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Ella Bay

Erosion Prone Area Reassessment

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Ella Bay

Erosion Prone Area Reassessment

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Title :	Ella Bay Erosion Prone Area Reassessment
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Synopsis :	This report describes the Erosion Prone Area assessment methodology and its application to Ella Bay in Johnston Shire. Because of this site-specific assessment a recommendation is made regarding the EPA widths.

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1 INTRODUCTION

1.1 Background

A development is planned over Lot 320 on N157629 at Ella Bay in Johnstone Shire (see Figure 1-1 for locality). The development adjoins the beach area and therefore needs to be considered in the context of the policies and regulations established by the then Beach Protection Authority and administered now by the Environment Protection Agency through the Coastal Protection and Management Act (1995).

These policies focus on protecting the beaches by allowing natural short and long term fluctuations to occur without interferences which would be detrimental to beach amenity. The State Coastal Management Plan defines broad issues for consideration for conservation of the State's coastal amenity and this is then given a local context by Regional Coastal Management Plans in which the original Beach Protection Authority (BPA) coastal management districts and erosion prone areas are retained.

Erosion prone areas are those areas of the coast and rivers that, in the opinion of the EPA, may be subject to erosion or encroachment by tidal waters. The planning and management guidelines are aimed at maintaining the amenity of the beaches by retaining erosion prone areas as development free buffer zones.

The then Beach Protection Authority investigated the nature and behaviour of a number of beach types in southern, central and northern Queensland, in the 1970/80's and established generalised guidelines for determining erosion prone area widths. These widths have been set on the basis of the BPA's established practices, together with an aerial photography interpretation of the regional coastal processes.

The site is within the Wet Tropics Coast Regional Coastal Management Plan. The existing designated erosion prone area width varies along the proposed development site and is ranging between 110 m and 400 m (at the southern edge of the site and the area around the outflow location of a creek that cuts across the beach at the proposed site respectively). The designated erosion prone area width is measured inland from the seaward toe of the frontal dune, or to bedrock, where bedrock occurs continuously above Mean High Water Springs (MHWS) within this zone.

1.2 Scope of Study

The Erosion Prone Area (EPA) map of Johnson Shire produced by the Beach Protection Authority in 1984 (refer Appendix C) show that the existing designated erosion prone area along the proposed development site is up to 400m wide.

A preliminary investigation of local beach conditions and assessment of historical behaviour of the coastline and associated features have identified aspects, which may limit the width of coast vulnerable to erosion. This is in particular the case for the area around the outflow location of the creek that cuts across the beach at the proposed site, as it is understood that the EPA width for this area is based on generalised criteria and not site-specific coastal investigations.

As the erosion prone area width needs to be considered in the planning of the proposed development, this study was commissioned to reassess the designated EPA width based on a site-specific assessment of the relevant coastal and ocean processes.

The vulnerability of the coast along the proposed development site to erosion has been analysed by undertaking an Erosion Prone Area Calculation following the formula adopted by the BPA and a detailed assessment of the morphological behaviour of the creek that cuts across the beach at the proposed site.

To ensure sustainability for the proposed development, the potential impacts of climate change due to Greenhouse effects have been included in the assessment of the erosion prone areas.

In addition, the potential inundation extent from coastal flooding for storm events up to 1 in 100 year ARI has been investigated.

1.3 Ella Bay

The regional setting for Ella Bay is that it is located to the southern end of a beach about 10km long with substantial headlands of Heath Point immediately to the south and Cooper Point about 6 km to the north. Ella Bay Swamp, a National Park, is situated between the proposed development site and Cooper's Point. At the mid-point of the bay (at approximately 2.5 km to the north of the site), there is also a small rocky point seaward of Ella Bay Swamp. Cooper Creek flows out into the Coral Sea in the vicinity of Cooper Point.

To the south Heath Point connects to Flying Fish Point. Immediately to the south of Flying Fish Point is the mouth of the Johnstone River. The Johnstone River supplies substantial amounts of sediment to the beach system to the north including Ella Bay during flood events.

The Great Barrier Reef is located approximately 36 kilometres offshore.

For Ella Bay, the beach shape and its long term stability are predominantly influenced by the existence of the headlands and the smaller rock formations along the beach, the presence of the Johnstone River and its sand supply and the prevailing winds, waves and currents.

The regional beach shape is controlled by the dominant headlands (Heath Point and Cooper Point) and to a lesser extent the small rock formation seaward of Ella Bay Swamp. The parabolic shape of Ella Bay is common in areas where both longshore sand transport and a control point exists and the beach is not aligned to the dominant wave direction. For this area the dominant wind/wave direction is from the south to southeast and the beach unit faces slightly south of east.

The beach is exposed to day to day winds and waves from the southeast to northeast with the south and southeast direction being predominant on average. However, the fetch distances are relatively short because of the proliferation of offshore islands and shoals. There may be some penetration of longer period waves from the Northeast and South (associated with channels and gaps between the islands and shoals) however these will lose a large proportion of their energy due to diffraction, refraction and bottom friction before reaching the site. Cyclonic conditions will cause significant changes to beach conditions because of the existence simultaneously of high winds, large waves and elevated water levels.

Sand supply to the area comes from the south (primarily from the Johnstone River), around the headland, driven by the predominant winds. However, cyclones may redistribute the sand within the beach unit. The amount of sand that is supplied to the system is subject to irregular sediment exports from the Johnstone River and these generally occur during flood events. As a result of intermittent supplies of sand from the Johnstone River, the shoreline in the Bay may experience periods of advancement and retreat.

A very low foredune at about 3mAHD exists at the site and is indicative of low rates of incipient dune growth. Vegetation extends down to the seaward edge of the frontal dune, where various types of pioneer vegetation is currently evident. The vegetation on the frontal dune is distinctive from the vegetation in the back beach area indicating recovery from a short-term erosive event (likely to be an historical cyclone). Photographs of the beach of Ella Bay are included in Appendix B.

The sandy beach face extends down to high tide level from where a steep intertidal slope extends out to low tide level. Typically the beach slope within the intertidal zone, based on topographical surveys of the beach near the site, is ranging between 1 in 8 to 1 in 12.

Historical aerial photography 1943, 1952, 1964, 1981, 1986 and 1996 has been interpreted to assess regional trends and analyse the behaviour of the creek that cuts across the beach at the proposed development site.

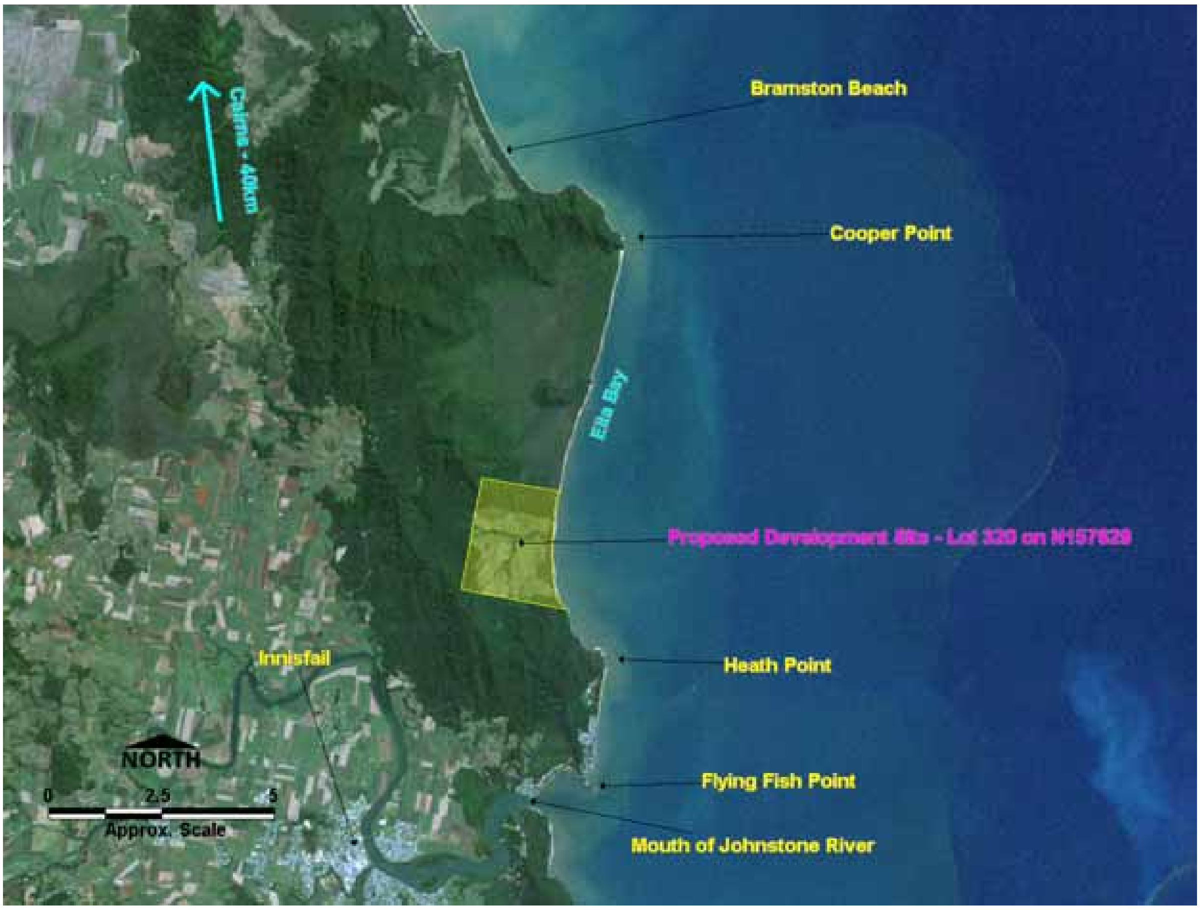

Figure 1-1 Locality Plan

2 PREVIOUS STUDIES

In order to provide input data for the review of the erosion prone area at Ella Bay, previous studies have been reviewed. These are listed below and a summary of significant findings is detailed after:

James Cook University – Ocean Hazard Assessment – Stage 3 report (JCU, 2004)

EPA - Wave data recording program, Dunk Island, 1998–2002 (EPA, 2005)

BMT WBM – Cardwell Inundation Study – Cardwell Shire Council (BMT WBM, 2007)

Ocean Hazard Assessment

The Ocean Hazard Assessment – Stage 3 report is the third in a series of studies to investigate the community vulnerability in Queensland to tropical cyclones and climate change and is part of the "Queensland Climate Change and Community Vulnerability to Tropical Cyclones" project. The project was completed through the combined efforts of the Queensland Environmental Protection Agency, Department of Natural Resources and Mines, Department of Emergency Services, and the Australian Bureau of Meteorology (Queensland) with much of the numerical modelling completed by the James Cook University.

The Ocean Hazard Assessment – Stage 3 report looked at storm surge levels during tropical cyclones at various locations along the coast of Queensland and the potential impacts of climate change on the storm surge levels.

The report contained the following findings for Flying Fish Point:

- The 100yr ARI storm tide level is 1.94mAHD
- The 100yr ARI storm tide level with green house allowance is 2.27mAHD
- The 500yr ARI storm tide level is 2.19mAHD
- The 500yr ARI storm tide level with green house allowance is 2.64mAHD

Wave data recording program, Dunk Island

This report provides summaries of wave data analysis of wave measurements recorded 12.7km north of Dunk Island and 8km northeast of Clump Point during the period from December 1998 to November 2002. The Dunk Island wave recording station was commissioned as a project to study cyclonic wave conditions by EPA.

The Dunk Island wave station is located approximately 60 km to the south of Ella Bay.

The wave records are based on spectral analysis of Waverider Buoy measurements on a nominal recording interval of 1 hour. The greatest significant wave height recorded at Dunk Island during the period from 1998 to 2002 is 3-3.2m. A wave height exceedance chart based on the wave records is presented in Figure 2-1.

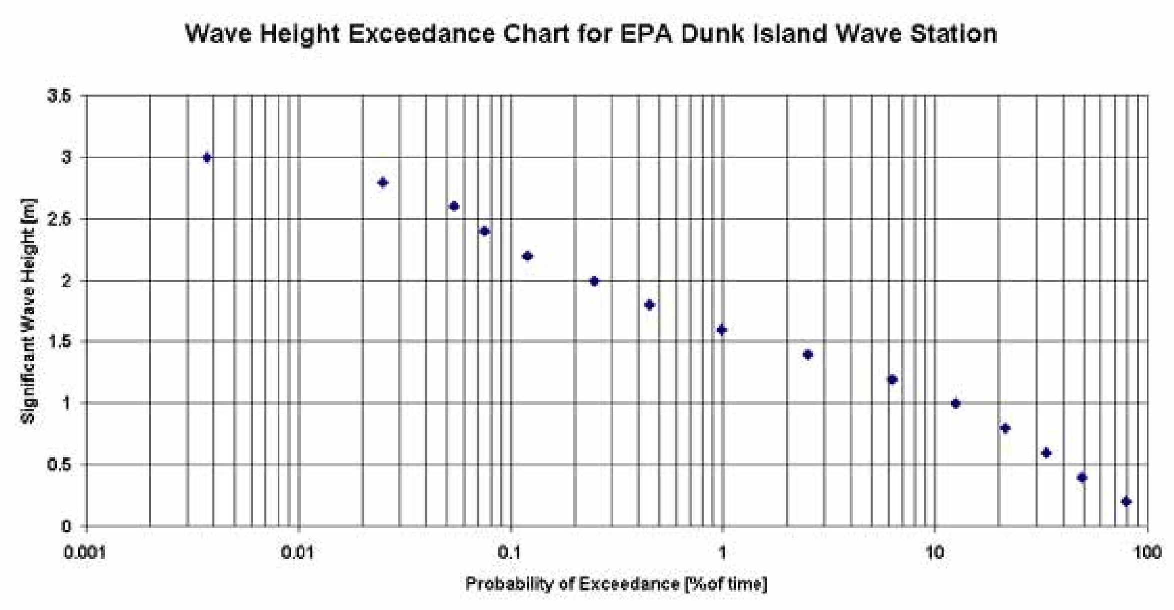

Figure 2-1 Wave Height Exceedance Chart – EPA's Dunk Island Wave Station

No estimations of wave direction data have been provided.

For extreme cyclonic conditions, the waves near the proposed development site are likely to be influenced by the limited fetch due to the presence of the Reef. This affects the suitability of the wave records for extreme storm conditions.

Cardwell Inundation Study

This study investigates the risk for Cardwell Shire Council to coastal and fluvial inundation. The coastal inundation potential is analysed by simulating synthesised tropical cyclone events using a numerical storm surge model.

As part of the study, cyclonic wave conditions were analysed at various locations along the Cardwell Shire coastline using SWAN wave models. The extreme wave conditions were derived from 50,000 years of parameterised tropical cyclone events.

For Wongaling Beach, the most northern location considered by the Cardwell Inundation Study, the 1:100 year maximum significant cyclonic wave height is predicted to be 3.82 m. Wongaling Beach is located 45 km to the south of Ella Bay.

3 EROSION PRONE AREA CALCULATION COMPONENTS

3.1 Basic Considerations

Erosion prone area widths are determined to cater for potential erosion of the dune system over a specified planning period. Both short term (cyclone-related) and longer term (gradual) trends are included in the assessment together with an allowance for potential sea level rise associated with the Greenhouse Effect. Provision must also be included for a factor of safety on the estimates and an allowance made for slumping of the dune scarp following erosion. The following relationship was used by the Beach Protection Authority for determination of the erosion prone area widths. This formulae continues to be recognised by the Environmental Protection Agency as a reasonable method of assessing shoreline recession risk.

$$E = [(N \times R) + C + G] \times (1 + F) + D$$

Where

E = Erosion Prone Area Width (metres)

N = Planning Period (years)

R = Rate of Long Term Erosion (metres/year)

C = Short Term Erosion from the design cyclone (metres)

G = Erosion due to Greenhouse Effect (metres)

F = Factor of Safety

D = Dune Scarp Component

The various components in the above relationship are determined on the basis of the characteristics of the individual beaches together with presently accepted practices as discussed below.

3.2 Planning Period (N)

The duration of the planning period influences the erosion prone area width calculations by effecting:

- the total extent of gradual long term erosion;
- the extent of possible sea level rise due to the Greenhouse Effect; and
- the selection of design cyclone conditions which are based on an accepted risk level.

In accordance with current policies, a planning period of 50 years has been adopted.

3.3 Rate of Long Term Erosion (R)

The rate of long term erosion can be estimated by extrapolating past trends and/or determining any deficit in the local sediment budget. Consideration is also given to local features and/or characteristics, which may influence the potential extent of long term erosion.

For this study, historical aerial photographs of the region have been interpreted to determine progressive long-term shoreline change.

3.4 Short Term Erosion (C)

Short term erosion of the upper beach and dune can occur from time to time, associated with cyclone or severe storm events. Such events usually involve co-existing storm surges and high waves. Selection of the design cyclone parameters for determination of the short term erosion component are discussed in Section 4.2.

Storm erosion involves the movement of sand from the upper beach and dune in the offshore direction. This sand would be returned gradually to the upper beach by wave and wind action over a relatively longer period of time. In cases where the dune is low and overtopped, sand may also be carried landwards.

Where appropriate the erosion distance can be calculated on the basis that a characterised equilibrium beach profile is developed during the cyclone attack and that this profile provides a volume balance between the material eroded from the upper beach/dune and that deposited on the lower zone of the beach slope. The empirical Edelman method as modified by Vellinga, 1983 can be used for this type of calculation. This method predicts an equilibrium profile based on the wave height and grain size of the dune sand.

3.5 Erosion Due to Greenhouse Effect (G)

Provision is required for coastal recession associated with an expected sea level rise due to the Greenhouse Effect. It is impossible to state conclusively by how much the sea will rise, and no policy yet exists regarding the appropriate provision, which should be made in the design of new coastal developments.

However, the intergovernmental Panel on Climate Change predicts sea level rise using world atmospheric models on a 5 yearly basis. Currently the EPA uses a predicted rise of 0.3m for a 50 year planning timeframe to take account of the uncertainties in prediction methods.

In assessing the coastal recession associated with an increase in mean sea level, consideration has been given to the geography of the area, existing beach profiles and sediment characteristics. It is considered that beach ridges are likely to be predominantly wave formed with the coarser particles being moved onshore to the upper beach face/dune and the finer particles remaining in the nearshore zone. This has resulted in beach profiles with two distinct slopes; a steep upper beach face with coarse sand and a flat nearshore zone with fine sand.

The standard method of Bruun (refer Figure 3.1) for predicting beach response to sea level rise is based on the upper beach/dune sand eroding and depositing in the nearshore zone to maintain the same depths below mean sea level. This rule is not applicable in north Queensland where the beach sand is sorted as described above. Therefore an alternative assessment using recession at the existing beach slope is also used and a nominal value selected based on the two analyses.

The potential impacts of climate change on the extreme sea water level (ie. storm surge levels) are investigated in the Ocean Hazard Assessment Stage 3 report. For Flying Fish Point, the 1 in 100year

ARI storm tide level with green house allowance is 2.27mAHD (an increase of 0.33m compared to present 1 in 100 year ARI levels).

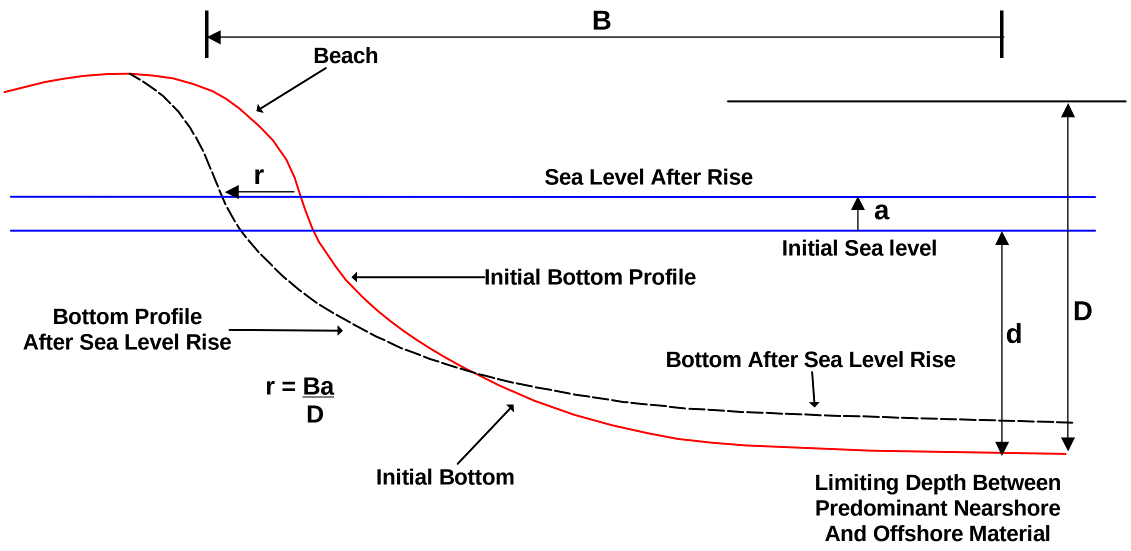

Figure 3-1 Bruun Rule for Shoreline Response to Rising Sea Level

3.6 Factor of Safety (F)

A factor of safety is included in the assessments of the short term, long term and Greenhouse Effect erosion components to provide for uncertainties and error margins in the calculation procedures. In accordance with current policies, this factor of safety has been set at 40%.

3.7 Dune Scarp Component (D)

The erosion prone areas are specified as measured from the toe of the frontal dune. The short and long term erosion components provide a measure of the recession of the dune toe. The dune scarp component provides for the horizontal distance between the toe and the crest after slumping to a stable slope (about 1 in 3).

4 STANDARD EROSION PRONE AREA WIDTH CALCULATION

The erosion prone area width for the beach compartment being studied has been assessed using the methods and design criteria described in the previous section. The width is the extent of possible shoreline recession during the 50 year planning period.

4.1 Long Term Erosion (N x R)

For this study, historical aerial photographs of the region have been analysed to determine progressive long-term shoreline change at Ella Bay. Historical aerial photography from 1943, 1952, 1964, 1981, 1986 and 1996 has been interpreted.

In this section, the historical shoreline movements away from the creek that cuts across the beach on the proposed development site are discussed. The historical shoreline movements near the creek are discussed in Section 5 of this report.

From the historical photographs it is evident that the shoreline at the proposed development site is experiencing some degree of short term movement from year to year, with a coastline fluctuation of up to 50 metres.

There is however no long term trend noticeable in the shoreline movements during the period from 1943 to 1996. Seaward shoreline movements appear to be followed by landward shoreline movements. Therefore, it is considered that the shoreline at the proposed development is not subject to continued long-term shoreline erosion. This is as expected since the nearby Johnson River supplies sand to the beach. Accordingly, the erosion component is likely to be very low and may even have been slightly negative in the last 50 years.

Nevertheless, due to the fact that the coastal system is directly influenced by sand exports from the Johnstone River and that these imports vary significantly over time, a value of 20 metres has been adopted for long-term erosion term to allow for shoreline retreat as a result of medium term fluctuations in the sand supply.

4.2 Short Term Erosion (C)

The accepted method of determining the short term erosion of a beach is to use the Vellinga (1983) method to determine a storm profile (based on the offshore wave height, storm surge level and sediment grain size). The method of determining these three variables and an interpretation of the application of the Vellinga method is given below.

Offshore Wave Height

At the site, Ella Bay faces on average east, with slightly south of east along the northern beaches of the site and slightly north of east along the southern beaches of the site. As such the beaches of the proposed site are exposed to waves from the north through east to the south.

Due to the presence of the Great Barrier Reef with its offshore shoals and islands wave energy from swells of the Coral Sea are being attenuated significantly and the short term erosion of the beach which will be dominated by short period, locally generated seas during ambient conditions and cyclonic waves during storm events. The most severe wave conditions are likely to be experienced during cyclones when associated elevated water levels (esp. storm surge) can increase the severity of the wave attack.

The nearest recorded wave heights are at the EPA station of Dunk Island which is located approximately 60 km to the south of Ella Bay. Analyses of wave data recorded at this station during the period from 1998 to 2002 are presented in (EPA, 2004).

The greatest significant wave height recorded at Dunk Island during the period from 1998 to 2002 is 3-3.2m. It is however noted that the nominal recording interval used for the wave data analysis is significantly smaller than a typical storm duration (nominal recording interval is 1 hour). Using the wave measurements for statistical estimates of extreme wave heights during design storm events without corrections for the difference in interval length tends to result in higher predictions for wave heights during extreme storm conditions. Furthermore, due to the presence of the Great Barrier Reef, wave heights in this region are likely to be fetch-limited during extreme cyclonic conditions.

Wave conditions during extreme cyclonic conditions were investigated by BMT WBM for the Cardwell Inundation Study (BMT WBM, 2007). For Wongaling Beach, the 1:100 year maximum significant cyclonic wave height is estimated to be 3.82m.

Given the relative proximity of Wongaling Beach to the proposed development site, the 1:100 year maximum significant cyclonic wave height for Ella Bay is considered to be similar to the wave height for Wongaling Beach. Therefore, a significant wave height of 4m is adopted for design wave conditions at Ella Bay.

Storm Surge Level

A storm tide level with an average return period of 100 years was adopted for design purposes. Such a level has a 40% probability of occurrence in the 50 year planning period.

The extreme storm surge levels have been obtained from Ocean Hazard Assessment Stage 3 report. The 1 in 100 year ARI storm surge (without wave setup) is 1.94mAHD at Flying Fish Point.

Using the surveyed beach profiles and an assumed foreshore slope of 1 in 100, the wave set-up for the design wave conditions was calculated to be up to 0.30m; in accordance with the adopted value supported by EPA).

Therefore the adopted total storm tide level at the beach (including Greenhouse and wave setup) is 2.24m AHD.

Beach Profiles

Surveys across the frontal dune, beach face and intertidal flats were carried in August 2007 at five sections across the site on a vertical datum of AHD. The survey plan is shown in Appendix A.

Sediment Size

Sediment samples were taken at a number of locations on the beach at the proposed site and sediment grain size was tested by sieve analyses. Sieve analyses test reports indicate that the median grain size of the beach material at the proposed development site is in the range from 0.5 mm to 0.8mm.

For the assessment of the erosion prone areas, a conservative D_{50} grain size of 0.5 mm has been adopted.

Short Term Erosion (C)

The method of Vellinga (1983) was used to determine the likely foreshore slope under storm conditions. The offshore wave height of 4.0m, storm tide level of 2.24m AHD and a D_{50} grain size of 0.5mm for the beach sediment were used to calculate the Vellinga equilibrium storm profile.

Figure 4.1 shows the surveyed cross-sections for August 2007 with the Vellinga equilibrium storm profile arranged to give a balance between erosion and accretion in the beach profile. The calculations indicate that a dune toe recession of about 11 to 19m may be experienced during a design storm condition. Allowing for multiple events in one year it is considered appropriate that 25m be allowed for short term erosion.

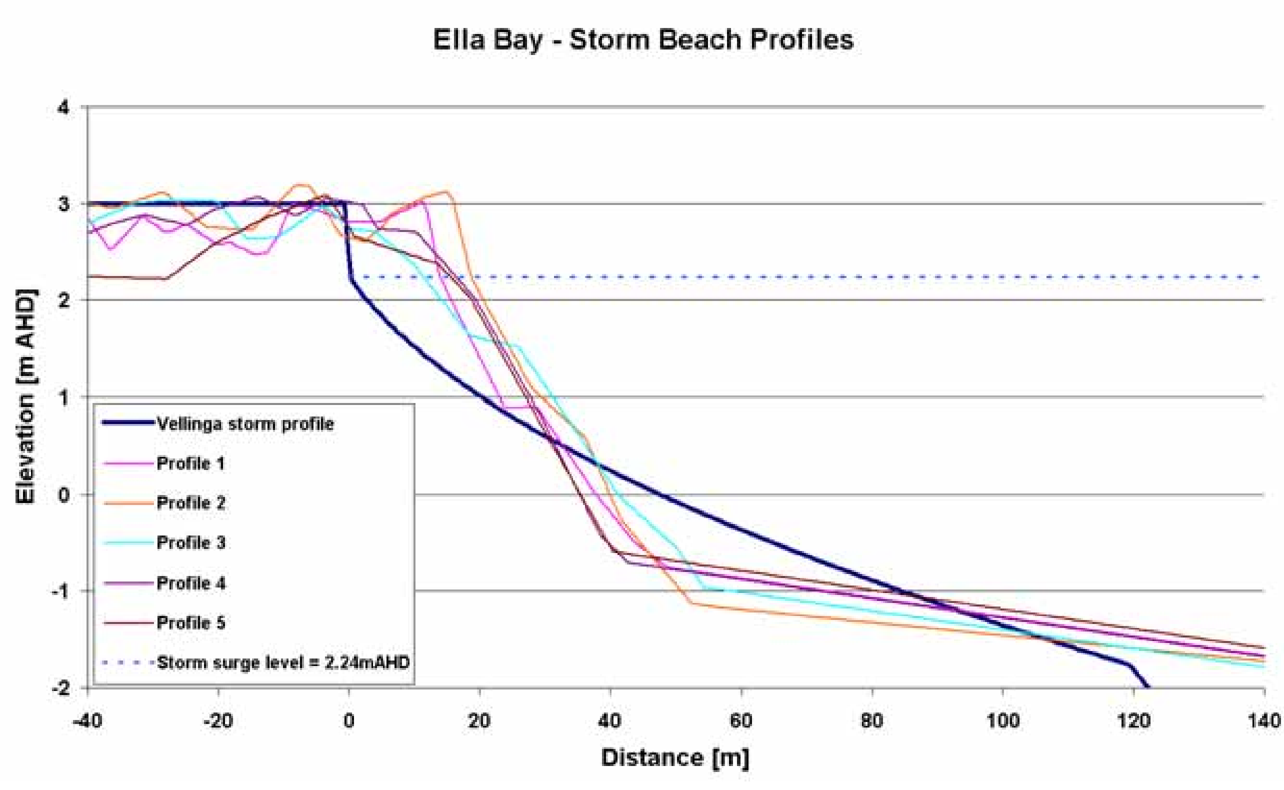

Figure 4-1 Vellinga Predicted Storm Profile

4.3 Erosion Due to Greenhouse Effect (G)

As described in Section 3.5 the Bruun rule is not an appropriate method for predicting shoreline recession due to sea level rise where the sand profile across the beach is sorted as in north Queensland. Therefore, calculations are made with both the Bruun and beach slope methods to derive a representative recession value.

The current value adopted by EPA for sea level rise related to the Greenhouse effect is 0.3m in 50 years. The impact of this increase has been assessed by both the Bruun method and beach slope method and these are given below. It should be noted that this takes into account sea level rise only and not the broader meteorological considerations such as increased storminess and changing wind/wave directions which are still poorly understood in the scientific community.

For the Bruun method it has been assumed that the depth of closure is 7m and the intertidal beach slope is 1:12 (from survey) and the dune height is 3.0m.

Therefore, the predicted recession = 0.3 * 7 * 12 / (7 + 3) = 2.5m.

For the beach slope method sea level rise of 0.3m at an upper beach slope of 1:12 (from survey) gives a recession value of 3.6m.

Therefore, based on the above analysis, it is considered appropriate to conservatively allow 5 metres for the future impacts of the predicted Greenhouse induced sea level rise.

4.4 Dune Scarp Component (D)

The erosion prone areas are specified as measured from the toe of the frontal dune. The short and long term erosion components provide a measure of the potential recession of the dune toe. The dune scarp component provides for the horizontal distance between the toe and the crest of the dune after slumping to a stable slope (about 1 in 3).

The dune scarps were inspected during a site visit in June 2007 and are believed to be associated with TC Larry. A typical dune scarp is shown in Figure 4-2.

Figure 4-2 Dune Scarps as present along the proposed site at June 2007

It is considered that under extreme conditions which may include several cyclones in one year that the erosion scarp could be up to 2m high. Therefore, it is considered appropriate to allow for a post-storm dune scarp component of 6m.

4.5 Standard Erosion Prone Area Width (E)

On the basis of the above components and the factor of safety as discussed in Section 2.6, the erosion prone area width has been determined as follows:

E = [(N x R) + C + G] x (1 + F) + D

where

E = (N x R) = 20m

C = 25m

G = 5m

F = 0.4

D = 6m

E = 76m

It is therefore recommended that an erosion prone area width of 80 metres be adopted for the open beach area away from the creek. The EPA width is measured from the seaward toe of the frontal dune, which is usually approximated by the vegetation line.

5 CREEK AREA EROSION PRONE AREA WIDTH CALCULATION

A creek flows eastwards to the beach in the middle of the proposed development site. Locations where watercourses flow out into sea are often morphologically active areas and potentially vulnerable to the effects of longshore drift causing the entrance to move and accelerated erosion during cyclones. Effects of severe cyclones may include permanent relocation of river/creek mouths.

In order to define the erosion prone area around the creek on the development site, the vulnerability of the tidal entrance has been analysed.

5.1 Historical Morphological Behaviour of the Creek Entrance

Historical aerial photographs of the area around the creek entrance from 1943, 1952, 1964, 1981, 1986 and 1996 were interpreted to assess the behaviour of the creek entrance over time.

The aerial photographs indicate that the alignment of the channel is more or less stable for the section upstream of the point were the creek reaches the beach and turns into northern direction behind the beach. However, the location where the creek cuts across the beach is subject to significant spatial variations from year to year and the entrance is frequently cut off from sea following periods of minor runoff in the creek. The closure of the creek entrance is due to infilling by longshore sand transport processes.

The outflow location of the creek may be located as far as 750m north from the point where the creek reaches the beach (in 1986), but is always located north of the point where the creek reaches the beach (due to the predominant wind and wave direction from a southerly direction). On aerial photographs where the entrance is open, sand lobes are observed on both sides of entrance.

The alignment of the creek behind the beach front is subject to some degree of fluctuation, with the landwards bank of the creek moving subsequently landwards and seawards over a distance in the order of 50 m (shoreline perpendicular) during the period from 1943 to 1996. The shoreline itself shows smaller fluctuations, resulting in alternately widening and narrowing of the beach near the entrance area. However, the historical photography shows no noticeable long term trend in the realignment pattern of the creek along the beach.

5.2 Erosion Prone Width Calculation for Creek Area

To define the erosion prone area around the creek, relevant erosion terms in the standard erosion prone area width calculation as presented in Section 4 were re-assessed for the area around the creek entrance.

5.2.1 Long-term Erosion Term for Creek Area

The historical photography shows no noticeable trend in the long-term shoreline evolution near the creek entrance. However, periodic realignment of the creek along the beach does occur and there is the potential for extreme events to produce an unfavourable combination of interrupted longshore sand supply and creek entrance breakout.

Based on these considerations, it is considered appropriate that 50m be applied as the long-term erosion component for the creek area.

5.2.2 Short-term Erosion Term for Creek Area

During severe cyclonic conditions, there is a potential that the complete beach in front of the creek is eroded and the landward bank of the creek is subject to wave attack. In such a situation, erosion may occur land inwards from the creek.

To assess short-term erosion component for the area around the creek, the likely storm beach profile under storm conditions was determined using the method of Vellinga (1983). For the Vellinga analysis, the storm conditions used were identical to the conditions used for the remaining sections of the shoreline (Refer to Section 4).

In the Vellinga calculation for the creek area, it is assumed that the beach front between the creek and the sea is completely eroded and a Vellinga-type beach profile is fully developed near the western embankment of the creek.

The predicted beach profile for a 1 in 100 year ARI storm event is shown in Figure 5-1. If the sand spit in front of the creek were completely eroded, there is a potential for a further 35 m retreat of the shoreline in a design storm event. Therefore, allowing for multiple events in one year, it is considered that an appropriate short-term erosion value for the Creek Area is 40m.

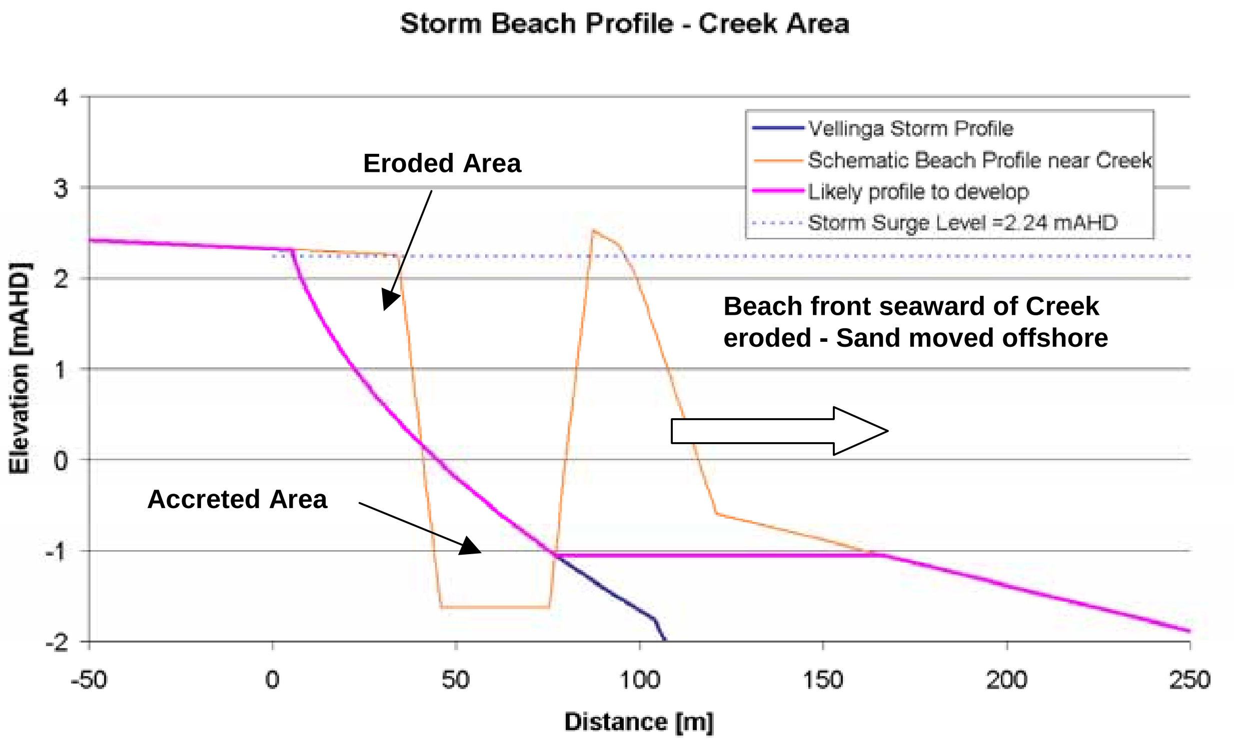

Figure 5-1 Vellinga Predicted Storm Profile at Creek

5.3 Erosion Prone Area Width for creek Area (E)

On the basis of the re-assessed components and the component as discussed in Section 4, the erosion prone area width for the creek area (taken from the western bank of the creek) has been determined as follows:

E = [(N x R) + C + G] x (1 + F) + D

where (N x R) = 50m

C = 40m

G = 5m

F = 0.4

D = 6m

E = 139m

It is therefore recommended that an erosion prone area width of 140 metres be adopted for the area around the creek entrance, measured landward from the western bank of the creek.

The EPA widths given on the original BPA plan are from the regional beach alignment and are relative to the seaward toe of the frontal dune, which generally would be aligned with vegetation to the north and south. Therefore, to be consistent with the widths indicated on the BPA plan the width will need to include the distance from the western bank of the creek to the regional line of vegetation to the north and south of the creek entrance area. For the proposed development site, this distance is approximately 60m, resulting in a total erosion prone area width of 200m.

The erosion prone area width of 200m is recommended for the shoreline area from the location where the creek reaches the beach to the northern extremity of the site, which is approximately the coastal zone between MGA Zone 55 coordinates [400 500, 8 069 730] and [400 600, 8 070 750].

6 OVERALL EROSION PRONE AREA

On the basis the results of the calculations in Sections 4 and 5, the Erosion Prone Area widths for the site have been assessed. It is recommended that the EPA width for the zone where the creek historically has had its entrance be reduced to 200 metres (measured from the regional alignment of the vegetation). For the remaining areas of low lying coastline at the site an EPA width of 80m or to bedrock, where bedrock occurs continuously above MHWS, is recommended..

For the tidal reach of the creek, the nominal erosion prone area of 40 m each side of the existing channel as required by EPA is considered appropriate.

The resulting erosion prone area widths for the proposed development site are presented in Figure 6-1.

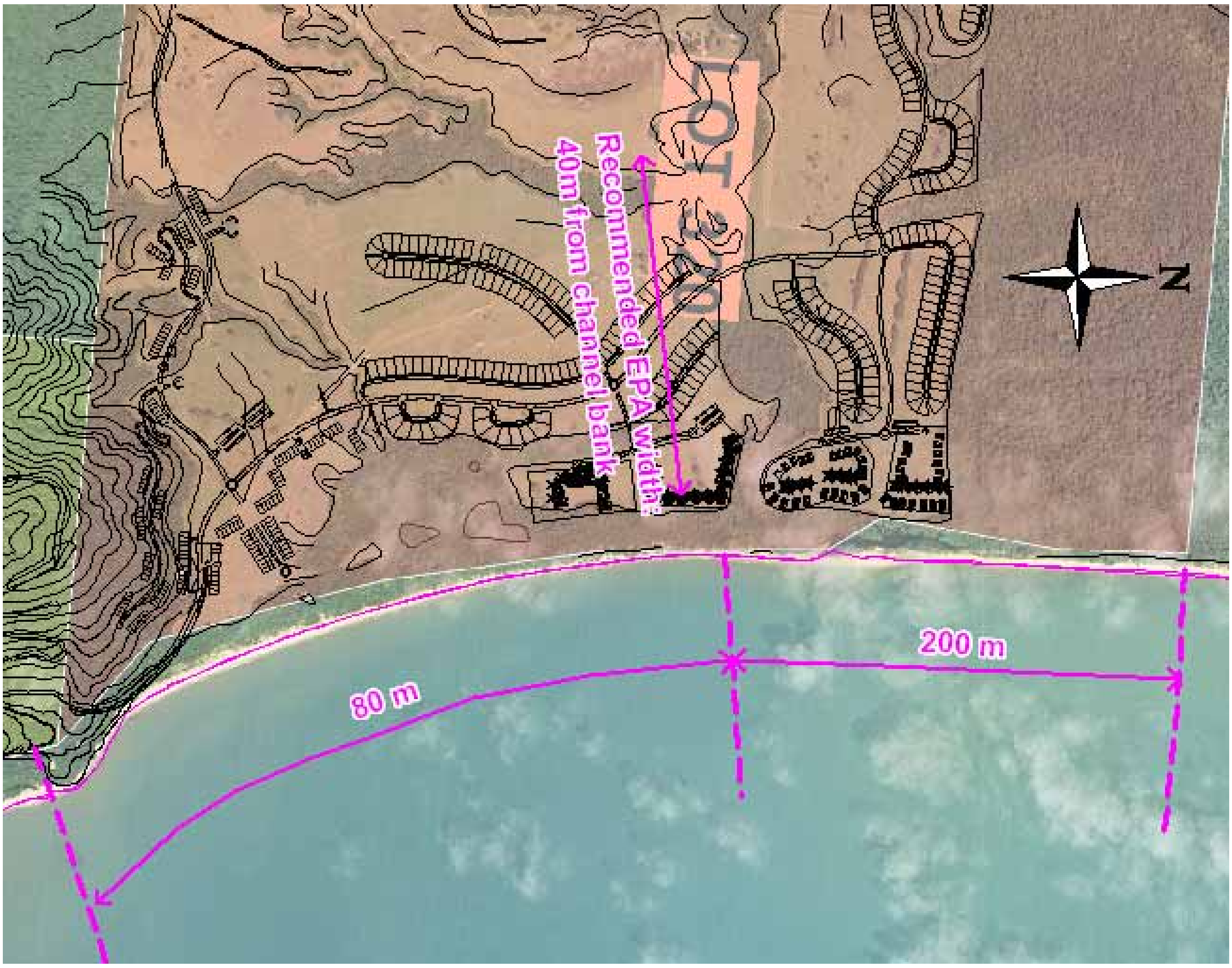

Figure 6-1 Erosion Prone Areas of Proposed Development Site

BMT WBM

7 RISK OF COASTAL INUNDATION

To assess the risk of the proposed development site to seawater inundation during cyclones, the potential extent of flooding for the 1 in 100 year ARI storm surge event has been determined. The assessment of the risk to coastal inundation has been undertaken on the basis of topographical survey data of the site that was provided C&B Surveyors. It is noted that the topographical survey does not cover the entire site.

7.1.1 Extreme storm tide level

The inundation extent is based on the 100yr ARI storm tide level with Greenhouse allowance and wave setup, but without wave runup.

Wave setup is an elevation of the mean (time-averaged) water surface due to the pumping effect of waves, while wave runup is the intermittent process of advancement and retreat of the instantaneous shoreline location of the water on a time-scale that is of the order of the incoming wave period (~10s). For this site, the wave runup is considered to be insignificant due to the attenuating effect of the wide zone of dense vegetation fronting the site.

The 100yr ARI storm tide level with Greenhouse allowance was derived from the Ocean Hazard Assessment Stage 3 report (JCU, 2004) and is given as 2.27mAHD.

For the design wave conditions the wave set-up was calculated to be approximately 0.30m and this agrees with the accepted value used by the Environment Protection Agency.

The 1 in 100yr ARI storm tide level with Greenhouse sea level rise allowance and wave setup for the proposed development site is estimated to be approximately 2.57mAHD.

7.1.2 Inundation extent

For this study, five surveyed beach profiles of the beach along the site were obtained. The surveyed beach profiles indicate that the 1 in 100yr ARI storm tide level remains below the level of the dune crests along the coastline.

The main flood mechanism for storm surge events is likely to be backup within the creek, causing seawater to spill out of bank and inundate areas behind the dunes that have elevations below the storm surge level.

Therefore, the inundation level for the proposed development site, based on the 1 in 100 year ARI storm tide level is considered to be 2.57mAHD.

The available survey data indicates that some proposed properties may be within the flood envelope of a 1 in 100 year ARI storm surge event. However more detailed assessment of the flood risk of the proposed development was not possible, as the coverage of the survey data was limited.

The actual extent of inundation and its impact on the proposed development will need to be assessed using survey that covers the entire potential flow path and has an appropriate accuracy. The impacts of this inundation on development may be mitigated by earthworks or building design.

8 CONCLUSIONS AND RECOMMENDATIONS

The Environment Protection Agency uses the original Erosion Prone Area Plans produced by the Beach Protection Authority to assess erosion risk for beachfront development. The Plan for Johnston Shire (SC 3394) is shown in Appendix C.

On the basis of a site-specific assessment of relevant coastal and ocean processes, the existing Erosion Prone Area Plan widths for Lot 320 on N157629 at Ella Bay have been reassessed. This has included calculations using the accepted BPA formula and includes an analysis of the open beach areas as well as the area influenced by the creek and its historical entrance behaviour.

Using the accepted BPA calculation procedure, for a 50 year planning timeframe and including long and short term erosion, sea level rise due to the Greenhouse effect and erosion scarp slumping, an erosion prone width of 200m has been calculated around the creek entrance and 80m for the remaining beach areas of the proposed development site.

It is therefore recommended that the Erosion Prone Area width for the beach zone around the creek entrance be reduced to 200m (measured from the regional alignment of the seaward toe of frontal dune). This width is recommended for the shoreline between the historical location of the most southerly creek entrance (MGA Zone 55 coordinate [400 500, 8 069 730]) to the northern boundary of the proposed development site. For the remaining low lying coastline of the proposed development site an Erosion Prone Area width of 80m or to bedrock, where bedrock occurs continuously above MHWS, is recommended.

The recommended Erosion Prone Area widths to be adopted are shown in Figure 6-1 and are defined as the distance from the seaward toe of the frontal dune or the edge of vegetation as stated in the Coastal Protection Act. The precise location of the Erosion Prone Areas of the Site will need to be determined on the site by a surveyor.

In addition, the assessment of the inundation risk of the site has indicated that the 1 in 100 year ARI coastal inundation level is RL 2.57mAHD. This is the actual predicted water level and has no allowance for freeboard. The actual extent of inundation and its impact on the proposed development will need to be checked by accurate survey. The impacts on development may be mitigated by earthworks or building design.

9 REFERENCES

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Vellinga, P. (1983). Predictive Computational Model for Beach and Dune Erosion during Storm Surges, Delft Hydraulics Laboratory, Publication 294, Delft, February 1983

APPENDIX A: BEACH PROFILE SURVEYS

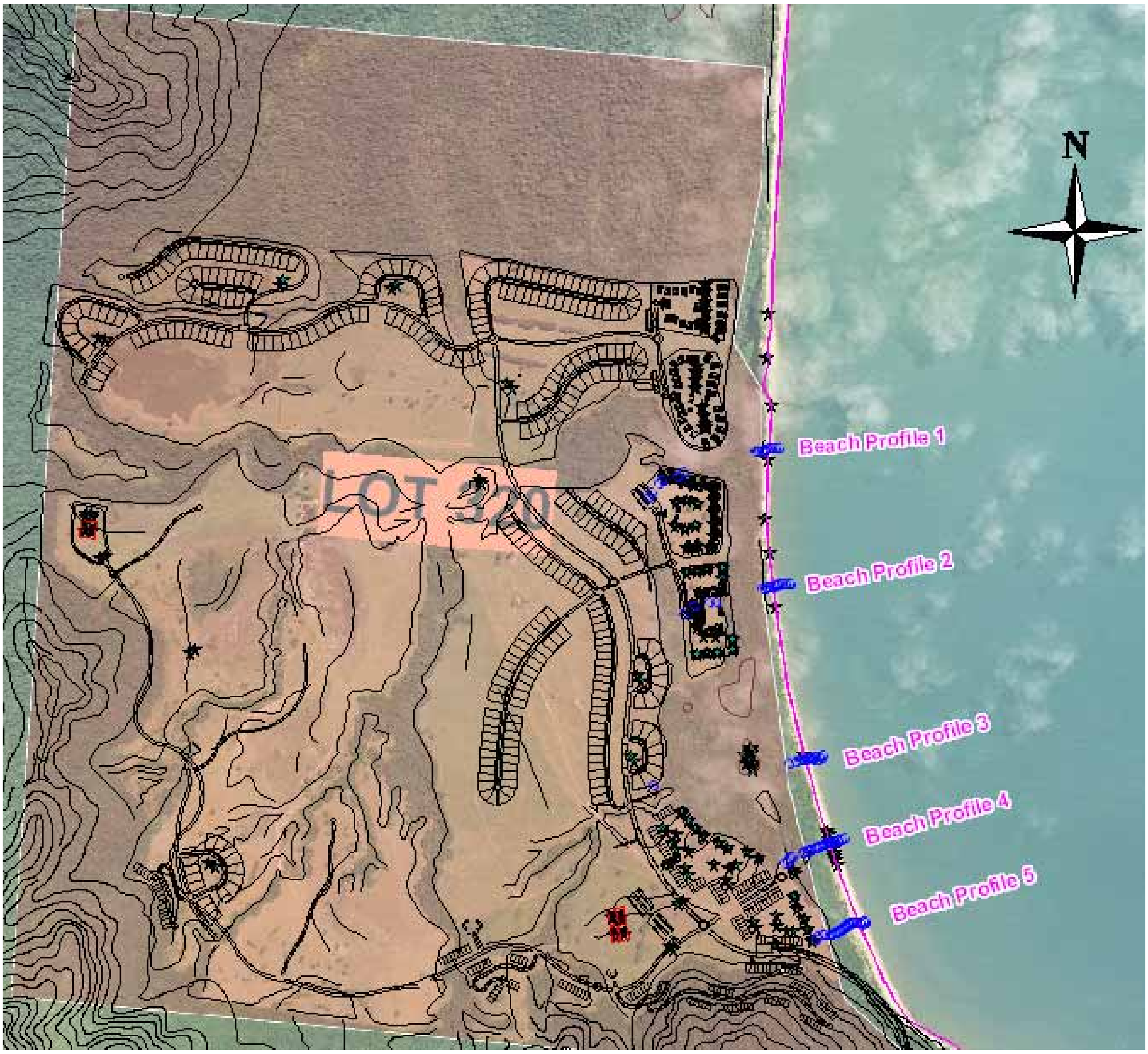


Figure A-1 Survey Locations of Beach Profiles

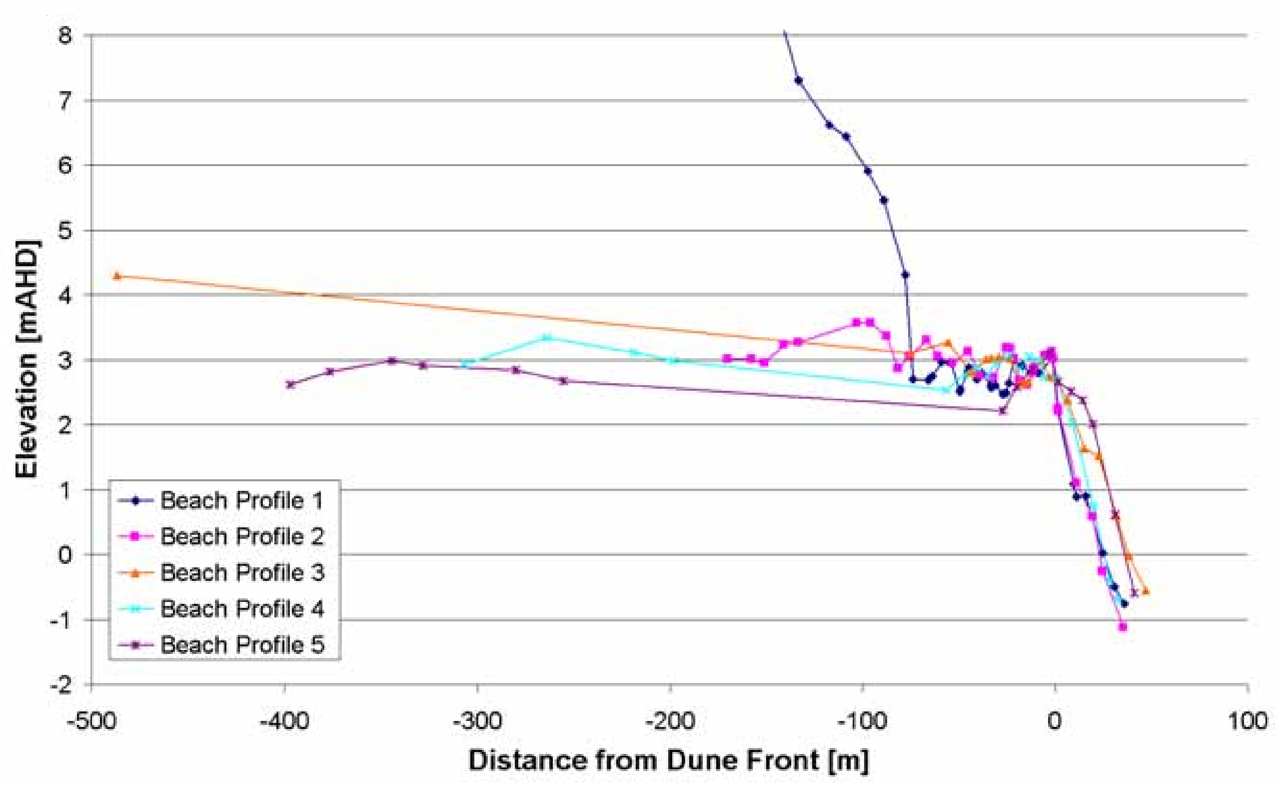


Figure A-2 Surveyed Beach Profiles at the Proposed Development Site

APPENDIX B: GROUND PHOTOGRAPHS – JUNE 2007

Figure B-1 Ella Bay From Heath Point

Figure B-2 Beach of the Proposed Development Site, Looking North

Figure B-3 Dune Scarps near Site

Figure B-4 Pioneer Vegetation on Beach Dune near Site

Figure B-5 Location where Creek approaches the Beach

Figure B-6 Creek Meandering at Proposed Development Site

APPENDIX C: EROSION PRONE AREA MAP BY BPA

LEGEND

County	BALURGA	Special & Informal Lease & Road Licence (temp closure)	S L : I L : R L
Parish	BULIMBA	Pastoral Holding & Forest Grazing Lease	H : F G L
Portion & Reserve Nos	7, R.7	Real Property Information Sub. 4, Resub. 4 : Section V : Lot. 2	
Area ... Approx 12 3 35 : Surveyed	12 3 35	Survey Office Plan No	Csh 1805
Freehold	F	Real Property Plan No	R P 107582
Leasehold L : 4 Specimen :	A Specimen	Trigonometrical Station	▲
Agricultural & Grazing Farm	A F . G F.	Astronomical Station	△
Grazing Homestead	G H	Post Office, Telephone Office, Post & Tel Office	P O
Grazing Homestead Freeholding Lease	G H F L.	State Bdy	
Prickly Pear Selection	P P S	Pastoral District Bdy	
Prickly Pear Development Selection	P D S	County : Parish	
Perpetual Lease Selection : Purchase Lease	P L S . Pur L	Holding & F G L	
Auction Perpetual Lease & Auct. Purchase F'hold	A P L : A P F	Past Dist & Holding	
Miner's Homestead & M H. Perpetual Lease	M H. : M H P L	County & Holding	
Non-competitive Lease & Soldier's Non-comp. Lease	N C L . S.N.C.L	Parish & Holding	
Settlement Farm Lease	S.F L	Mining Field	
Special Lease Purchase Freehold	S L P F	Irrigation Channel	
Permit to Occupy	Permit F 123	Irrigation Drain	
Block	ARCHER	Block	
Homesteads	■	Water Facilities	W F
Tanks ▫ Wells	○	Bores • Dams	

Notes

(1) The seaward boundary of the erosion prone area for all local authority area/s to which this plan relates shall be defined by the seaward limit of Queensland waters.

(2) On land adjacent to coastal waters the landward boundary of the erosion prone area shall be defined as:

(i) a line measured 40 metres landward of the plan position of the mean high water springs (MHWS) tide level except where approved revetments exist, in which case the line is measured 10 metres landward of the upper seaward edge of the revetment, irrespective of the presence of outcropping bedrock; or

(ii) a line located by the linear distance (in metres) specified on this plan measured, unless specified otherwise, inland from:

(a) the seaward toe of the frontal dune. (The seaward toe of the frontal dune is normally approximated on aerial photography by the seaward limit of terrestrial vegetation); or
(b) a straight line drawn across the mouth of a waterway between the alignment of the seaward toe of the frontal dune on either side of the mouth.

or (iii) the plan position of Highest Astronomical Tide (HAT);

whichever provides the greater erosion prone area width except:

(a) where the linear distance specified on this plan is less than 40 metres, in which case note (2)(i) does not apply, however notes (2)(ii) and (2)(iii) do apply;
(b) where outcropping bedrock is present and no approved revetments exist, in which case the line is defined as being coincident with the most seaward bedrock outcrop within these defined boundaries but not seaward of the line of HAT;
(c) in approved canals in which case the line of HAT applies, irrespective of the presence of approved revetments or outcropping bedrock.

(3) Erosion prone areas defined in accordance with the above are deemed to exist throughout all the local authority area/s to which this plan relates, irrespective of whether the entire local authority area is depicted on erosion prone area plans for the local authority.

(4) Coastal waters, as referred to in note (2), are defined to be Queensland waters to the limit of HAT.

✻ Indicates possible presence of outcropping bedrock

Erosion Prone Area Plans may be updated from time to time and a new revision created. Please check with the Environmental Protection Agency or the Local Government that this copy is the current revision prior to using the contained information in any way

F	Notes modified as per amendment adopted at BPA meeting March 7, meeting No. 195	9/7/03			
E	Width altered at Garners Beach. Approved at Authority meeting of 13/06/02.				Surveyor
D	Notes modified as per amendment adopted at BPA meeting on 30/11/95, and renumbered.				Date
C	Special Note A deleted and replaced with Special Note B. Approved at Authority Meeting of 9.6.94				Vessel
B	Special Note A approved at the Authority Meeting of 16.9.93				Ref B.M.
A	SPECIAL NOTE ADDED	24·04·89	KJJ		Field Books
	Revisions			Associated Drawings	

DEPARTMENT OF HARBOURS AND MARINE – QLD
BEACH PROTECTION AUTHORITY

Prepared	Checked	Submitted	Drawn	
Supervised		Recommended	Traced	PL
		Engineer to the Authority 27·12·84	Checked	

JOHNSTONE SHIRE
EROSION PRONE AREAS

Scale	Date	
1 : 100 000	4·12·1984	SC 3394 F

APPENDIX D: SEDIMENT SAMPLING REPORTS –AS1289.3.6.1

AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD (AGE)
UNIT 3, 17 EDITH STREET (PO BOX 788),
INNISFAIL QUEENSLAND 4860

Ph: (07) 4061 3103
Fax: (07) 4061 8094

CHAIN OF CUSTODY AND ANALYSIS REQUEST

DESPATCHED TO: Andrew Maddocks and Associates

ADDRESS: 15 Flying Fish Point Road
Innisfail Qld 4860

CONTACT: Howard Hughes

AGE JOB No. NE 137

PURCHASE ORDER No.

ANALYSIS REQUIRED:

PRELIMINARY RESULTS BY:

FINAL REPORT BY:

AGE CONTACT: Rob Lait

SAMPLE ID	LAB NO.	MATRIX: WATER	MATRIX: SOIL	MATRIX: EFFLUENT	MATRIX: OTHER	PRESERVATION METHOD: ICE	PRESERVATION METHOD: ACIDIFIED	PRESERVATION METHOD: OTHER	PRESERVATION METHOD: NONE	Standard sieve analysis									REMARKS:
Ella Bay Beach Northern			☑							☑									INS/68-1
Ella Bay Beach Central			☑							☑									INS/68-2
Ella Bay Beach Southern			☑							☑									INS/68-3

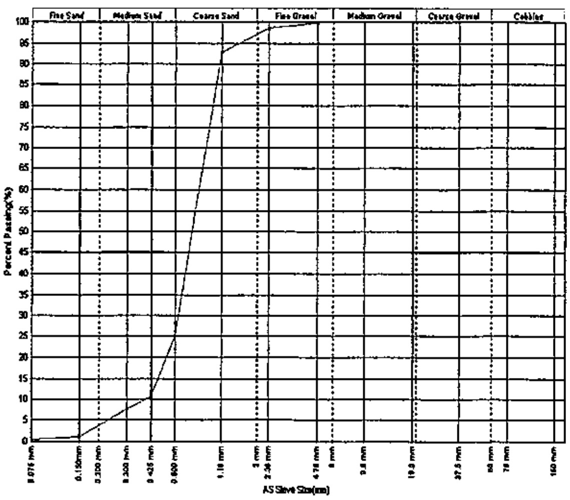
RELINQUISHED BY:	DATE/TIME	RECEIVED BY:	RELINQUISHED BY:	DATE/TIME	RECEIVED BY:
	24/08/07 1600				

MADDOCKS AND ASSOCIATES Pty Ltd
A.C.N. 060 526 481
15 Flying Fish Point Road,
INNISFAIL, Q. 4860
Ph 07 4061 7770, Fax 07 4061 7733

Quality of Materials Report

Client:	**Rob Lait AGE Consultants**	Report Number:	**INS/68 - 1**
Client Address:	**PO Box 788 Innisfail Qld 4860**		
Job Number:	**INS/68**	Report Date:	**28/08/2007**
Project:	**Material Complience Test** (Sand)	Order Number:	-
Location	**Ella Bay Beach , Innisfail**		**Page 1 of 1**
Lab No:	**362**	Sample Location	
Date Sampled:	**24/08/2007**	North	
Date Tested:	**24/08/2007**		
Sampled By:	**Client**		
Sample Method:	**Unknown**		
Material Source:	**Ella Bay Beach**	Spec Description:	-
For Use As:	-	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm		**100**	
2.36 mm		**99**	
1.18 mm		**93**	
0.600 mm		**25**	
0.425 mm		**11**	
0.300 mm		**8**	
0.150 mm		**1**	
0.075 mm		**0**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)			-	
Plastic Limit (%)			-	
Plasticity Index			**0**	
Linear Shrinkage (%)			-	

Form Number

REP ASQUAL-1-37

MADDOCKS AND ASSOCIATES Pty Ltd
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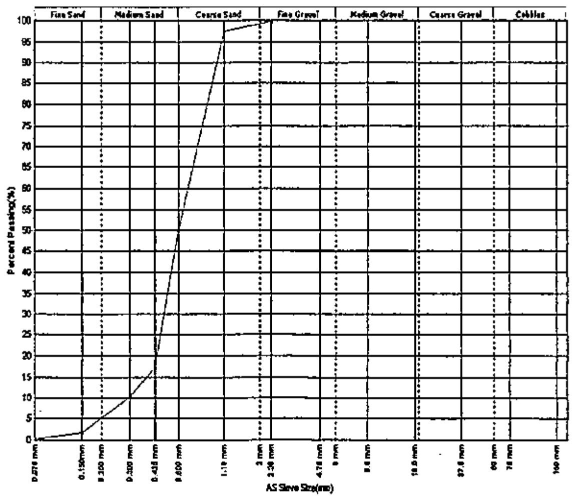
15 Flying Fish Point Road,
INNISFAIL, Q. 4860
Ph 07 4061 7770, Fax 07 4061 7733

Quality of Materials Report

Client:	**Rob Lait AGE Consultants**	Report Number:	**INS/68 - 2**
Client Address:	**PO Box 788 Innisfail Qld 4860**		
Job Number:	**INS/68**	Report Date:	**28/08/2007**
Project:	**Material Complience Test (Sand)**	Order Number:	-
Location	**Ella Bay Beach , Innisfail**	**Page 1 of 1**	
Lab No:	**363**	Sample Location	
Date Sampled:	**24/08/2007**	South	
Date Tested:	**24/08/2007**		
Sampled By:	**Client**		
Sample Method:	**Unknown**		
Material Source:	**Ella Bay Beach**	Spec Description:	-
For Use As:	-	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm			
2.36 mm		**100**	
1.18 mm		**97**	
0.600 mm		**50**	
0.425 mm		**17**	
0.300 mm		**10**	
0.150 mm		**2**	
0.075 mm		**0**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)			-	
Plastic Limit (%)			-	
Plasticity Index			**0**	
Linear Shrinkage (%)			-	

Form Number

REP ASQUAL-1-37

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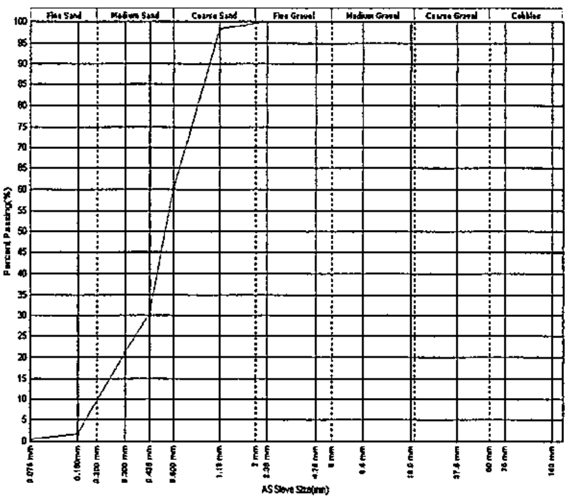
Quality of Materials Report

Client:	**Rob Lait AGE Consultants**	Report Number:	**INS/68 - 3**
Client Address:	**PO Box 788 Innisfail Qld 4860**		
Job Number:	**INS/68**	Report Date:	**28/08/2007**
Project:	**Material Compilence Test (Sand)**	Order Number:	-
Location	**Ella Bay Beach , Innisfail**	**Page 1 of 1**	
Lab No:	**364**	Sample Location	
Date Sampled:	**24/08/2007**	Central	
Date Tested:	**24/08/2007**		
Sampled By:	**Client**		
Sample Method:	**Unknown**		
Material Source:	**Ella Bay Beach**	Spec Description:	-
For Use As:	-	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
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53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm			
2.36 mm		**100**	
1.18 mm		**98**	
0.600 mm		**60**	
0.425 mm		**30**	
0.300 mm		**21**	
0.150 mm		**2**	
0.075 mm		**0**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)			-	
Plastic Limit (%)			-	
Plasticity Index			**0**	
Linear Shrinkage (%)			-	

	Approved Signatory	Form Number
		REP ASQUAL-1-37

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