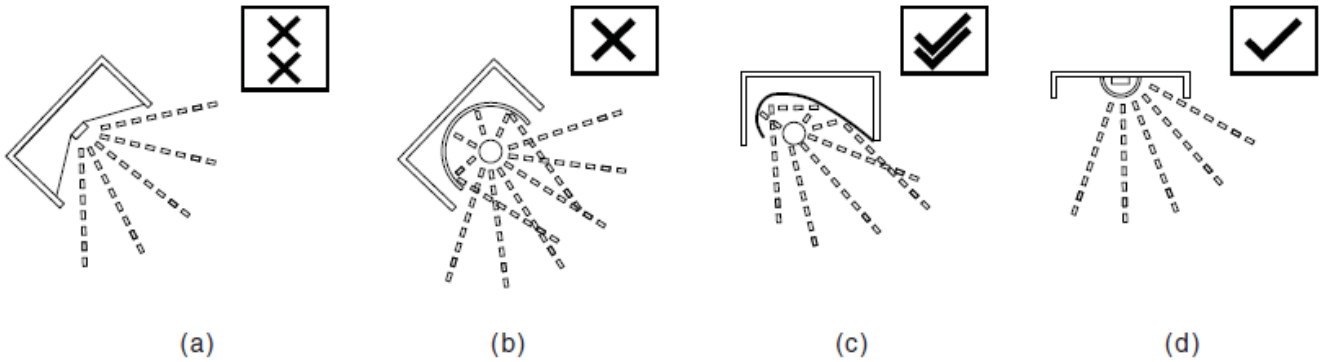


Figure 7: Luminaire Design and Their Ability to Control Environmentally Obtrusive Light (AS4282:2019)

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 (see Figure 8 A and C) will be largely avoided and comply with Council guidelines for public areas.

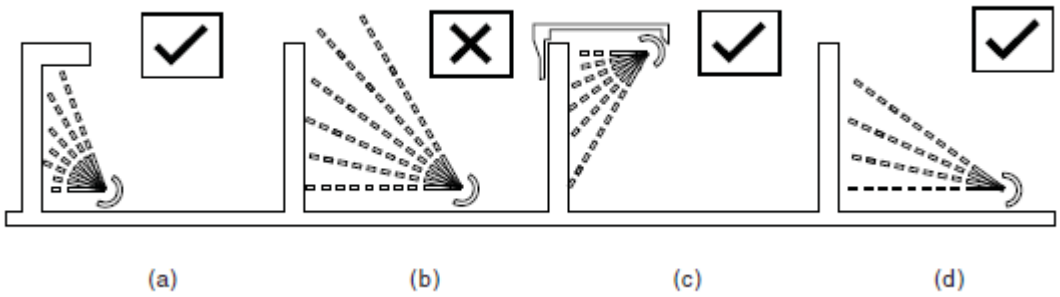


Figure 8: Luminaire Design to Avoid Skyward Illumination and Control Environmentally Obtrusive Light (AS4282:2019)

4.1 Conceptual Lighting Discussion and Design Intents

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 2700K. 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 mount fixtures 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 luminair 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.

4.2 Luminaires Selection

The lighting plan has adopted two types of luminaires RFL540-SEL LED for street lighting and PTY424 LED for park lighting. These are dark-srk 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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we-ef

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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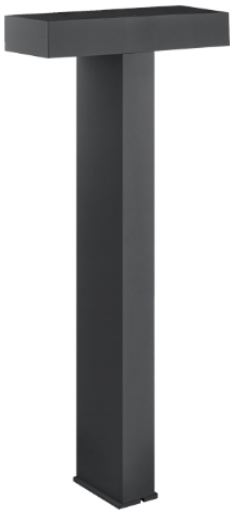

Description

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

5 Numerical 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 building is highly detailed with a polygon count well in excess of the file size limits limits of the Agi32 lighting model. The model included a large number surfaces inside buildings which do not have any relevance for a extrnal lighting assessment. Hence the original 3D CAD design was significantly simplified due to these considerations. Though the lighting model has reducted the complexity of the buildings and the landform it has sought to include all street and park lighting potentially visible from Moreton Bay Marine Park, refer to Figure 9 showing the luminair locations.

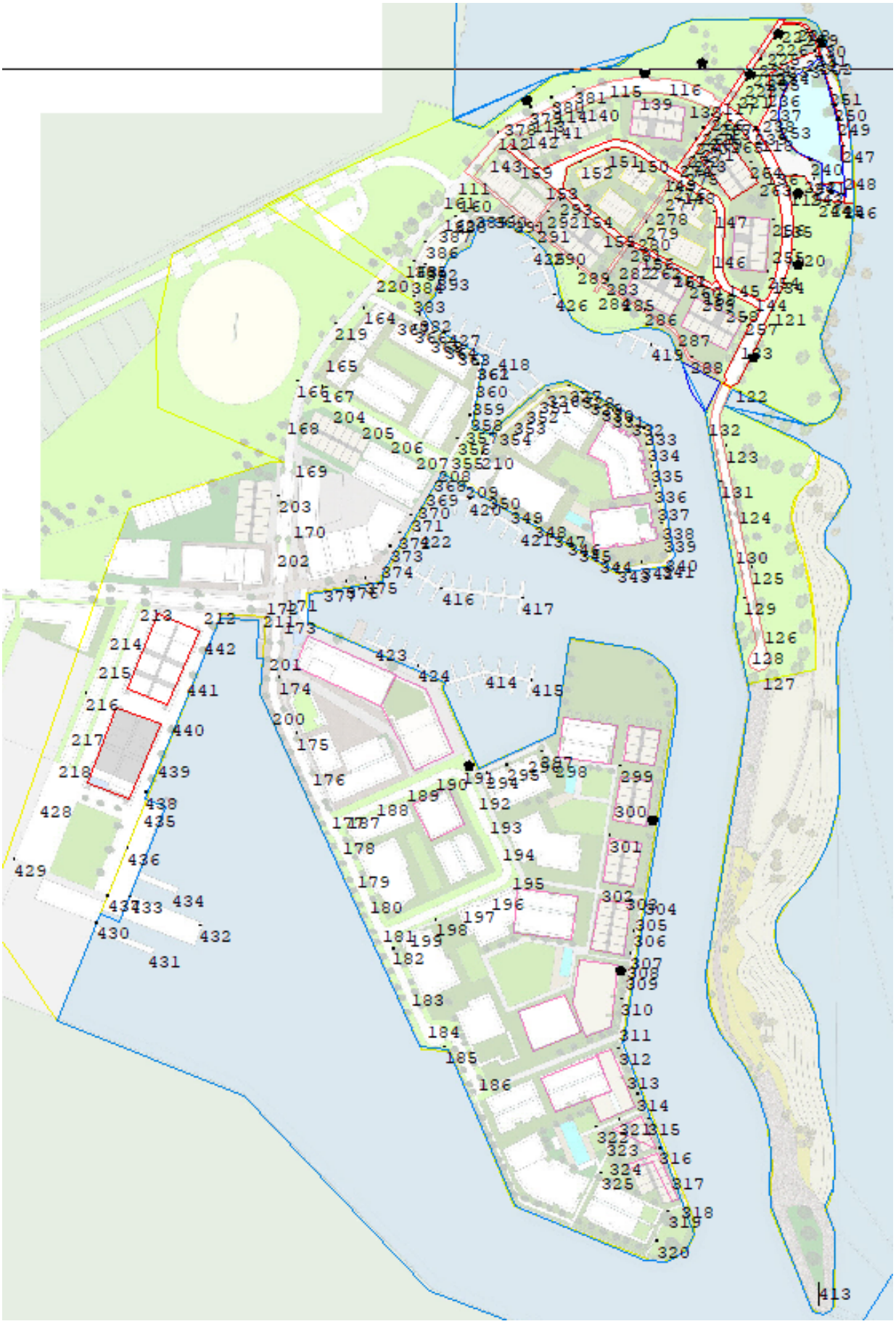

Figure 9: Luminaire Locations

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 also 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 this NE precinct. The lighting of the parkland has focussed on providing higher levels of illumination of the the hardstand areas and permited lower levels of illumination of the grassed areas. This would be equivalent to lighting required for a Type 2 community park as described in Redland Open Space Strategy 2026 (December 2012).

Buildings are included in 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 street lights and reflections from various surfaces. During the assessment process it was found that higher levels of reflected light occured 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.

5.1 Illumination Levels

The calculated illumination levels (Lx) at ground level are shown for the the entire site in Figure 10. Enlargements of this figure are presented in Figure 11 to Figure 14 . A 5m grid spacing has been adopted to calculate the lighting levels. The contours show that directly under the 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 quicky reduces to 1 Lux within the boundaries of the site. Apart from some minor illumination of the marina water, there is not any light spiill onto mudflats nor into the water.

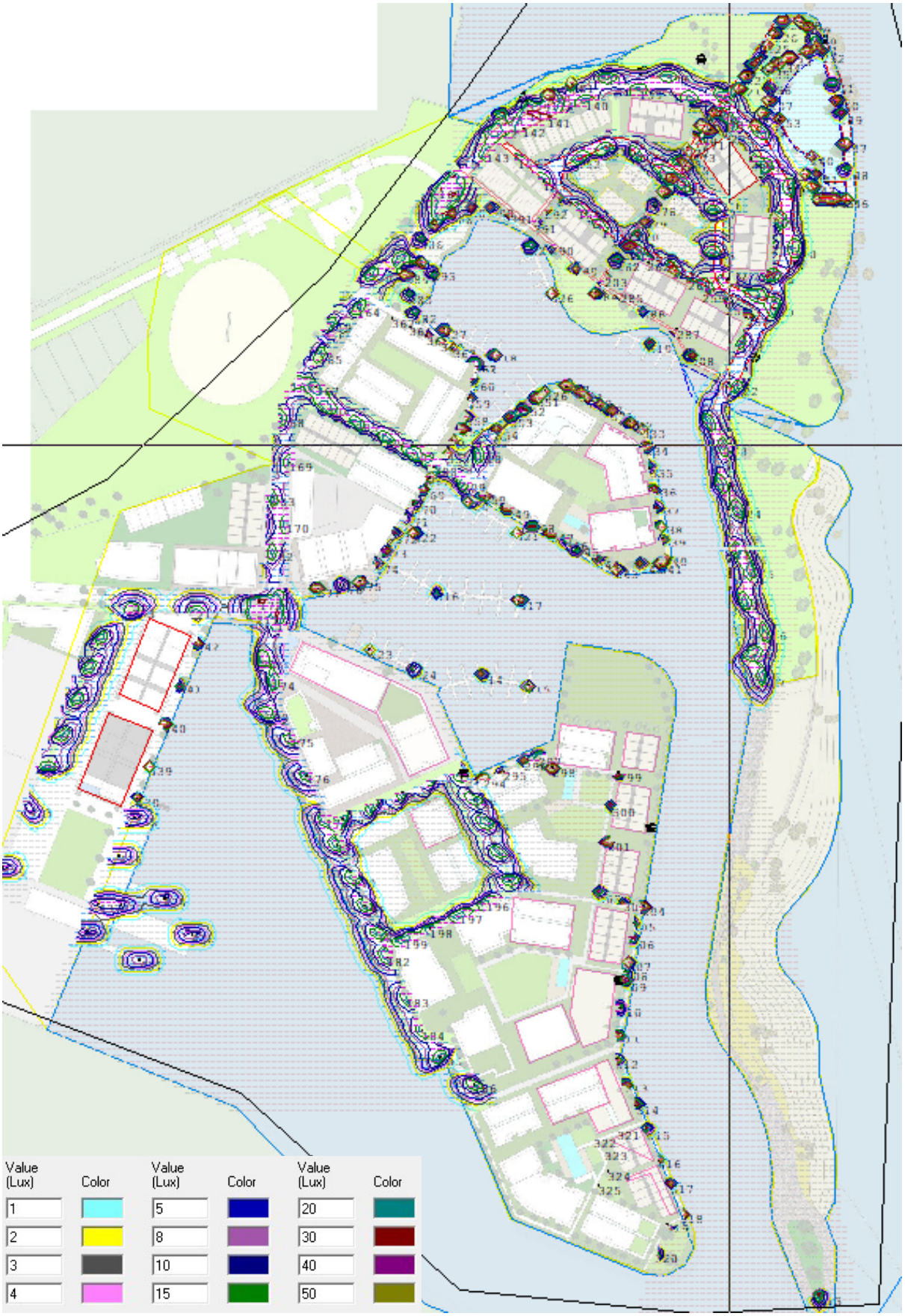

Figure 10: Predicted Lighting Levels for The Entire Site (Lx)

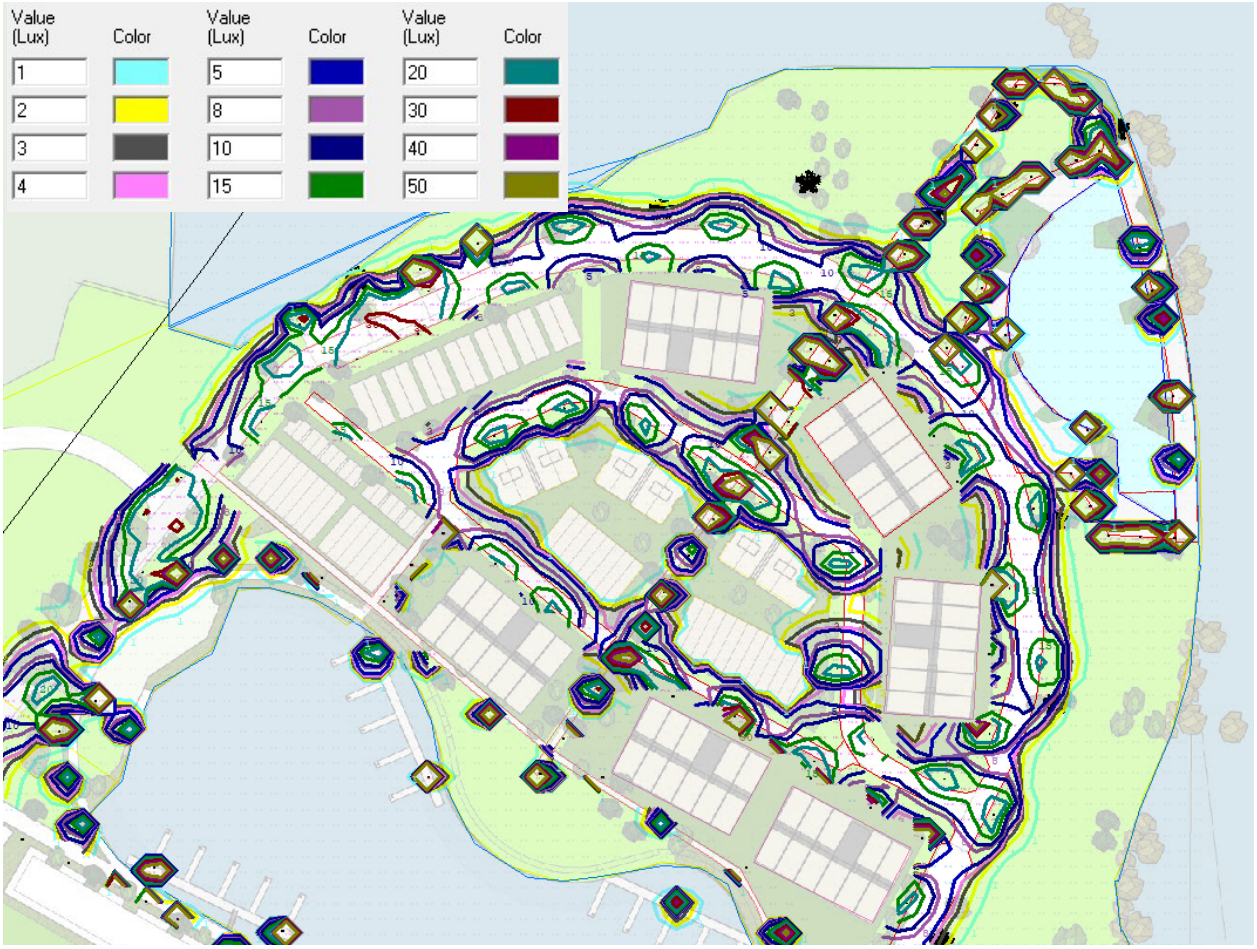

Figure 11: Predicted Lighting Levels for The Northern Section (Lx)

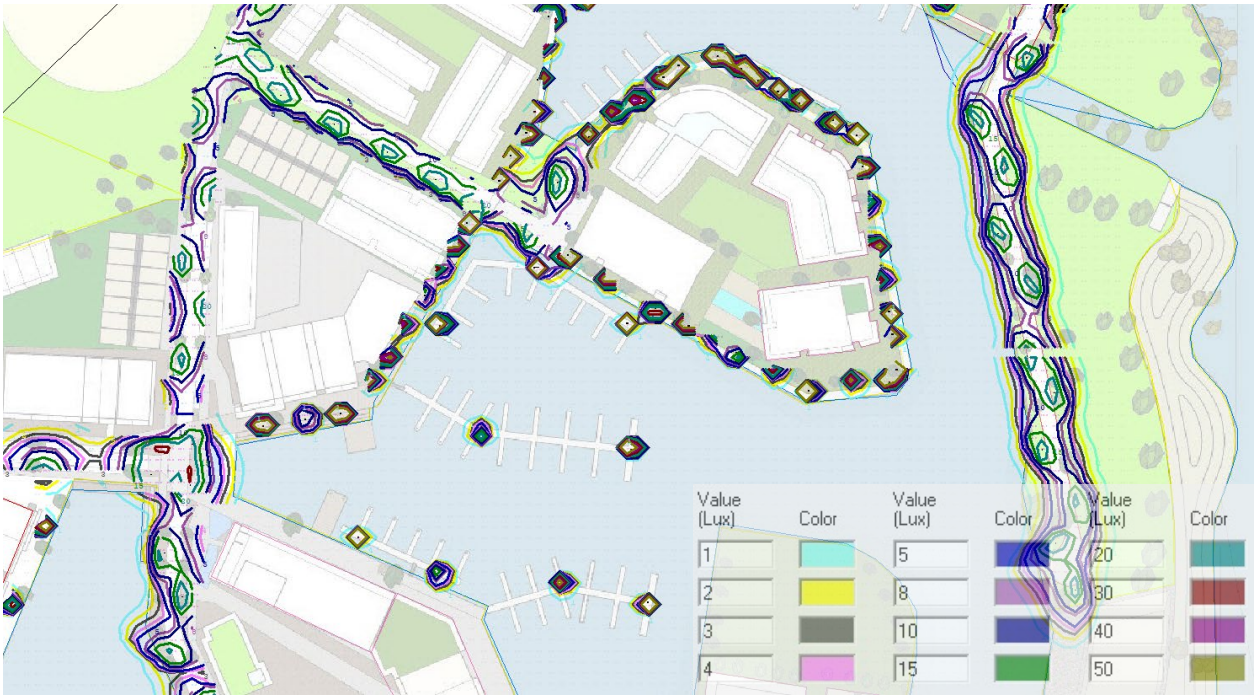

Figure 12: Predicted Lighting Levels for The Central Section (Lx)

Figure 13: Predicted Lighting Levels for The Commercial District (Lux)

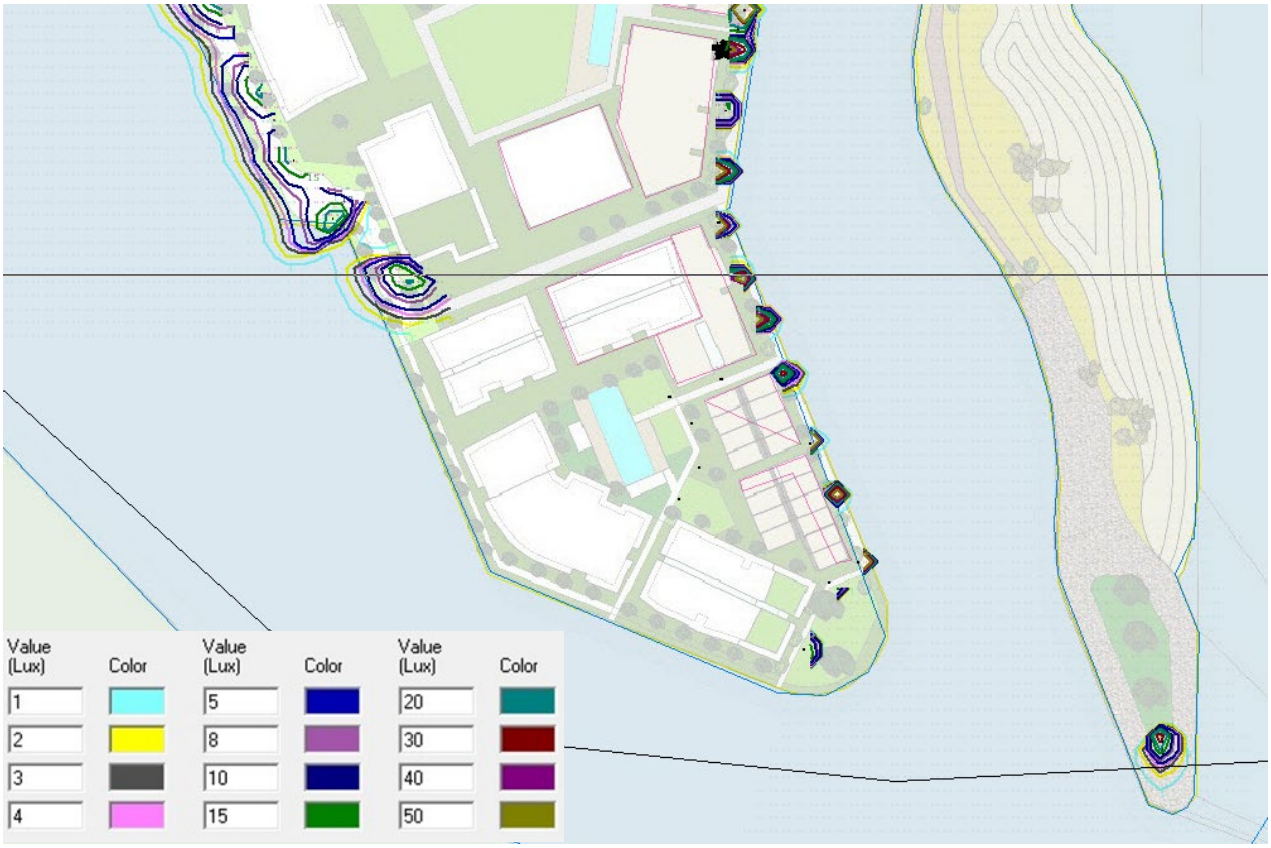

Figure 14: Predicted Lighting Levels for The Southern Section and Marina Entry Beacon (Lx)

5.2 Rendered Views

The rendered view from directly above the site (an aerial view) is contained in Figure 15.

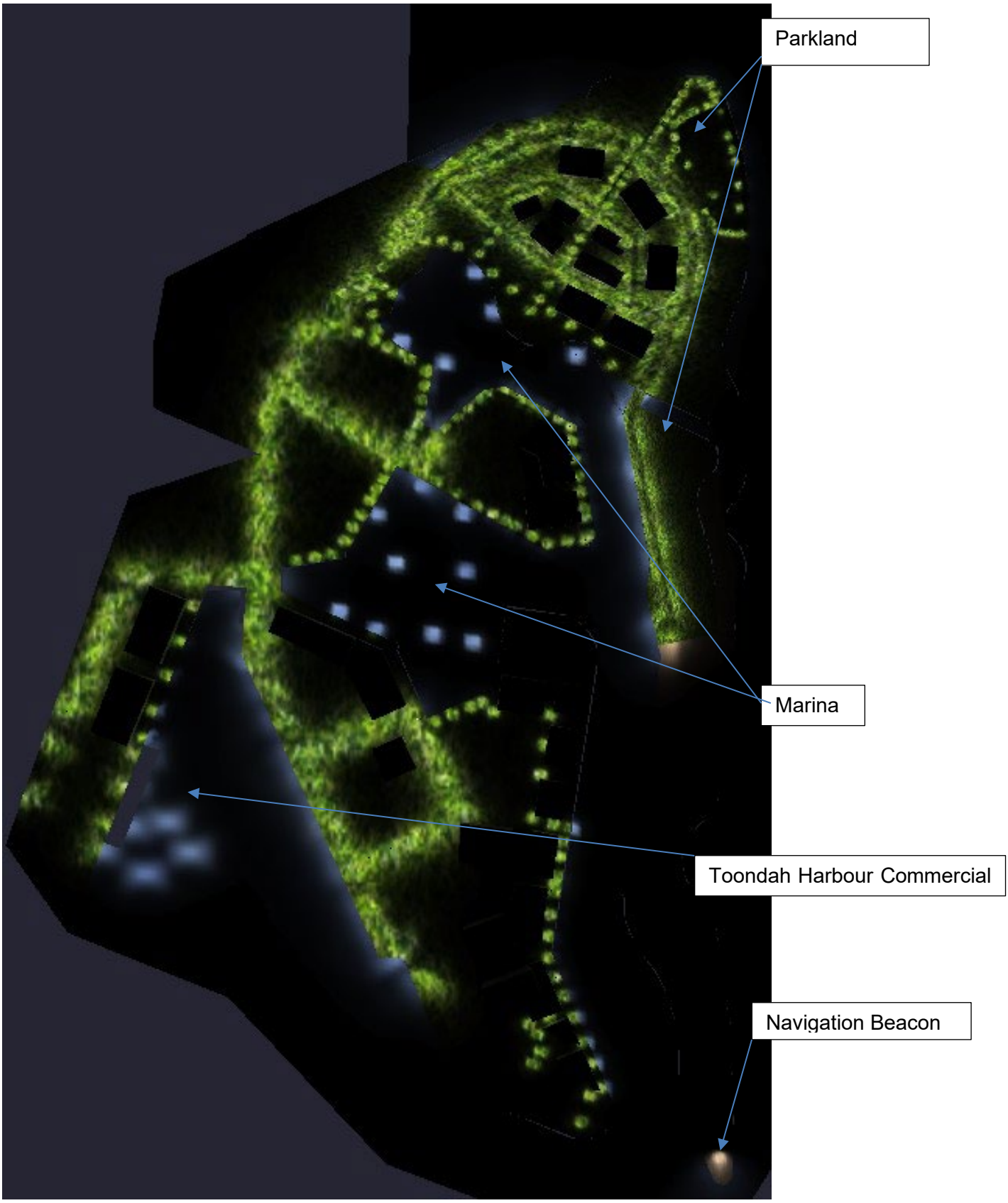

Figure 15: Aerial Render View of Site

Renders of the development are presented from several locations including:

1. location 400m NE of the site (Figures 15 to 17)
2. location 150m NE of the site (Figure 29)
3. 100m south of Cassim Island and 300m from the navigation beacon for the marina entrance (Figures 18 to 20)
4. Nandeebie Clay Pan excluding screening effect of mangroves (Figures 21 to 23)
5. Marine navigation channel entrance (Figure 24)
6. Cassim Island (Figures 25 and 26)
7. Offshore Sandbank (i.e. due east of Cassim Island, excludes screening effect of Cassim Island) (Figure 28)
8. Oyster Point (Figure 27)

The approximate view locations are contained in Figure 16

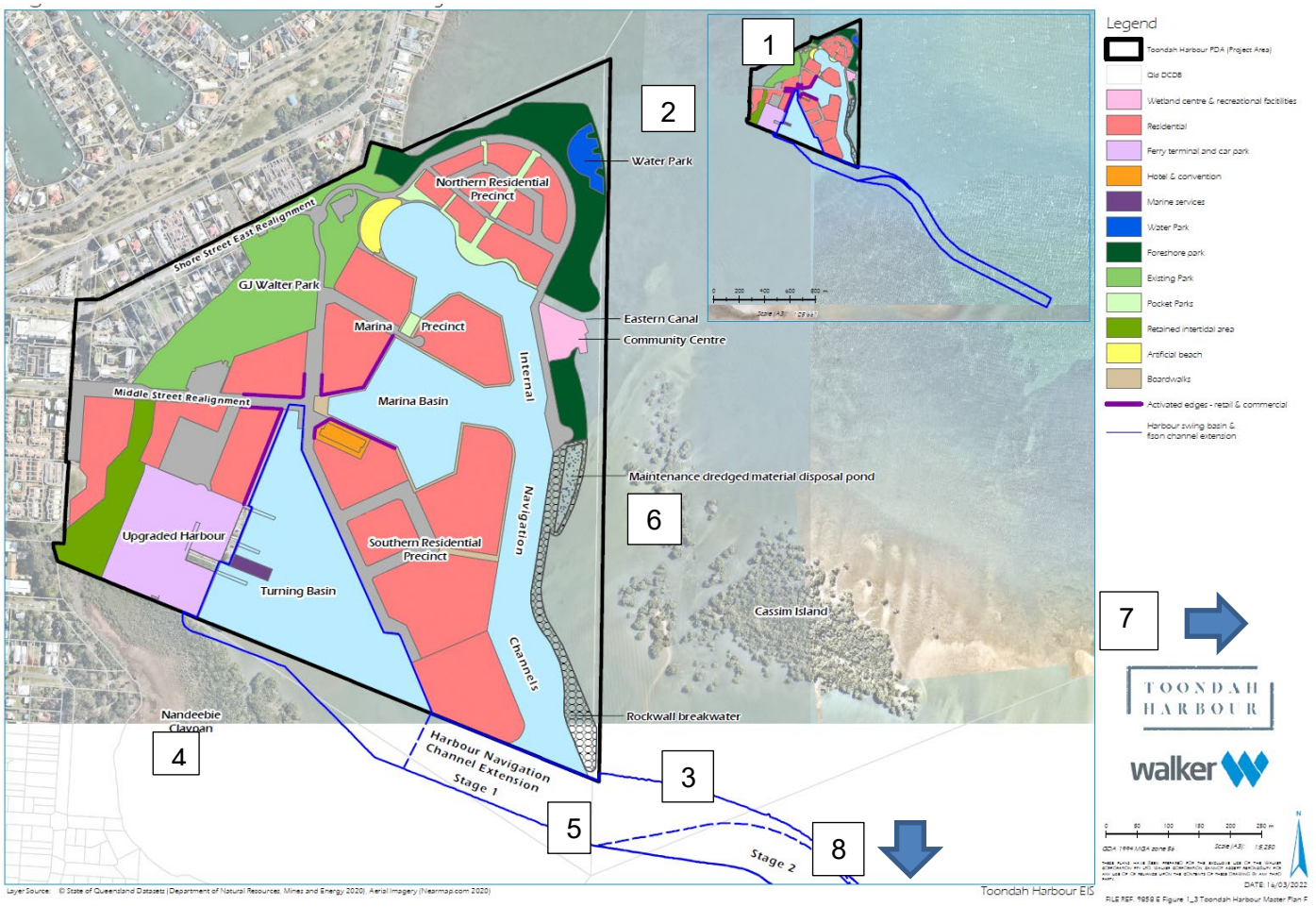

Figure 16: Approximate View Locations

Human eyesight field of view is approximately 135° and for bird 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 2m above the water, refer to Figure 17 to Figure 31. Figure 31 represents a location on mudflats close to the perimeter of the site. This figure 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 is 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.

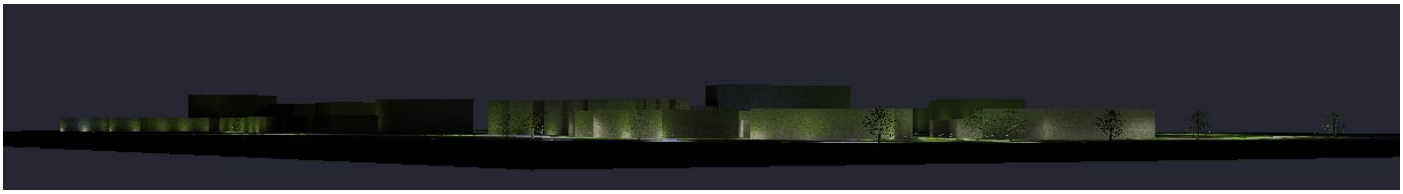

Figure 17: NE Location, 400m from Site 30° Field of View

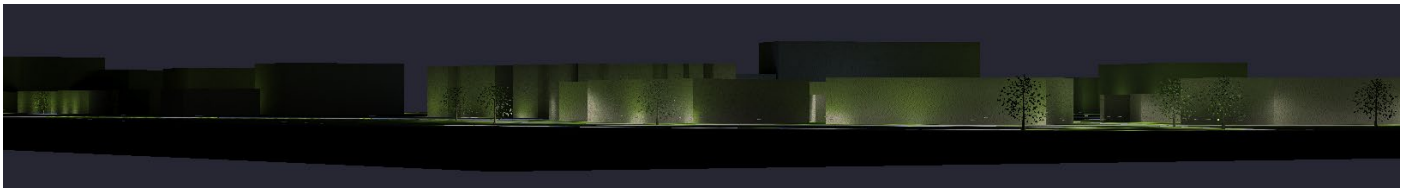

Figure 18: NE Location, 400m from Site 15° Field of View

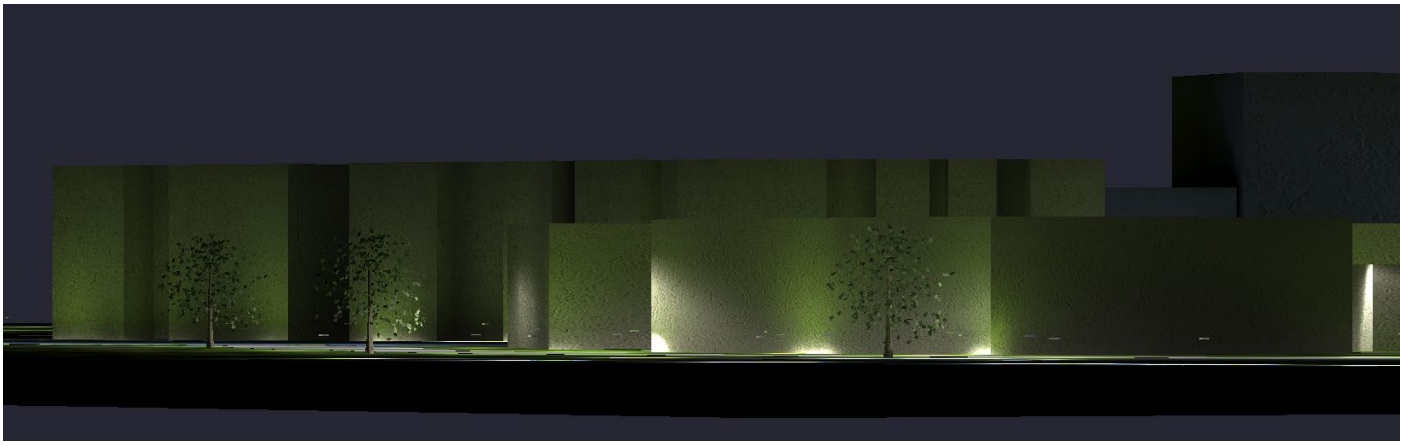

Figure 19: NE Location, 400m from Site 5° Field of View

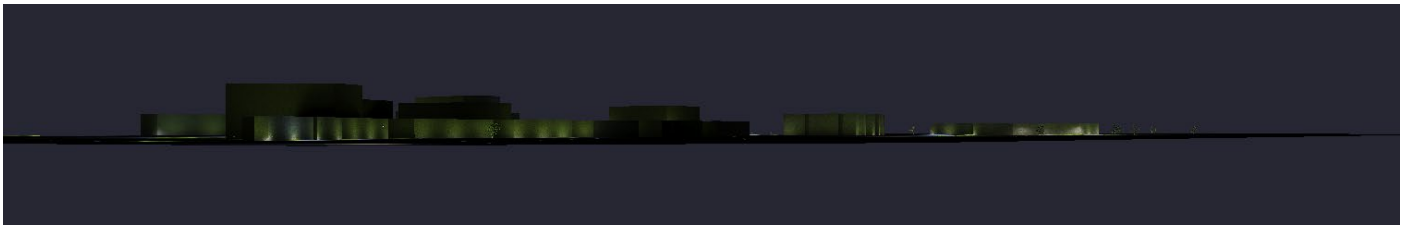

Figure 20: 100m South of Cassim Island Site 30° Field of View

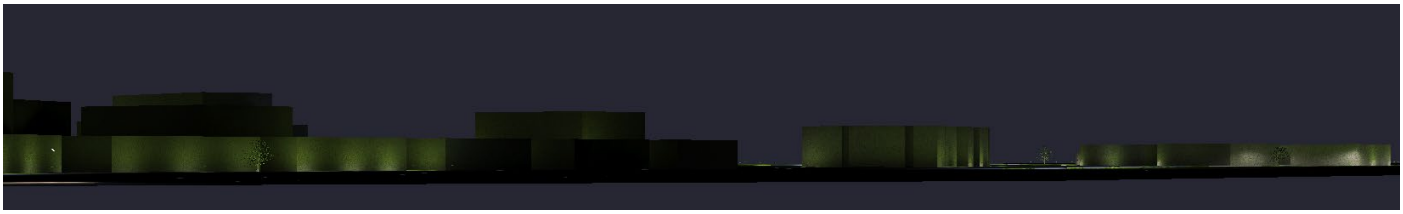

Figure 21: 100m South of Cassim Island Site 15° Field of View

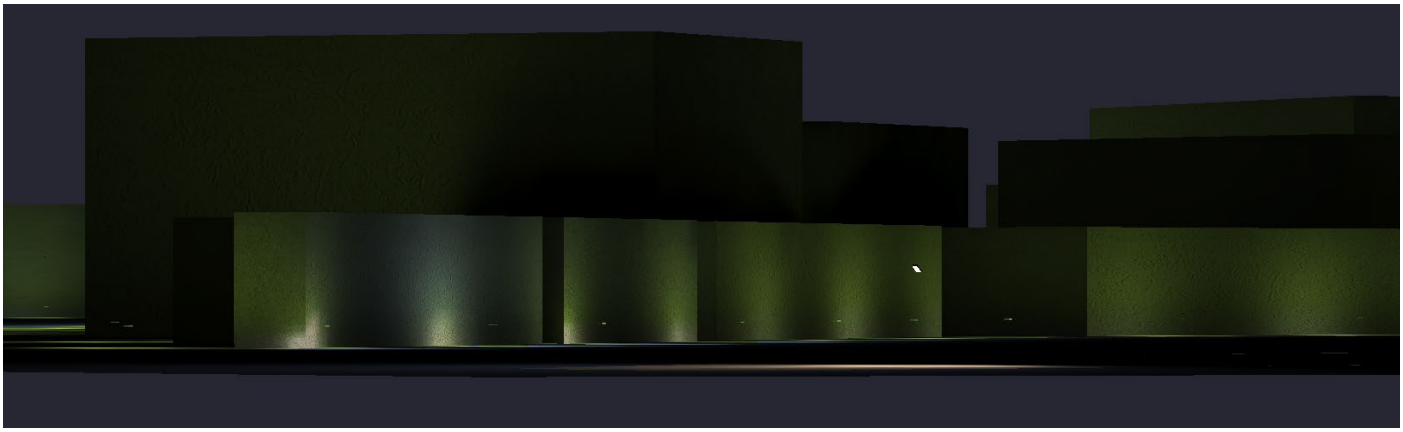

Figure 22: 100m South of Cassim Island Site 5° Field of View (Showing Marina Navigation Beacon)

Figure 23: Nandeebie Clay Pan (Excludes Screening Effect of Mangroves) Site 30° Field of View

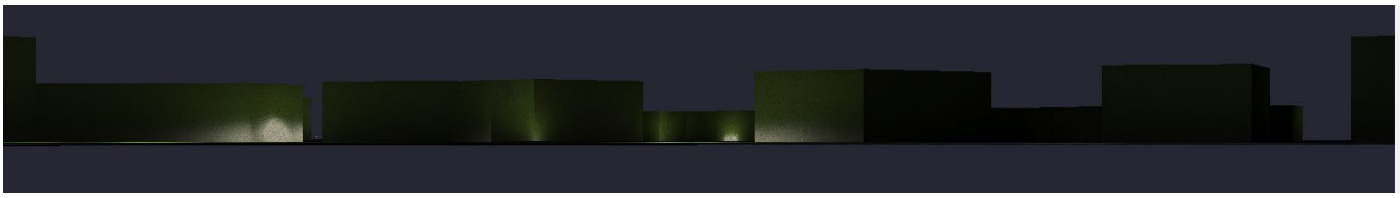

Figure 24: Nandeebie Clay Pan (Excludes Screening Effect of Mangroves) Site 15° Field of View

Figure 25: Nandeebie Clay Pan (Excludes Screening Effect of Mangroves) Site 5° Field of View

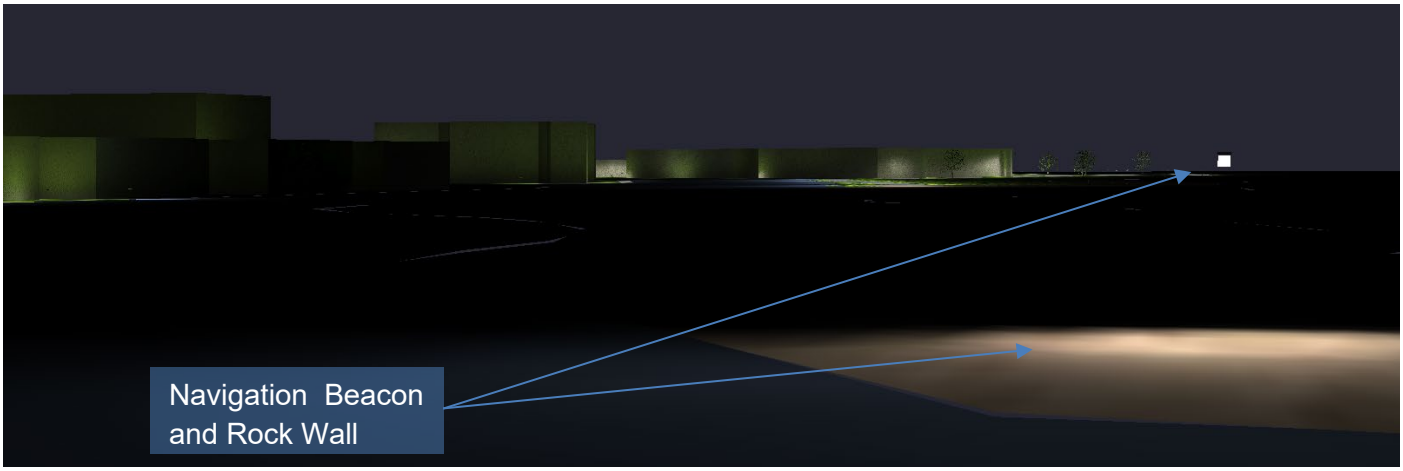

Figure 26: Marina Navigation Chanel Entrance Site 30° Field of View

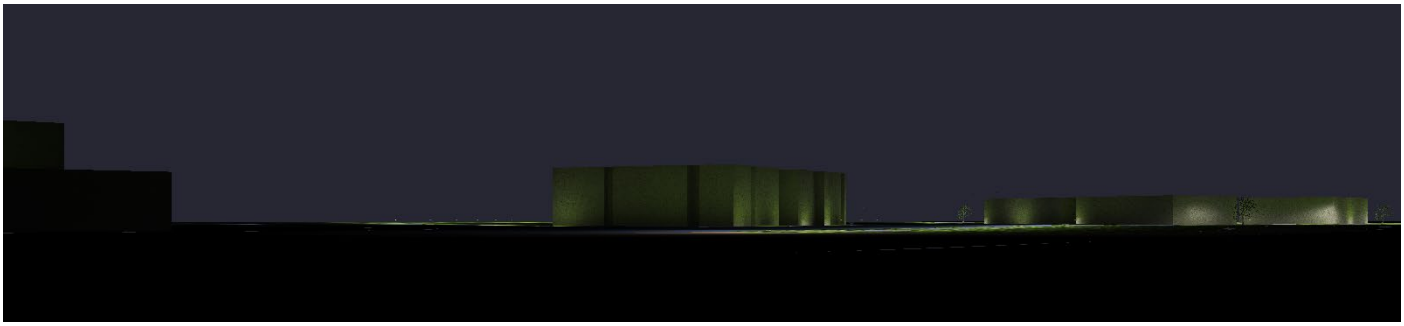

Figure 27: Cassim Island site Looking North 30° Field of View

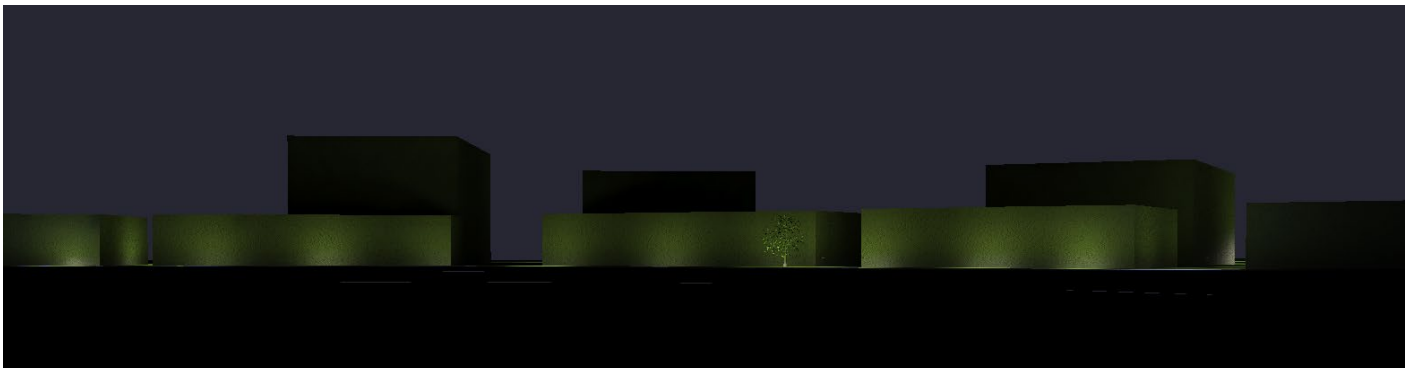

Figure 28: Cassim Island Looking South West 30° Field of View

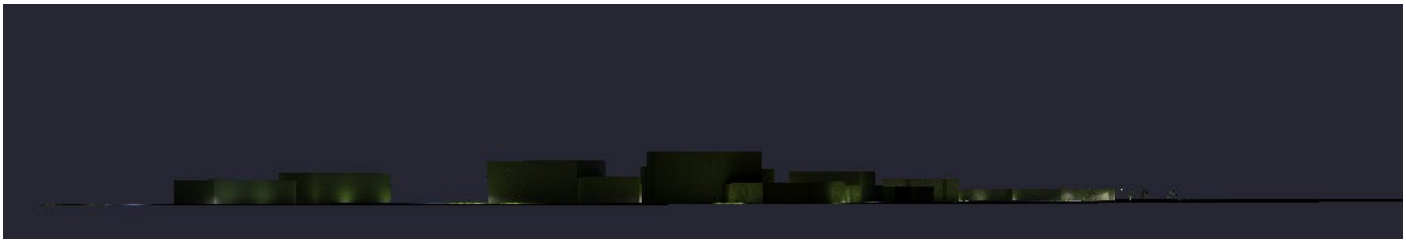

Figure 29: Oyster Point Looking North 30° Field of View

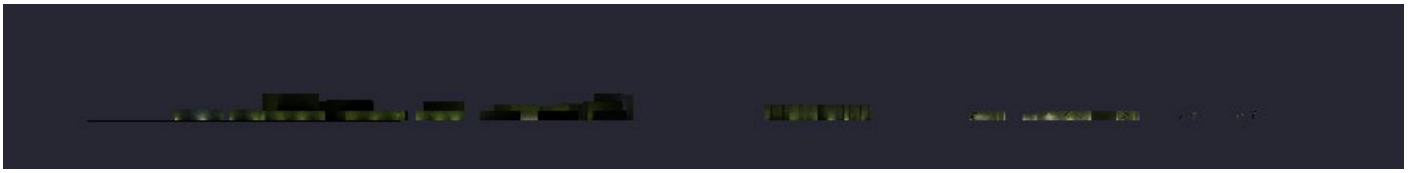

Figure 30: Sand Bank 1.5km From site Looking West 30° Field of View

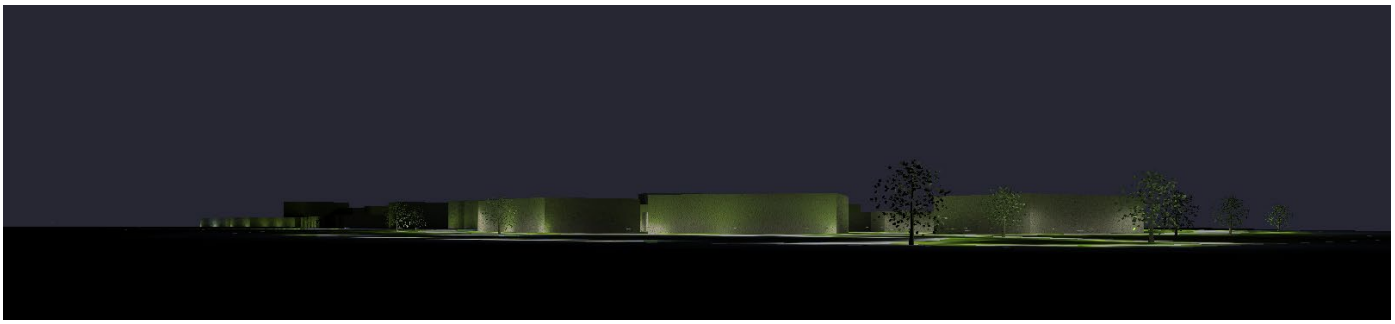

Figure 31: NE of site (150m) Looking SW 30° Field of View

6 Conclusions

The existing public lighting was measured, and this report contains contours of illumination levels in public areas. The highest measured illumination levels were at major intersections and at certain high-traffic locations within the harbour. Unlike the intersections, the measured high lighting level was due to low-level luminaires and consequently the affected area was comparatively small. Apart from areas immediately below street luminaires and the security lighting in the public carparks, the lighting levels for the Harbour and the surrounds is very low, well below 1 Lux. There is minimal light spill onto Morton 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.

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

1. Comply with Redlands City Council lighting code, 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
2. Maintain or reduce lighting exposure onto Moreton Bay
3. Avoid wasteful illumination into the sky
4. Avoid excessively bright points of light when viewed from Moreton Bay, all existing residential areas and from public areas
5. Avoid illumination of large vertical surfaces visible from Moreton Bay and from existing residential areas
6. Support for vegetation to assist with screening ground level visibility and avoid light spill onto surround areas.

The conceptual lighting model developed has addressed the lighting strategy described above, specifically it has been designed to be a low environmental 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 2700K. These are “amber” lights which are specifically designed to protect marine and avian life from the adverse aspects of urban lighting.

The assessment investigated the relative importance of the various lighting sources, and it was found that street lighting and park lighting are the dominant light sources for the development. While the residential units may be sources of light, these are typically minor diffuse sources. Curtains and blinds on windows significantly reduce the environmental light escaping residential units.

The modelling has demonstrated that the conceptual design will readily comply with a Dark Site with Curfew as described in AS4282.2019. This implies the level of illumination is almost zero free from glare.

The report has not specifically addressed construction phase however the same approach is to be adopted for construction area lighting. The impact from construction phase should be lower since the areas to be illuminated are much smaller. In the event mobile plant requires the use of lighting on machinery (driving lamps) the construction contractor will consider providing temporary fencing around the work compounds.

Appendix A: Lighting Definitions

Dwelling – a building in which people normally reside, e.g. house, motel, hospital

Floodlight – a specific form of luminaire which emits light within a limited range of directions

Luminaire—apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except for the lamps themselves, all the parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries with the means for connecting them to the electric supply.

Luminous Flux – The light emitted by a light source or luminaire or received by the surface irrespective of the directions in which it is distributed. The unit is the lumen (lm).

Illuminance E – The luminous flux incident on a surface per unit area. The unit is the lux (Lx). Ev is the illuminance in the vertical plane.

Obtrusive light—spill light which, because of quantitative, directional or spectral attributes in a given context, gives rise to annoyance, discomfort, distraction or a reduction in the ability to see essential information, e.g. signal lights.

Principal plane (of the luminaire light distribution)— the vertical plane through the luminaire which contains the reference direction.

Public lighting— lighting provided for the purposes of all-night safety and security on public roads, cycle paths, footpaths and pedestrian movement areas within public parks and gardens, but not including car parks.

Reference direction —the direction of the maximum luminous intensity from a floodlight or, where there is no unique maximum, the direction of the centre of the light beam.

Spill light (stray light)—light emitted by a lighting installation which falls outside the boundaries of the property on which the installation is sited.

Threshold increment (TI)—the measure of disability glare expressed as the percentage increase in contrast required between an object and its background for it to be seen equally well with a source of glare present.