REPORT

Pebbly Beach Planning Report

Planning and Approvals

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Date: 26 November 2024

Royal HaskoningDHV

Enhancing Society Together

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Appendix C – Pre-lodgement Meeting Minutes
Appendix D – Development Plans
Appendix E – Prescribed Tidal Works Code Responses
Appendix F – State Development Assessment Provisions – State Code Responses

Appendix G – Coastal Processes Report (Royal HaskoningDHV, 2024a)
Appendix H – Vegetation Survey and Clearing Plans
Appendix I – Options Assessment and Multi-Criteria Analysis
Appendix J – Basis of Design Report (Royal HaskoningDHV, 2024b)

1 Introduction

Haskoning Australia Pty Limited, a company of Royal HaskoningDHV (RHDHV), have been engaged by AECOM (on behalf of the Department of Transport and Main Roads – TMR) to prepare a Development Application for revetment wall works at Captain Hook Highway at Pebbly Beach, south of Port Douglas. The works being undertaken by TMR aim to address the erosion and subsequent damage to Captain Cook Highway as a result of Cyclone Jasper.

1.1 Background

Pebbly Beach is a pocket beach, situated between the headlands of Yule Point to the north and the 40-meter-high White Cliffs to the south. The beach has an east-northeast aspect and is mostly shielded from waves by the white cliffs to the south and the wider protection of the Great Barrier Reef located approximately 30 kilometres (km) east of the site. Pebbly Beach is located on the foreshore of the Captain Cook Highway, south of Port Douglas. Captain Cook Highway runs along the Coral Sea coastline, with private land and the Mowbray National Park to the west.

The Captain Cook Highway experienced extensive damage as a result of tropic cyclone Jasper that crossed the coast north of Port Douglas at a Category 2 system from the 13th to the 28th of December 2023. The system resulted in strong onshore winds in area (gusts up to 130 km/h) which led to elevated sea levels and high waves impacting the highway at Pebbly Beach. The conditions led to coastal erosion undermining the Captain Cook Highway and overtopping waves contributing to road surface damage between approximately CH51.860km to CH52.460km. This event was activated under the Disaster Recovery Funding Arrangements (DRFA) – Event 24E – Tropical Cyclone Jasper, Associated Rainfall and Flooding and triggered eligibility for reconstruction of the essential public asset. Therefore, TMR proposed remediation works along Captain Cook Highway in the form of government supported transport infrastructure under the DRFA.

In some sections along Captain Cook Highway, temporary remediation measures were implemented with rock fill placed to buttress the road embankment and keep the highway open for traffic immediately after the cyclone event in December 2023. AECOM have designed protection works covering approximately 600 metres (m) of the foreshore in response to TMR's proposal. To support the design process, RHDHV have assessed the implications of six rock revetment wall construction options on coastal processes at Pebbly Beach to support the final design proposed as part of this Development Application.

1.2 Objectives

The objectives and functional requirements of the project are to:

- ensure construction works minimise impacts on coastal processes;
- effectively and efficiently management of obtaining statutory approvals;
- design a safe environment for site users;
- maintain visual aesthetic of the site;
- maintain good access and serviceability; and,
- protect and reinstate the trees, access stairs, landscaping, and foreshore areas.

1.3 Scope

The objectives will be addressed by the following scope of works:

1. Coastal protection works along approximately 600m of Pebbly Beach, consisting of a rock revetment wall. The coastal protection is to better prepare for extreme storm events, prevent further damage to roads on Captain Cook Highway and reduce erosion; and,
2. Preservation amenity at the site, including minimising impacts to the beach, vegetation, visual amenity and access stairs.

1.4 Application Particulars

This report has been prepared to present and evaluate the project against the requirements of the *Planning Act 2016* and the *Coastal Protection and Management Regulation 2017* for the consideration of the Assessment Manager and relevant Referral Agencies. An overview of the subject site and Development Application is provided in **Table 1-1**.

Table 1-1: Summary of Application Details

Applicant:	**Department of Transport and Main Roads.**
Proposed Development:	Establishing a rock revetment wall to stabilise a section of Captain Cook Highway along Pebbly Beach.
Type of Approval Sought:	Development Permit for Operational Work for Prescribed Tidal Works, including the removal, damage and destruction of marine plants.
Real Property Description:	• State Controlled Road Reserve (being Captain Cook Highway). • Unallocated State Land (being the ocean).
Waterways:	• Amber Waterway (being unnamed waterway).
Assessment Manager:	Pursuant to the Planning Regulations 2017, Schedule 8, Table 2, Item 1 (d) the Assessment Manager is Douglas Shire Council.
Owner Details:	• Department of Transport and Main Roads – State-Controlled Road Reserve. • Department of Resources – Unallocated State Land.
Owners Consent:	Note, Owners consent is required for works on any land below the high-water mark as per section 51(2) of the *Planning Act 2016*. Consent is required by the State of Queensland. Owners consent is provided in **Appendix B**.

A summary of referral requirements and roles have been provided in **Table 1-2**.

Table 1-2: Summary of Referral Requirements and Roles

Referral requirement	**Referral agency and role**	**Assessment Benchmarks**
Schedule 10, Part 17, Division 3, Table 2 of the Planning Regulation 2017.	The Chief Executive, represented by the State Assessment and Referral Agency.	State Code - Maritime safety.
Schedule 10, Part 17, Division 3, Table 1 of the Planning Regulation 2017.	The Chief Executive, represented by the State Assessment and Referral Agency.	State Code 8 - Coastal development and tidal works.
Schedule 10, Part 6, Division 3, Subdivision 3, Table 1 of the Planning Regulation 2017.	The Chief Executive, represented by the State Assessment and Referral Agency.	State Code 11 - Removal, destruction or damage of marine plants.

1.5 Pre-lodgement

Pre-lodgement consultation was undertaken with the State Assessment and Referral Agency. Pre-lodgement advice and documentation is provided in **Appendix C**.

1.6 Supporting Information

The following technical reports and documentation has been included in support of this Development Application:

- Appendix A: Development Application Forms
- Appendix B: Owners Consent
- Appendix C: Pre-lodgement Meeting Minutes
- Appendix D: Development Plans
- Appendix E: Assessment against the Coastal Regulation
- Appendix F: Assessment against the State Development Assessment Provisions
- Appendix G: Coastal Processes Report (Royal HaskoningDHV, 2024a)
- Appendix H: Vegetation Replanting and Landscape Plans
- Appendix I: Vegetation Survey and Clearing Plans
- Appendix J: Options Assessment and Multi-Criteria Analysis
- Appendix K: Basis of Design Report (Royal HaskoningDHV, 2024b)

1.7 Application Contact

The Applicant contact for this Development Application is:

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2 Project Site

The project site is located at Pebbly Beach with the works beginning just south of Chainage 52km on Captain Cook Highway and extending north past Pebbly Beach Drive (shown in the figure as a yellow dashed line - **Figure 2-1**). The project site sits within the coastal management district and erosion prone area. Mapping shows there are areas of marine plants across the project site and the area of proposed development sits within the GBR Coastal marine park. These constraints have been considered and incorporated into the design solution adopted for this site.

Figure 2-1: Overview of project site

2.1 Land Tenure

Figure 2-2 shows the current land parcel tenure status for the areas surrounding the site. Works will occur within road parcels identified as Captain Cook Highway, which is a state-controlled road under the control

of the Department of Transport and Main Roads (TMR). Areas that are not within the identified parcels are unallocated state land, namely sections of the foreshore.

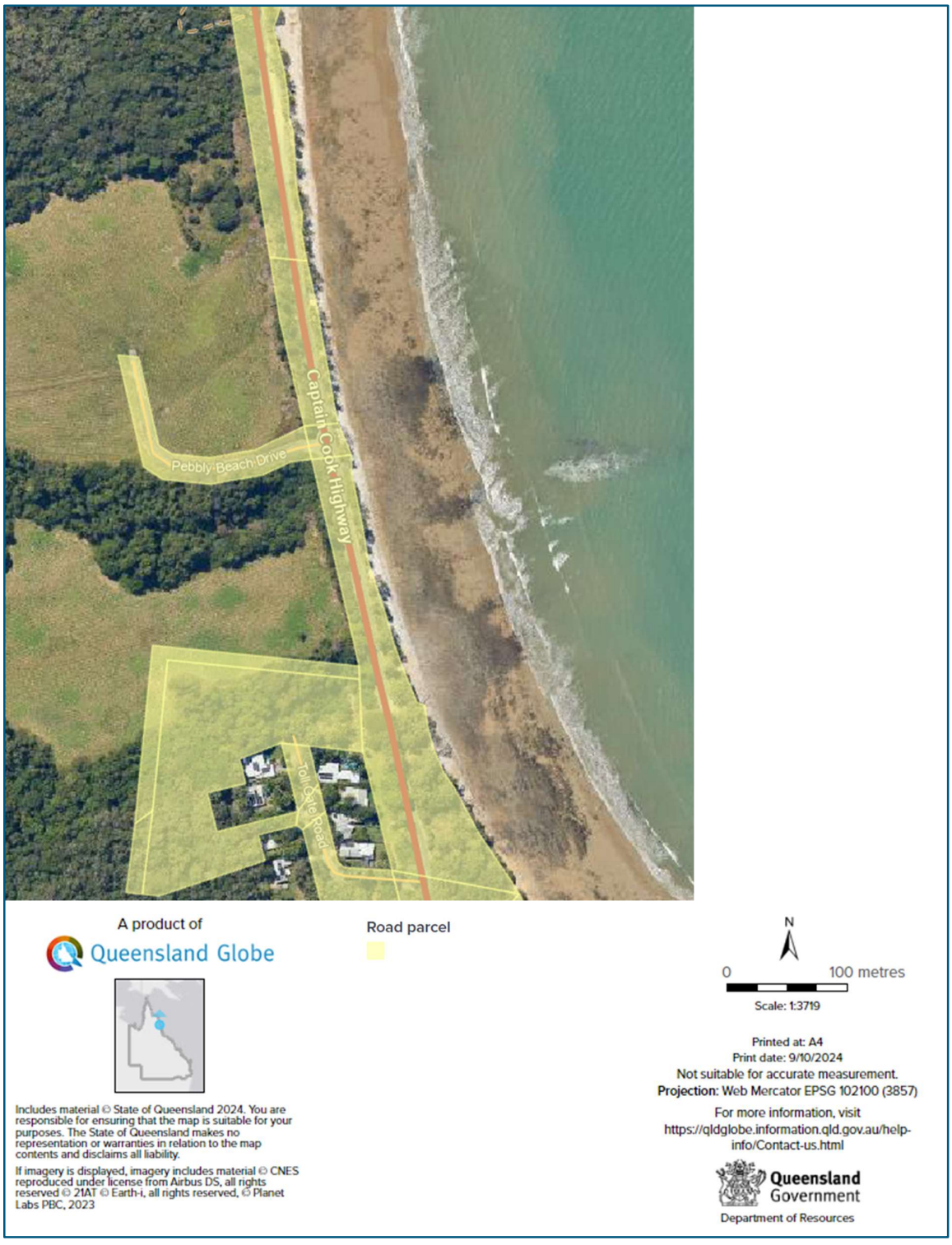

Figure 2-2: Land Tenure (source: Queensland Globe, 2024)

2.2 Site Conditions

The geomorphology of the area controls the sediment transport to the site. Prominent rocky headlands with exposed rock reefs extending offshore reveal that the sediment transport to the beaches in the area is controlled by the headlands. Yule Point is the control for this section of coast and effectively anchors the coast (**Figure 2-3**). These features are important as it reveals the coastline, and beaches will remain stable when considering the risks from long term erosion.

Figure 2-3: Existing site conditions

2.2.1 Long Term Erosion Analysis

The results of the *CoastSat* and *Digital Earth Australia (DEA)* analysis can be found in the Coastal Processes Report in **Appendix G**. To summarise, both indicated that Pebbly beach is relatively stable, with potentially minor rates of recession through the central and southern parts of the beach. The northern end of the embayment has very little available sediment and will not experience recession. If we accept this analysis on face value, the mobile beach is experiencing slow rates of recession.

It is noted that the visual analysis of the data from both methods contains a significant variability (10's of meters) and that the beach location today is roughly found in the middle of the observed data. It is likely that the beach is actually stable (not experiencing recession).

2.2.2 Coastal Geomorphology

As seen in **Figure 2-4** below, unlike most beaches in this region, the platform on this this beach is rocky, rather than fine sand.

Figure 2-4: Rocky platform at the site

The pebbles that make up much of the beach material are rounded and often pale in colour. Similar pebbles are not found on adjacent beaches and do not even extend to the northern or southern extremities of Pebbly Beach (**Figure 2-5**). The pebbles on the beach have been sorted under wave action with pebbles at the northern end of the beach typically smaller than those at the southern end (**Figure 2-6**).

Figure 2-5: Cobble and pebble sized material

Figure 2-6: Pebbles graded along the beach from coarse (left) to finer at the northern end (right)

The beaches north and south of Pebbly Beach are comprised entirely of sand, as seen in **Figure 2-7**.

Figure 2-7: Sand at the Southern end of Pebbly Beach

2.2.3 Existing Structures

Three culverts are located across the extent of the proposed works, and all were considered as part of the existing storm water (creeks) outlets during the design phase. **Figure 2-8** shows a culvert located under Captain Cook Highway on the Southern end of the site.

Figure 2-8: Existing culvert at site

Following Cyclone Jasper, emergency works were deployed in front of the embankment. The emergency works have since been buried and a pebble berm now exists at the rear of the beach profile (see **Figure 2-9**).

Figure 2-9: Pebble beach berm in front of eroded embankment and emergency rock wall

2.2.4 Vegetation

2.2.4.1 Regional Ecosystems

A *Vegetation Management Act 1999* Vegetation Management Report was used to identify remnant Regional Ecosystems (RE) under Category B, R and X across the site (**Figure 2-10** and **Table 2-1**). A response to potential impacts on REs is provided in **Section 5.2**.

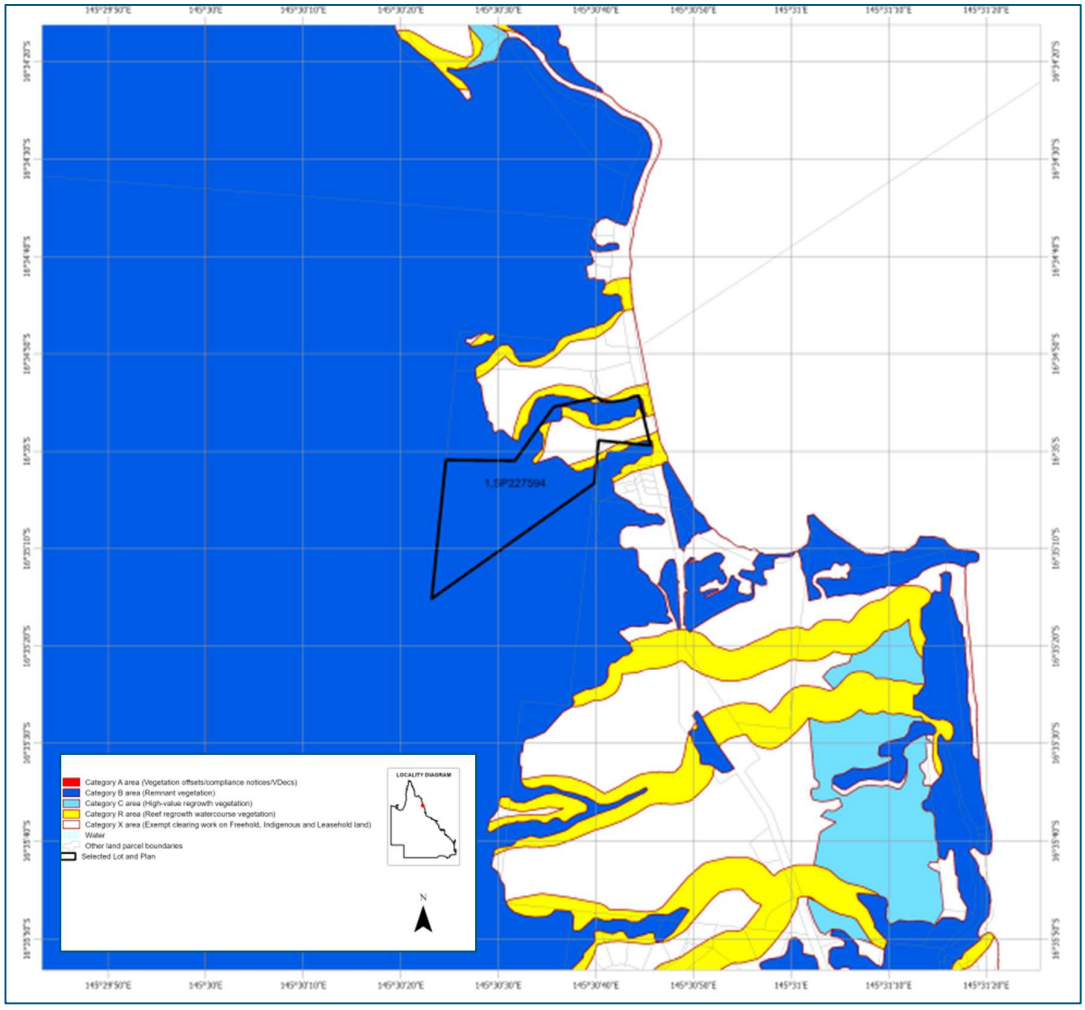

Figure 2-10: Regional Ecosystems Mapping

Table 2-1: Regional Ecosystems at the site

RE	VMA Status	Category	Description
7.11.49	Of concern	B	*Eucalyptus leptophleba, Corymbia clarksoniana* and *E. platyphylla* open forest to woodland on metamorphic foothills
7.3.10	Of concern	B	Simple-complex mesophyll to notophyll vine forest on moderate to poorly drained alluvial plains of moderate fertility
7.3.10	Of concern	R	Simple-complex mesophyll to notophyll vine forest on moderate to poorly drained alluvial plains of moderate fertility
Non-rem	None	X	None

2.2.4.2 Protected Plants

The protected plants flora survey trigger map identifies 'high risk areas' where threatened and near threatened plants are known to exist or are likely to exist. High-risk areas mapping is located at the base of the proposed works (**Figure 2-11**). However, no protected plants were identified as per the vegetation survey in **Appendix I**. Clearing for maintenance of road structures is also exempt from the requirements of the *Nature Conservation Act 1992*.

Figure 2-11: High risk area and clearing plans overlayed

2.2.4.3 MSES - Marine Plants

The vegetation survey (**Appendix I**) identified a combination of terrestrial and marine associated species most of which are located above Highest Astronomical Tide (HAT). Marine species including mangroves were identified in a small area near culverts at or below HAT, however most vegetation is located above HAT and comprise a combination of coconut palms, coastal she-oaks *(Casuarina sp.*), coastal cottonwood and beach almonds at road level and down the eroding slope (**Figure 2-12**).

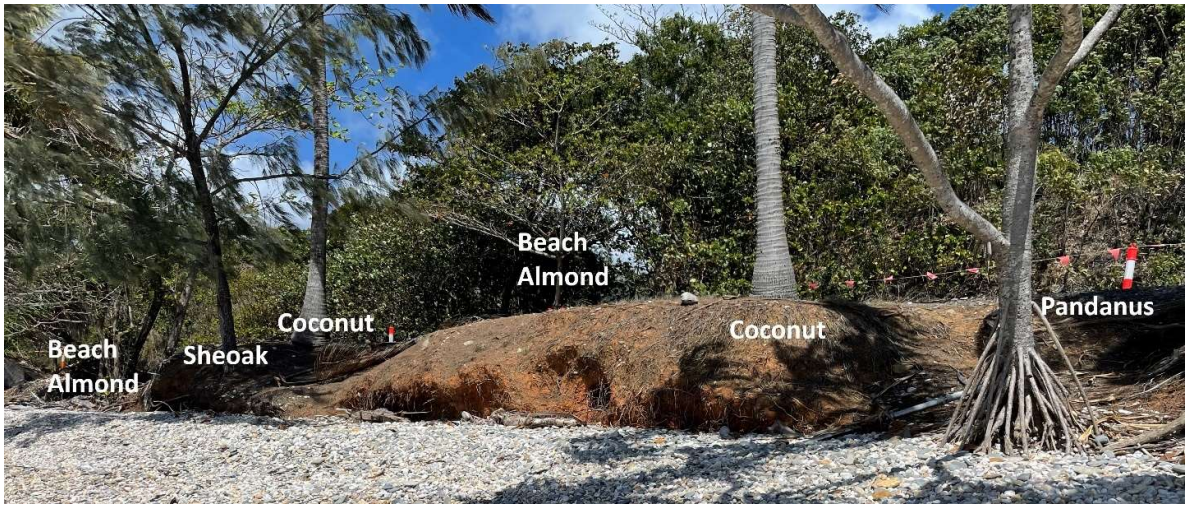

Figure 2-12: Mature tree species above HAT

Some species are considered marine plants regardless of their placement below or above HAT, such as casuarinas or mangroves (pictured below **Figure 2-13**).

Figure 2-13: Mangrove nearby culvert

2.2.4.4 MSES – High Ecological Significance Wetlands

Along with MSES Marine plants, High Ecological Significance wetlands and waters are associated with the marine environment below HAT, which coincides with the proposed works footprint (see **Figure 2-14**). As a result of the works, no impacts to the Great Barrier Reef wetland values will occur. A significant impact assessment and determination of offsets required was undertaken in **Section 5.2**.

Figure 2-14: High ecological significant wetlands overlay

2.2.5 Public Amenity and Access

Currently, there are no public facilities such as restrooms or a formalised access structure on to Pebbly Beach. Access to the beach is primarily achieved by entering via the Captain Cook Highway, and the small parking area (pictured below in **Figure 2-15**). Current access and community use was reviewed as part of the design process, with the addition of a formalised staircase leading from the car park to the foreshore.

Figure 2-15: Carpark at the site

3 Coastal Processes

Considering the location of the proposed works, it is crucial to consider the coastal processes informing the design and the significance this may have on the planning and approvals pathway. A coastal processes report was formally prepared by Royal HaskoningDHV (2024) and is attached in **Appendix G**. The following provides a summary of coastal processes at Pebbly Beach that informed the final preferred design.

3.1 Wind Climate

The wind climate at Pebbly Beach has been characterised using data from the Low Island climate station, operated by Bureau of Meteorology (BOM). The wind station (Low Island) is situated 16 km north of the study site with data collected from 1967 to 2024. The data is considered representative of the local wind climate relevant to coastal conditions due to its location off the coast. An analysis of wind data from Low Island shows that southeast winds are dominant, with winds from South through East occurring approximately 70% of the time. During the morning there was a more southerly bias, while during the afternoon there was a more easterly bias (**Figure 3-1**). Average sustained wind speeds of 20–30 km/h (5.7 to 8.3 m/s) are typical.

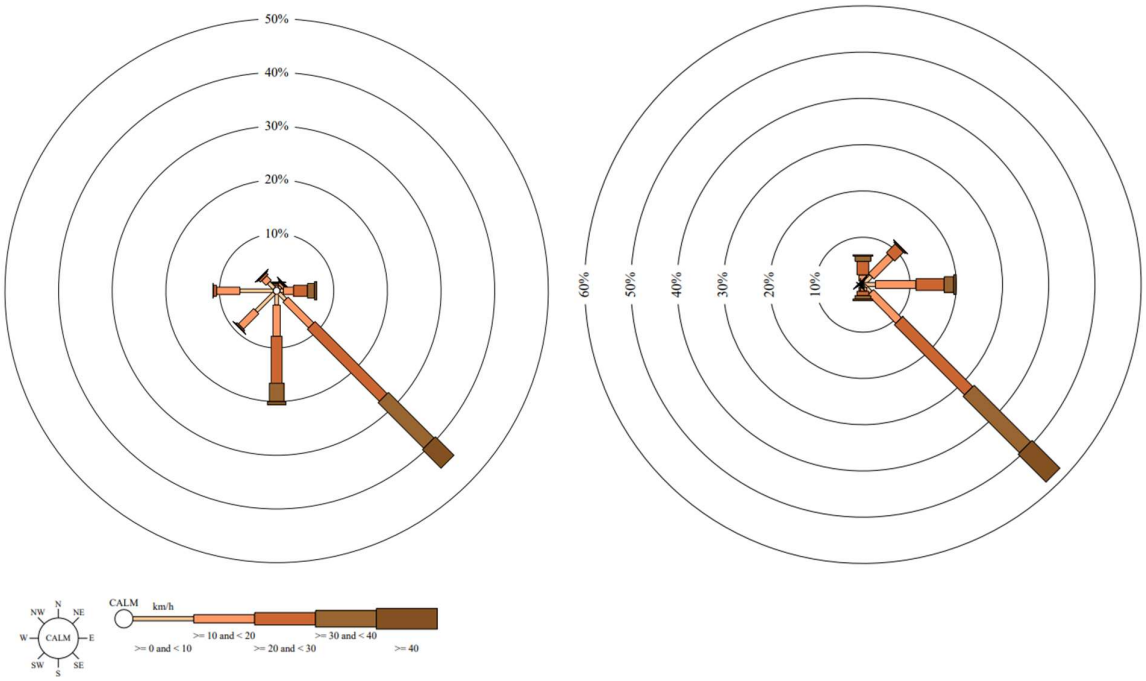

Figure 3-1: Low Island Wind Roses – 9am (left) and 3pm (right) from 1967 to 2024 (BOM, 2024)

3.2 Wave Climate

Pebbly beach is somewhat shielded from ocean swell waves by the Great Barrier Reef, located approximately 30km east of the site, however, attenuated swell passing through a passage south of Batt Reef does reach the site. As a result, the wave climate is a combination of the shorter period sea waves generated by the winds from the southeast and highly attenuated longer period swell waves approaching from east-northeast. The impact of regional setting is presented graphically in **Figure 3-2**.

Figure 3-2 Impact of Regional Setting on Wave Climate

Nearer to shore Pebbly Beach is located in a shallow embayment featuring rocky outcrops extending up to 300m offshore. These outcrops dissipate a significant amount of energy, reducing wave height and energy at the shoreline. Due to the shallow bathymetry, wave heights are largely depth limited, even under the extreme wave conditions. In addition, refraction and diffraction combined with bed friction further reduces the height of waves propagating towards Pebbly Beach.

3.2.1 Ambient Waves

The ambient wave climate at Pebbly Beach has been characterised using data from the Cairns wave rider buoy (WRB), operated by the Department of Environment, Science and Innovation (DESI). The WRB is situated 25 km south of Pebbly Beach in 12 meters of water, with data collected from 1997 to 2023. Despite its distance from Pebbly Beach, the data is still useful in defining the local wave climate. Wave heights have been analysed in terms of the recorded significant (total) wave height. The associated wave roses are presented in **Figure 3-3**. This shows two distinct wave conditions, with short period local sea waves approaching form the E through ESE, and longer period swell waves approaching from the NE.

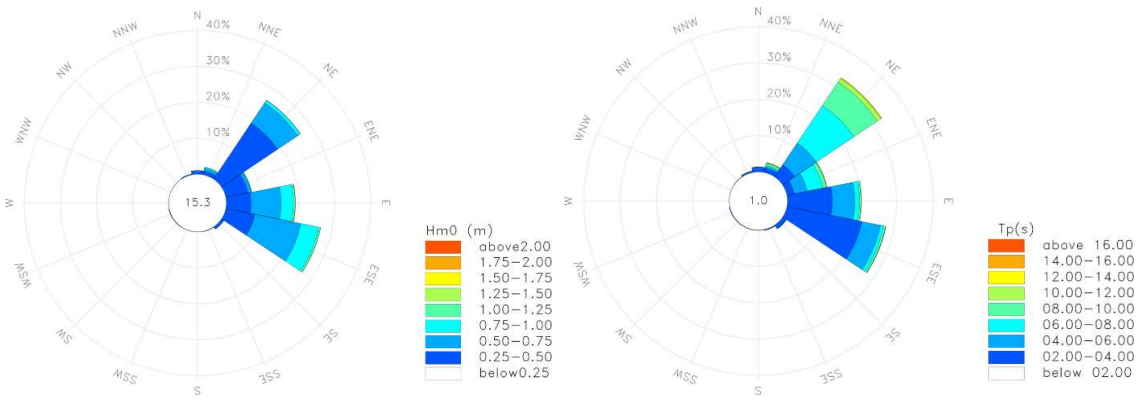

Figure 3-3: Cairns Wave Rider Buoy, wave height (upper) and wave period (lower) roses from 1997 to 2023

Frequency tables were also calculated for the probability of occurrence (**Table 3-1**) of wave height for a given wave direction. The wave analysis shows that:

- The most common wave direction is swell waves reaching the Cairns wave rider from NE (33%)
- However, seas waves ESE (28%) and east (20%) are dominant;
- The most common wave height is in the low range from 0.50 to 0.75 metres (43% of the time)
- The wave heights in the study area are relatively low for the majority of time; and,
- During extreme events, significant wave heights up to 3 metres have been measured.

Table 3-1 Probability of occurrence (%) of wave heights for given wave directions at the Cairns WRB

Directional sector

Wave Height Classes, Hs [m]	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0.00-0.50	0.38	0.70	6.60	4.03	1.25	0.95	0.58	0.24	0.07	0.10	0.06	0.04	-	-	0.05	0.26	15.33
0.50-0.75	0.74	1.07	18.74	6.26	6.84	8.22	0.67	0.10	0.03	0.04	0.07	0.10	-	-	0.01	0.21	43.10
0.75-1.00	0.24	0.71	6.77	0.91	8.36	13.02	0.12	0.01	-	-	0.03	0.04	0.01	-	-	0.02	30.26
1.00-1.25	0.08	0.30	0.85	0.12	3.46	5.06	0.01	-	-	-	-	-	-	-	-	-	9.94
1.25-1.50	0.02	0.07	0.06	0.03	0.45	0.51	-	-	-	-	-	-	-	-	0.01	-	1.19
1.50-2.00	0.01	0.01	-	-	0.05	0.03	-	-	-	-	-	-	-	-	-	-	0.13
2.00-2.50	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	0.02
2.50-3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
Above 3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
Total	1.47	2.86	33.02	11.35	20.41	27.80	1.38	0.35	0.10	0.14	0.16	0.18	0.01	0.00	0.07	0.49	

Probability of occurrence [%]: 50, 40, 30, 20, 10, 0

Spectral peak energy periods (Tp) in the Cairns region generally range from 2 to 12 seconds, though most recordings fall within a narrower range of 2.5 to 6.0 seconds. These shorter periods result from the limited fetch distances where the waves are generated. The long period waves with periods greater than 6 seconds are swell waves, generated outside the reef and propagating through gaps with significantly reduced heights. Although sea waves typically have short periods, longer periods can occur during events with wind speeds over 55km/h (Beach Protection Authority, 1984), usually associated with tropical cyclones. Swell waves generally have periods greater than 6 seconds, and as seen in the wave period rose in Figure 3-3 the distribution by direction reveals that waves from the east-southeast and east sectors tend to have shorter periods compared to the northeasterly waves. Meaning these waves are produced by wind (sea waves).

When compared with the Cairns data the wave climate offshore of Pebbly Beach would be different in the following ways:

1. Swell waves would approach from an east-northeasterly direction due to the relative position of the gap in the reef relative to the site (refer **Figure 3-2**).
2. Sea waves offshore would be larger due to the longer fetches in the dominant SE corridor.

As described previously this wave climate will be heavily modified by the bathymetry with local headlands and reefs and rock platforms reducing the wave heights and restricting angles of approach.

3.2.2 Extreme Waves

Table 3-2 presents the significant wave height and peak wave period for various Average Recurrence Interval (ARI) events, with wave heights provided by BMT WBM (2013) and wave periods based on the observed wave climate during tropical cyclones. The 200-year ARI event will be used as the design condition in accordance with the Queensland Prescribed Tidal Works Code. A significant offshore wave height of 2.8m and a period of 6.2 seconds have been selected for this event. It is important to note that this wave height was determined at a depth of approximately 10m and will require transformation to obtain the design wave height and period at the structure's toe.

Table 3-2: Offshore Significant Wave Height and wave periods

Parameter	5% AEP 20 yr ARI*	2% AEP 50 yr ARI*	1% AEP 100 yr ARI	0.5% AEP 200 yr ARI	0.2% AEP 500 yr ARI	0.1% AEP 1,000 yr ARI	0.01% AEP 10,000 yr ARI
Hs (m)	2.66	2.71	2.74	**2.80**	2.85	2.87	2.92
Tp (seconds)	5.2	5.7	6.0	6.2	6.5	6.7	7.0

**Note: The study (BMT WMB, 2013) only provided data for 100-to-10,00-year ARI events. Therefore, interpolation was used to obtain the 20-and 50-year ARI design wave heights.*

3.3 Water Levels

The design water level at the site has been determined based on a combination of:

- astronomical tides
- storm surge due to tropical cyclones; and,
- sea level rise.

3.3.1 Ambient (tidal)

Tidal planes for Port Douglas (approximately 20km north of Pebbly Beach) are provided in **Table 3-3**.

Table 3-3: Port Douglas Tidal Planes (MSQ, 2024)

Tidal Plane	2024 Water Level m above LAT	2024 Water Level m above AHD
Highest Astronomical Tide (HAT)	3.40	1.82
Mean High Water Springs (MHWS)	2.54	0.96
Mean High Water Neaps (MHWN)	1.88	0.30
Mean Sea Level (MSL)	1.65	0.07
Australian Height Datum (AHD)	1.58	0.00
Mean Low Water Neaps (MLWN)	1.42	-0.16
Mean Low Water Springs (MLWS)	0.75	-0.83
Lowest Astronomical Tide (LAT)	0.00	-1.58

3.3.2 Extreme (cyclonic)

The design water levels from the various studies are presented in **Table 3-4**.

Table 3-4: Design storm tide surge levels (including wave setup) for Oak Beach (BMT WBM, 2013)

Location	1% AEP 100 yr ARI	0.5% AEP 200 yr ARI	0.2% AEP 500 yr ARI	0.1% AEP 1,000 yr ARI	0.01% AEP 10,000 yr ARI
Storm Surge (excluding wave setup + runup)	1.29 m AHD	1.60 m AHD	2.01 m AHD	2.31 m AHD	3.13 m AHD
Storm Tide (excluding wave setup + runup)	1.84 m AHD	2.09 m AHD	2.40 m AHD	2.66 m AHD	3.30 m AHD
Storm Tide (including wave setup + runup)	2.96 m AHD	3.26 m AHD	3.61 m AHD	3.88 m AHD	4.55 m AHD

Based on a 100-year design life and a 200-year ARI storm event, the design storm tide is **2.09m**. Note that the storm tide design used for rock rise calculation excludes wave setup and runup.

3.3.3 Sea Level Rise (future impacts)

Sea level rise is the projected increase in sea level caused by global warming due to climate change. A sea level rise of 0.8m has been allowed for in this design to coincide with a 100-year design life. This level is based on the IPPC Sixth Assessment report considering the SSP2-4.5 scenario (**Table 3-5**), which is the most likely scenario to occur based on the changes to the climate to date (2024). It should be noted that the Queensland government (Department of State Development, Infrastructure, Local Government and Planning, 2022) adopt the SSP5-8.5 scenario and adopt a 0.8m increase by 2100.

Table 3-5: SLR projections (Source: IPCC,2021)

	SSP1-1.9	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5	SSP5-8.5 *Low Confidence*
Thermal expansion	0.12 (0.09–0.15)	0.14 (0.11–0.18)	0.20 (0.16–0.24)	0.25 (0.21–0.30)	0.30 (0.24–0.36)	0.30 (0.24–0.36)
Greenland	0.05 (0.00–0.09)	0.06 (0.01–0.10)	0.08 (0.04–0.13)	0.11 (0.07–0.16)	0.13 (0.09–0.18)	0.18 (0.09–0.59)
Antarctica	0.10 (0.03–0.25)	0.11 (0.03–0.27)	0.11 (0.03–0.29)	0.11 (0.03–0.31)	0.12 (0.03–0.34)	0.19 (0.02–0.56)
Glaciers	0.08 (0.06–0.10)	0.09 (0.07–0.11)	0.12 (0.10–0.15)	0.16 (0.13–0.18)	0.18 (0.15–0.21)	0.17 (0.11–0.21)
Land-water Storage	0.03 (0.01–0.04)	0.03 (0.01–0.04)	0.03 (0.01–0.04)	0.03 (0.02–0.04)	0.03 (0.01–0.04)	0.03 (0.01–0.04)
Total (2030)	0.09 (0.08–0.12)	0.09 (0.08–0.12)	0.09 (0.08–0.12)	0.10 (0.08–0.12)	0.10 (0.09–0.12)	0.10 (0.09–0.15)
Total (2050)	0.18 (0.15–0.23)	0.19 (0.16–0.25)	0.20 (0.17–0.26)	0.22 (0.18–0.27)	0.23 (0.20–0.29)	0.24 (0.20–0.40)
Total (2090)	0.35 (0.26–0.49)	0.39 (0.30–0.54)	0.48 (0.38–0.65)	0.56 (0.46–0.74)	0.63 (0.52–0.83)	0.71 (0.52–1.30)
Total (2100)	**0.38 (0.28–0.55)**	**0.44 (0.32–0.62)**	**0.56 (0.44–0.76)**	**0.68 (0.55–0.90)**	**0.77 (0.63–1.01)**	**0.88 (0.63–1.60)**
Total (2150)	0.57 (0.37–0.86)	0.68 (0.46–0.99)	0.92 (0.66–1.33)	1.19 (0.89–1.65)	1.32 (0.98–1.88)	1.98 (0.98–4.82)
Rate (2040–2060)	4.1 (2.8–6.0)	4.8 (3.5–6.8)	5.8 (4.4–8.0)	6.4 (5.0–8.7)	7.2 (5.6–9.7)	7.9 (5.6–16.1)
Rate (2080–2100)	4.2 (2.4–6.6)	5.2 (3.2–8.0)	7.7 (5.2–11.6)	10.4 (7.4–14.8)	12.1 (8.6–17.6)	15.8 (8.6–30.1)

The extreme water level adopted for the design of coastal defences is **2.89m AHD (2.09 + 0.80)**.

3.4 Design Input

A revetment wall would be classified as Facility Category 3 (equivalent to a standard commercial structure) with a design working life of 50 years, as per AS4997. However, this revetment wall is a small component of a much larger project, for which a 100-year design life has been chosen. This extended design life was selected due to the project's proximity to the shoreline.

According to the Queensland Government's *Coastal Protection and Management Regulation 2017*, Schedule 3 (Prescribed Tidal Works Code), a revetment must withstand the effects of waves or a combination of waves and water levels resulting from a storm event with a 2% Annual Exceedance Probability (AEP), taking sea level rise into account. Typically, a revetment is designed for a 50-year lifespan, making the 2% AEP appropriate. However, given the 100-year design life of this project, a more stringent 0.5% AEP design event has been selected. This includes a 200-year wave height combined with a 200-year water level. Although this approach is conservative, as the likelihood of a 200-year wave coinciding with a 200-year water level is very low, it ensures robust protection.

The rock structure is designed to sustain up **to 5% damage in a 200-year ARI event**, balancing stability with cost-effectiveness. It is also capable of withstanding a 20-year ARI event with no damage.

3.4.1 Toe Level

After reviewing the provided cross-sections of the existing surface and aerial imagery, it has been determined that the toe will be founded on a non-erodible rock profile, found at approximately 0 m AHD or above. Since this rock bed is a non-erodible surface, no specific toe design is required for this section. Although the rock bed extends across the entire length of Pebbly Beach, the levels are to be confirmed.

The toe elevation has been designed at 0.35 m AHD but may extend as low as 0 m AHD. This variation has been addressed by applying a conservative sea-level rise (SLR) allowance. However, if the toe extends significantly below 0 m AHD, the design will need to be reassessed.

3.4.2 Design Water Depth

The design water depth at the structure has been taken as a 200-year ARI storm tide plus future sea level plus the tow design level (**Section 3.3**):

- Storm Tide: 2.09m AHD
- SLR: 0.8m
- Toe level: -0.35m

Therefore, the design water level for this site is **2.54m AHD**.

3.4.3 Design Wave Conditions

3.4.3.1 Offshore Design Wave Conditions

The offshore design wave conditions for a 200-year ARI event are (refer **Section 3.2**):

- Significant wave height of 2.8 m
- Peak wave period of 6.2 seconds

3.4.3.2 Onshore Design Wave Conditions

The depth-limited wave height at the structure toe is provided in **Table 3-6**. The depth-limited breaking wave height is 1.37m for rock size. This is the maximum wave height that can occur in a water depth of 2.54m. As the depth-limited wave breaking height is smaller than the 100-year ARI shoaled wave height calculated above the depth limited wave height was chosen as the design wave height.

Table 3-6: Depth-limited wave height at structure (EurOtop, 2018)

ARI (years)	Slope	h_b/L_0	h/L_{op}	H_{m0}/h	h (m)	H_b (m)
200	100	0.04	0.04	0.54	2.54	**1.37**

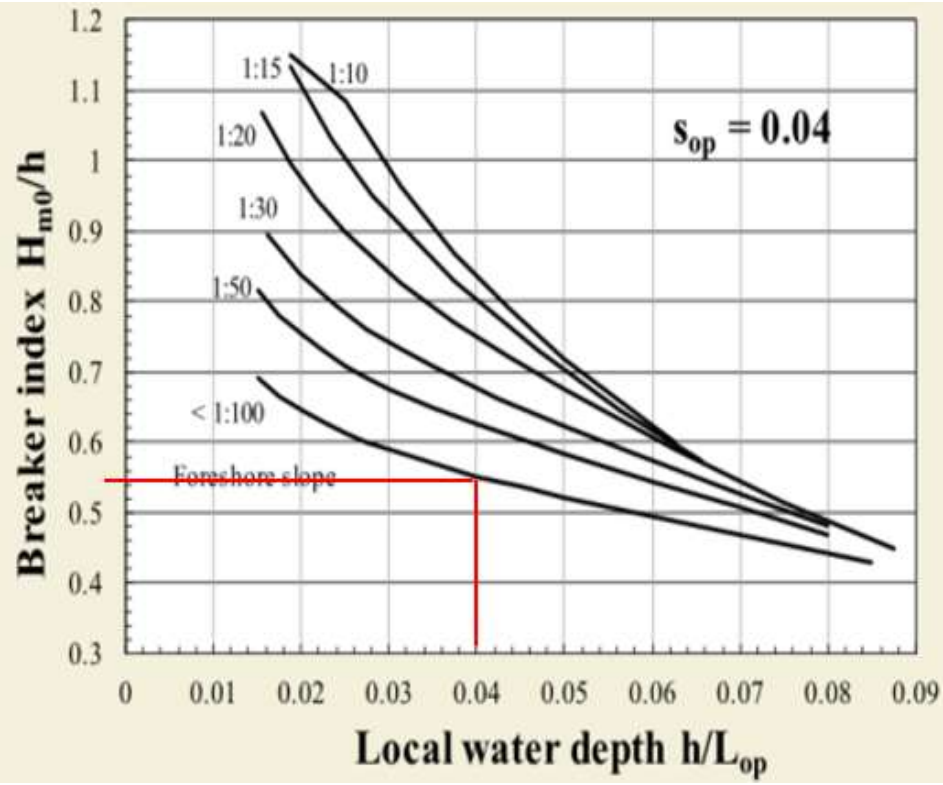

Figure 3-4: Depth-limited significant wave heights for uniform foreshore slopes (Figure 2.4, EurOtop 2018).

Therefore, the design (depth-limited) wave height at the structure (onshore) is **1.37m AHD**.

4 Proposed Development

4.1 Options Assessment

The initial options assessment was informed by the geotechnical investigation undertaken by AECOM (July 2024) and involved a comprehensive multi-criteria analysis (MCA) based on costs, constructability, timing, lifetime and maintenance requirements, environmental and cultural heritage impacts and public benefit. The MCA included the following options:

- Earth fill;
- Rock fill;
- Gabion wall;
- Grib wall;
- Cantilever retaining wall;
- Soil nail and shotcrete; and,
- Shift road alignment west.

A summary of the MCA results can be found in **Table 4-1**. Please note the values presented show the ranking of each option based on the main criteria and a number of sub-criteria.

Table 4-1: Summary of MCA ranking results

	Weighting	Earth fill	Rock fill	Gabion wall	Grib wall	Cantilever retaining wall	Soil nail and shotcrete	Shift road alignment west
Cost	30%	2	1	3	4	5	6	7
Constructability	25%	3	1	4	5	6	2	7
Timing	10%	1	2	4	6	5	3	7
Lifetime & maintenance	10%	5	1	7	6	4	2	3
Environment & heritage impacts	12.5%	5	3	1	2	4	6	7
Public benefit	12.5%	1	2	3	4	7	5	6
Overall	**100%**	**2**	**1**	**3**	**4**	**5**	**6**	**7**

From this initial options assessment, the rock fill ultimately ranked first and design optioneering began for rock fill options. The design development has included various iterations and options, from the do-nothing scenario to a continuous rock revetment wall. The process has considered stability of the embankment, longevity of the asset, minimising the footprint, lowest impact on coastal processes, public amenity and maximising the vegetation retention or replanting.

Therefore, the options considered at the site are as follows:

1. Option 1: Do Nothing;
2. Option 2: Piece meal revetment wall;
3. Option 3: Patch repair revetment wall;
4. Option 4: Narrow continuous rock revetment wall; and,
5. Option 5: Wide continuous rock revetment wall.

The full options assessment and multi-criteria analysis can be found in **Appendix J**, and Basis of Design (Royal HaskoningDHV, 2024b) in **Appendix K**.

4.2 Recommended Option

The impacts to coastal processes heavily informed the development of the preferred design. The coastal processes impact assessment concluded that the proposed rock revetment wall will not exacerbate coastal erosion and that the coastal processes will continue unimpeded. The works will necessitate the loss of trees with a base below 4.0 m AHD, though many trees will be retained. The new rock revetment wall will push into the beach profile, reducing the width of the beach and increasing the risk of the beach being completely flooded at high tide. The impact of the encroachment will be minimised by placing beach material located within the footprint of works back on the beach in front of the rock revetment wall. Rough placement is allowed as the waves will reshape the to the natural beach profile however gravel is to be placed in close proximity to where it was excavated due to the grading of the slope.

Because of the road embankment's vulnerability during extreme weather events, a continuous rock revetment wall is proposed to protect approximately 600 m of the foreshore. The proposed solution is Option 5 which adopts a robust, continuous, wide rock revetment wall that will protect the embankment from wave overtopping (**Figure 4-1**).

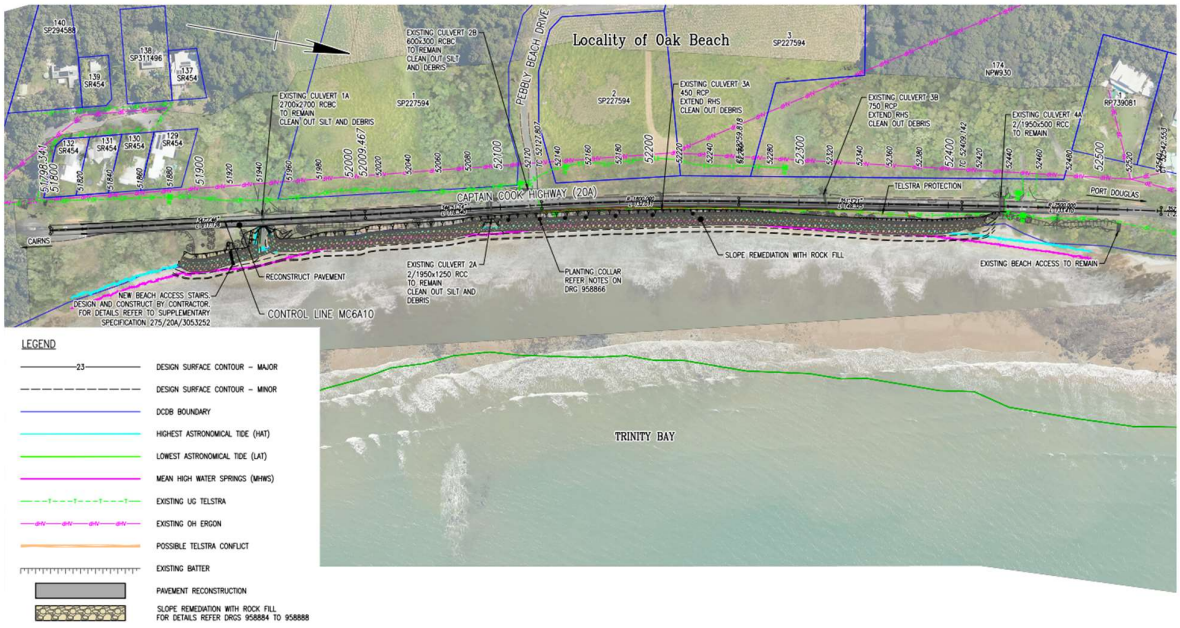

Figure 4-1: Proposed extent and solution (100% design)

Key features of the design for the proposed solution include:

- Robust protection (designed for a 200-year ARI event) including:
  - Heavy duty geotextile to contain embankment material;
  - Rock fill below the armour that is at least 0.8m thick;
  - Double layer primary rock armour that is 1.23m thick;
  - Horizontal section width of 3.7m.
- Toe founded on non-erodible strata or 0.0m AHD if not on rock. Anticipate finding rock above 0.0m AHD.
- Crest found at 4m AHD with:
  - Level defined based on no damage overtopping analysis in extreme events; and,
  - Adopted level is at least 1m below the crest of the embankment

- Profile position relevant to the existing embankment is defined by the geotechnical analysis.
- To improve public access and maintain current amenity, stairs will be installed at the southern carpark over the rock revetment wall. The stairs will be installed on top of a concrete slab and will require piling to support construction.

Refer to **Appendix D** for the final development plan.

4.3 Environmental Management Plan

TMR will provide the contractor with sufficient information to prepare a Construction Environmental Management Plan [EMP (C)]. The EMP (C) will be reviewed by TMR prior to construction, and ensure environmental aspects are appropriately managed during construction.

The EMP (C) will address key activities likely to have an environmental impact and implement strategies to protect and manage water quality, waste, flora and fauna, soils (including erosion and sediment), air quality and cultural heritage.

4.4 Operation and Maintenance

TMR will continue to maintain the asset, as per relevant standards and guidelines in line within TMR's Transportation Infrastructure Asset Management Policy.

5 Planning Framework

A Preliminary Environmental Assessment (PEA) was undertaken and informed the initial environmental impacts associated with the proposed works. However, since then, the design has been refined and a number of iterations have been made. The following section provides a review of potential Commonwealth, State and Local Government development and environmental approval requirements for the proposed works.

5.1 Commonwealth Matters

5.1.1 Environment Protection and Biodiversity Conservation Act 1999

An *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST) for the site (and 5 km buffer) was undertaken on the 10th of October 2024. The search identified 2 threatened ecological communities (TECs), 53 threatened species and 44 migratory species that are known to, or are likely to, use the area for breeding, roosting, or feeding, although field assessments confirmed the TECs are not present in the area. As per the significant impact guidelines, the works will not adversely affect critical habitats, reduce the extent or fragment an existing ecological community or clear any habitat used for breeding, roosting or feeding. Therefore, it is likely that the works will not have a significant impact on MNES, and a referral would not be required.

5.1.2 Native Title Act 1993

A search of the National Native Title Vision (NNTV) portal indicates that the area of works was accepted for an active native title claim registration on the 30th of April 2024 by the Djabugay Nation (QC2024/001). Given Native Title has not been extinguished over the project footprint, the assessing authorities will notify the proposed work in accordance with the provisions of the *Native Title Act 1993*.

5.1.3 Commonwealth Policy on the Management of Land in Australia Affected by Unexploded Ordnance

A search of the *Development Assessment Mapping Assessment (DAMS)* (Queensland Government, 2024) indicated no areas with substantial potential for UXO exist at or near the site.

5.2 State Matters

5.2.1 Planning Act 2016

The following section provides an evaluation of the Project against the relevant assessment benchmarks required under the *Planning Act 2016*.

5.2.1.1 Code for Assessable Development that is Prescribed Tidal Works

The *Coastal Protection and Management Act 1995* defines tidal works as, among other things, '*works designed to be exposed to tidal water because of shoreline fluctuations*'. By the very nature of the works, it is clear, the works are designed to be exposed to tidal water and is therefore considered tidal works. Tidal works (including prescribed tidal works) is made assessable development under the *Planning Regulation 2017* (17.1.28) which requires a development approval for operational work.

Schedule 3, Part 3 of the *Coastal Protection and Management Regulation 2017* provides the Code for Assessable Development that is Prescribed Tidal Works. This code applies for the assessment of a

development application for prescribed tidal works for which a local government is the Assessment Manager.

An Assessment against the Coastal Protection Management Regulation Schedule 3 has been provided in **Appendix E**. The works are compliant with the Code. The design and construction methodology are consistent with Australian Standards relating to the type of work.

5.2.1.2 State Development Assessment Provisions

The *Planning Regulation 2017* identified the relevant Referral Agencies for the project's activities which include the following.

- Schedule 10, Part 6, Division 3, Subdivision 2, Table 1, Item 1 of the Planning Regulation 2017: Removal, destruction or damage of marine plants.
- Schedule 10, Part 17, Division 2, Table 1 of the Planning Regulation 2017: Coastal development and tidal works.
- Schedule 10, Part 17, Division 3, Table 2 of the Planning Regulation 2017: Maritime safety.

Appendix 1 of the State Development Assessment Provisions identifies the following State codes as applicable to this Project:

- State Code 7: Maritime Safety.
  - The purpose of this code is to ensure development supports the viable operation of aids to navigation and supports the safe operation of vessels in navigable waterways. The proposed works are consistent with the requirements of this code.
- State Code 8: Coastal Development and Tidal Works.
  - The purpose of this Code is to ensure tidal works or development completely or partly within the coastal management district is managed to protect and conserve environmental, social and economic coastal resources and enhances the resilience of coastal communities to coastal hazards. The development is compliant with the Code.
- State code 11: Removal, Destruction or Damage of Marine Plants.
  - The purpose of this Code is to ensure the protection of marine plant communities that are fisheries resources and to ensure development provides ecosystem services that support fisheries productivity. A significant residual impact assessment was undertaken below.

All State Code responses can be found in **Appendix F**.

Significant Residual Impact Assessment

There are Matters of State Environmental Significance (MSES) near to the site, most notably marine plants and declared high ecological significance (HES) wetlands. As part of the *Significant Residual Impact Guideline 2014,* Module 4 and Module 11 addresses the significant residual impact criteria for HES wetlands and marine plants. If the works cause a significant residual impact to these matters an offset under the *Environmental Offset Act 2014* will be conditioned under the development permit. The responses to the significant residual impact criteria can be found below.

4.1 Significant residual impact criteria – Wetland and Watercourses

An action is likely to have a significant residual impact on prescribed wetlands or watercourses if it is likely that the action will result in environmental values being affected in any of the following ways (**Table 5-1**):

Table 5-1: Significant residual impact criteria for prescribed wetlands or watercourses

Criteria	Response
Areas of the wetland or watercourse being destroyed or artificially modified;	No areas of the wetland will be destroyed or artificially modified as part of the proposed works, and no impact to the GBR wetland values is expected.

	The proposed works have been designed to occupy the minimum footprint necessary to achieve the project objectives and design requirements.
a measurable change in water quality of the wetland or watercourse—for example a change in the level of the physical and/or chemical characteristics of the water, including salinity, pollutants, or nutrients in the wetland or watercourse, to a level that exceeds the water quality guidelines for the waters; or,	The proposed works were designed to not introduce toxic substances or potential contaminants that may change the physico-chemical characteristics of the nearby marine environment. TMR will provide the contractor with sufficient information to prepare an EMP (C). The EMP (C) will be reviewed by TMR prior to construction, and ensure environmental aspects are appropriately managed during construction. Works will stabilise the area and prevent further sedimentation into the nearby waterways.
the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected; or,	The proposed works will not adversely impact on the habitat of native species as they are a linear infrastructure at or above HAT and will not cause fragmentation of habitats for the same reasons. Vegetation will be left on the beach where it is present, and design has been made to maximise potential for overhanging vegetation that may provide some fisheries habitat. No impacts to Fish Passage streams or potential access to these areas.
a substantial and measurable change in the hydrological regime or recharge zones of the wetland, e.g., a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland; or.	As the proposed works are for coastal protection works, and therefore defined as a coastal-dependant development, they have been designed as far landward as possible and occupy the minimum footprint necessary to minimise interference with coastal processes and are therefore not altering the hydrology of the wetland. The only potential impacts are in the form of stabilising the foreshore, which will benefit the Great Barrier reef wetlands by repairing the degrading processes. Further to this, Wetland*Info* and Wetland*Maps* were accessed to confirm the site area is not a groundwater dependant ecosystem, and no impacts to groundwater flows are expected from the proposed works.
an invasive species that is harmful to the environmental values of the wetland being established (or an existing invasive species being spread) in the wetland.	No invasive species will be introduced as part of the proposed works.

See 'Offset Requirements' section for assessment response.

11.1 Significant residual impact criteria – Marine Plants

Any plant located below mean high water mark is considered to be a marine plant. There are also certain species which are considered to be inherent marine plants regardless of their location (e.g., mangroves, seagrass, saltcouch, algae, samphire). An action is likely to have a significant residual impact on marine plants where the impacts of the development shall result in:

- public infrastructure works impacting more than 25m^2 of marine plants; and,
- temporary impacts are expected to take 5 years or more for the impact area to be restored to its pre-development condition.

All vegetation that is currently dead or dying, which is considered a marine plant, will be left untouched to provide existing habitat value. To accommodate the revetment construction all vegetation that is located on the mid to lower slope area of the road embankment will be required to be removed. 834m^2 will be

permanently removed as part of the works and therefore a significant residual impact will occur, and an offset is required. See **Appendix I** for the vegetation survey and proposed clearing plans.
Rehabilitation is proposed to allow vegetation planting that will assist to reinstate amenity and replace some marine values for vegetation over hanging HAT. The plans attached in **Appendix H** show areas proposed for replanting and rehabilitation at the site.

Offset Requirements
A HES wetland is present on site and has been addressed as per Module 4. HES wetland in the proposed impact area is based on the presence of marine plants. For this reason, the marine plants and HES wetland proposed to be impacted could be considered "the same or substantially the same prescribed environmental matter". Under section 14 of the *Environmental Offsets Act 2014* and section 1.1.3 of the *Queensland Environmental Offsets Policy*, an offset condition shouldn't be imposed on an authority where an offset condition has already been imposed on an authority for the same or substantially the same prescribed activity and the same or substantially the same prescribed environmental matter. It is believed that the appropriate way to deal with this impact and subsequent offset is through the assessment against state Code 11. As per the performance outcome PO3, a financial offset will be required.

5.2.2 Aboriginal Cultural Heritage Act 2003

In order to determine the category of works and associated requirements under the *Aboriginal Cultural Heritage Act 2003*, a cultural heritage assessment was undertaken in alignment with the *Aboriginal Cultural Heritage Act 2003* Duty of Care Guidelines (DoC Guidelines). Additionally, designs were revised to ensure no impacts to the Wet Tropics of Queensland World Heritage Area and Great Barrier Reef Marine Park World Heritage Area (GBRWHA) occurred.

The cultural heritage risk assessment identified multiple risk allocations under the DoC Guidelines that are:

- High-risk Category 5 in areas where remnant vegetation or high-risk landscape features exist, or additional surface disturbance could occur.

Consultation, field assessment and agreement with the Djabugay Nation Native Title Claim group is required for works in areas assessed as high-risk Category 5 under the DoC guidelines. Consultation with the Yirrganydji Traditional Use of Marine Resources Agreement (TUMRA) group will be undertaken by TMR, as works are adjacent to the GBRWHA and the Yirrganydji TUMRA region.

5.2.3 Nature Conservation Act 1992

The protected plants trigger mapping coincided with the proposed development footprint. The vegetation survey (**Appendix I**) identified no protected, threatened or near threatened species to be cleared as part of the works, therefore a protected plant clearing permit is not required.

Clearing for maintenance of road structures is also considered exempt from the requirements of the *Nature Conservation Act 1992*, and a conforming flora survey is not required. TMR have confirmed no Endangered, Vulnerable or Near Threatened (EVNT) species are within the proposed clearing areas.

5.2.4 Vegetation Management Act 1999

The *Vegetation Management Act 1999* mapping identified regulated vegetation within the site. The clearing of regulated vegetation is exempt under Schedule 21, Part 1, Section 14(b) of the Planning Regulation 2017 as the infrastructure is government supported transport infrastructure.

5.2.5 Queensland Marine Parks Act 2004

The Great Barrier Reef Coast Marine Park (GBR Coast MP) boundary falls within the site and a permit is required under the *Queensland Marine Parks Act 2004*. TMR have obtained a marine park permit for access to site for construction purposes. Should project scope or requirements within the GBR Coast MP change, an amendment to the approval will be undertaken by TMR.

5.2.6 Environmental Protection Act 1994

All persons have a general environmental duty (GED) under the Environmental Protection Act 1994 (EP Act) to not carry out any activity that causes, or is likely to cause, environmental harm unless the person has an authority to do so or has taken all reasonably practicable measures to prevent or minimise the harm. It is an offence to fail to comply with the general environmental duty and this failure causes, or is likely to cause, serious or material environmental harm.

The contractor will prepare an EMP (C) that is reviewed by TMR and follows the TMR Road processes manual. Any Erosion Sediment and Control Plan (ESPC) will be reviewed by TMR and deemed suitable. Construction ESCP (CESCP) will also be signed off and ensured they are prepared by suitably qualified persons.

The EMP (C) will address the following:

- Emissions to air from particulate matter/dust caused from material handling.
- Noise impacts on nearby sensitive receptors from the general operation of the activity.
- Impacts to the receiving environment (surface and ground waters) from contaminated stormwater runoff and potential for the disturbance or removal of aquatic and marine habitat from the dredging activity.
- Water quality monitoring program.
- Potential disturbance of acid sulfate soils and non-acid sulfate acid soils and their impacts to land while being stockpiled or treated.
- Impacts to the flora and fauna as a result of disturbance to environmentally sensitive areas.

5.2.7 Fisheries Act 1994

A search of Queensland Globe identified one “amber” waterway intersecting the Project area at an existing culvert located at CH51940. The proposed works within the amber waterway have been design in accordance with the Accepted development requirements for operational work that is constructing or raising waterway barrier works (Date effective 1st October 2018) (Accepted Development Requirements). The proposed works include:

- Retaining the existing culverts and clearing of debris.
- The temporary removal of the existing pebbles to install rock scour protection at the existing culvert outlet. The pebbles are to be placed over the rock scour protection and reinstate preconstruction bed level of the waterway.

Overall, the project has been designed in accordance with the Accepted Development Requirements and therefore does not require an assessment against State Code 18.

5.3 Local Matters

As the subject works are located partly with the ‘tidal area of the local government’ they are prescribed tidal works. Pursuant to the Planning Regulations 2017, Schedule 8, Table 2, Item 1 (d) the Assessment

Manager is Douglas Shire Council, and they will assess the application against Schedule 3 of the *Coastal Protection and Management Regulation 2017*. The response is attached in **Appendix E**.

A Place of Local Significance was identified to the south of the site and mapped in Douglas Shire Council's Planning Scheme online mapping tool as number '28' (see **Figure 5-1** below).

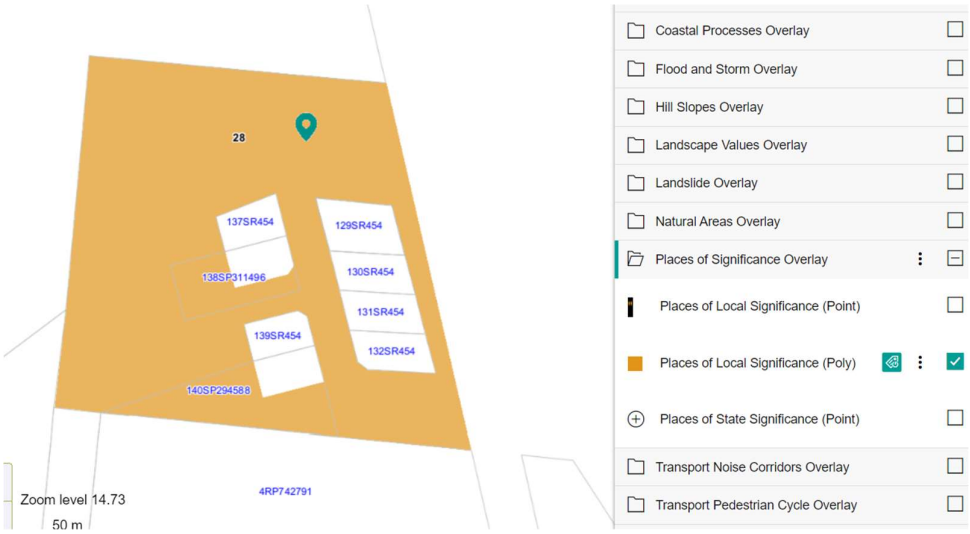

Figure 5-1: Place of Local Significance mapping (source: Douglas Shire Council, 2018)

The proposed development footprint is located outside of the Place of Local Significance and will not be impacted as part of the works. However, the significance of the area will be considered during construction and the contractor will follow cultural heritage requirements documented in principle supplied documents.

6 Conclusion

The Pebbly Beach coastal protection works were proposed to address the damage to Captain Cook Highway and associated coastal erosion as a result of Cyclone Jasper. An assessment of coastal processes and design optimisation was undertaken to identify potential options to address the issues at the site, minimise impacts on coastal processes and the environment, while meeting other project objectives. Without implementation of the project, it is likely that extreme weather events like Cyclone Jasper and associated coastal erosion risks will continue and increase risk to the public users.

The objectives and functional requirements of the works proposed at Pebbly Beach are to:

- ensure construction works minimise impacts on coastal processes;
- effectively and efficiently management of obtaining statutory approvals;
- design a safe environment for site users;
- maintain visual aesthetic of the site;
- maintain good access and serviceability; and,
- protect and reinstate the trees, access stairs, landscaping, and foreshore areas.

An options analysis has determined that a 600m wider continuous rock revetment wall is the preferred option to meet the shared objectives and design requirements for the site. This development application demonstrates that the proposed works meet the provisions of the *Planning Act 2016*, and the applicable state codes and is suitable for approval subject to conditions.