Figure 10: Interpretted Movement of Sediment Slugs along the Northern and Western Sides of Repulse Bay (Source: Google Earth 2010 Image).

Note: Dotted lines indicate sand slugs. Arrows indicate direction of travel.

3.4.3.1 Transient Changes to the Coastline

Shoreline change can occur over a range of time scales, and within the life scale of a human it is difficult to distinguish between natural, transient fluctuations in the beach line, and actual coastal erosion. Short-term coastline changes are natural responses to the itinerant nature of the beach management system. These changes can take place over a period of days (e.g. windy weather), or over several months to years (e.g. changes from El Niño to La Niña weather patterns). Periods of "normal" weather are usually sufficient to replace the sand to the beaches. These short-term, itinerant, changes do not constitute coastal erosion. The beach fluctuates within an 'envelope of change'. This style of beach behaviour has been documented in a number of countries where beach position may fluctuate over distances of five to twenty metres over periods of several years.

3.4.3.2 Permanent Loss of Sediment from the Coastline

Coastal erosion, or beach erosion, is the permanent loss of sediments from along the shoreline and is observed as the landward movement of the shoreline vegetation. Nevertheless, this does not necessarily constitute a pattern of erosion that requires action. The normal pattern of beach progradation includes periods when the ambient conditions fluctuate, but where the net movement is one of beach progradation. The record of beach progradation at Midge Point clearly indicates periods of mass erosion at the western end of the beach while the eastern end shows a relatively stable movement towards the sea .

Coastal erosion associated with sea level rise takes place over many years. Coastal erosion associated with human activities, however, can be almost instantaneous, and will not restabilise without intervention.

3.5 BEACH SYSTEMS

3.5.1 BEACH DEVELOPMENT

Five components need to be satisfied before sediment can be deposited, and maintained as a beach, along a coastline:

1. Sediment Supply: Sufficient weathered and eroded material needs to be available for transport along the coastline. Along mainland coasts the majority of this sediment has to be made available to the marine environment via the fluvial system;
2. Long-shore Drift: Suspended sediments are carried in a stream of seawater that is pushed parallel to the coastline by the action of the dominant winds or currents in a process known as long-shore drift; and
3. On-shore Wave Transport: The redirection towards the coastline and subsequent deposition of sand on to the coastline by wave action. Redistribution of the deposited sediment and the shaping of the beach is an ongoing function of the complex interplay between tidal forcing, wave dynamics, near-shore morphology, coastal morphology and long-shore drift.
4. Coastline Geomorphology: The geomorphology of the receiving environment must be suited to the receipt and retention of sediments.
5. Sea level Stability.

3.5.2 BEACH CLASSIFICATION

The most common classification of beach systems in North Queensland is the tidally dominated beach. Tide dominated beaches typically form in areas where the range of the

spring tide is ten to fifty times greater than the average height of the breaker wave. Midge Point Beach is typical of this classification (

Tide dominated beaches are categorised as low high-tide beaches fronted by inter- to low-tide tidal flats. Mean wave height is around 0.16m and the tidal range approximately 5m (Short 2012).

Tide dominated beaches usually have a small, steep, reflective, coarse-grained high tide beach, fronted by intertidal sand flats around 500m wide. Tidal energy is sufficiently high for the tidal currents to imprint themselves on the tidal flats. In some locations mangroves colonise the upper intertidal zone (Figure 11). Many of the intertidal zones grade from inner sand flats to outer mud flats, with the sand averaging 300m wide and the mud extending out on average to 500 m (Short 2012).

In areas where the tidal range is closer to 8m or greater, and the beach is near a river mouth that can supply mud sized particles to the shoreline, the beaches often form as tidal mud flats. In these instances, the high tide beach is usually narrow, grading abruptly into wide, low gradient intertidal mud flats. Mangroves usually colonise the upper intertidal zone (Short 2012).

The dominant features of the Midge Point beach are those of a tide dominated beach, fitting between tidal sand flats and tidal mud flats (Figure 12). This mixed category is typical of a tide dominated beach that is also affected by high energy events while receiving sediments from two sources (the sand sized sediments of the eastern shores of Repulse Bay, and the mud sized sediments from the Pioneer and O'Connell Rivers and Dempster Creek).

Figure 11: A typical tide dominated beach (Far Beach, Mackay, Queensland). Source: Short 2012. Photo: A D Short 2012.

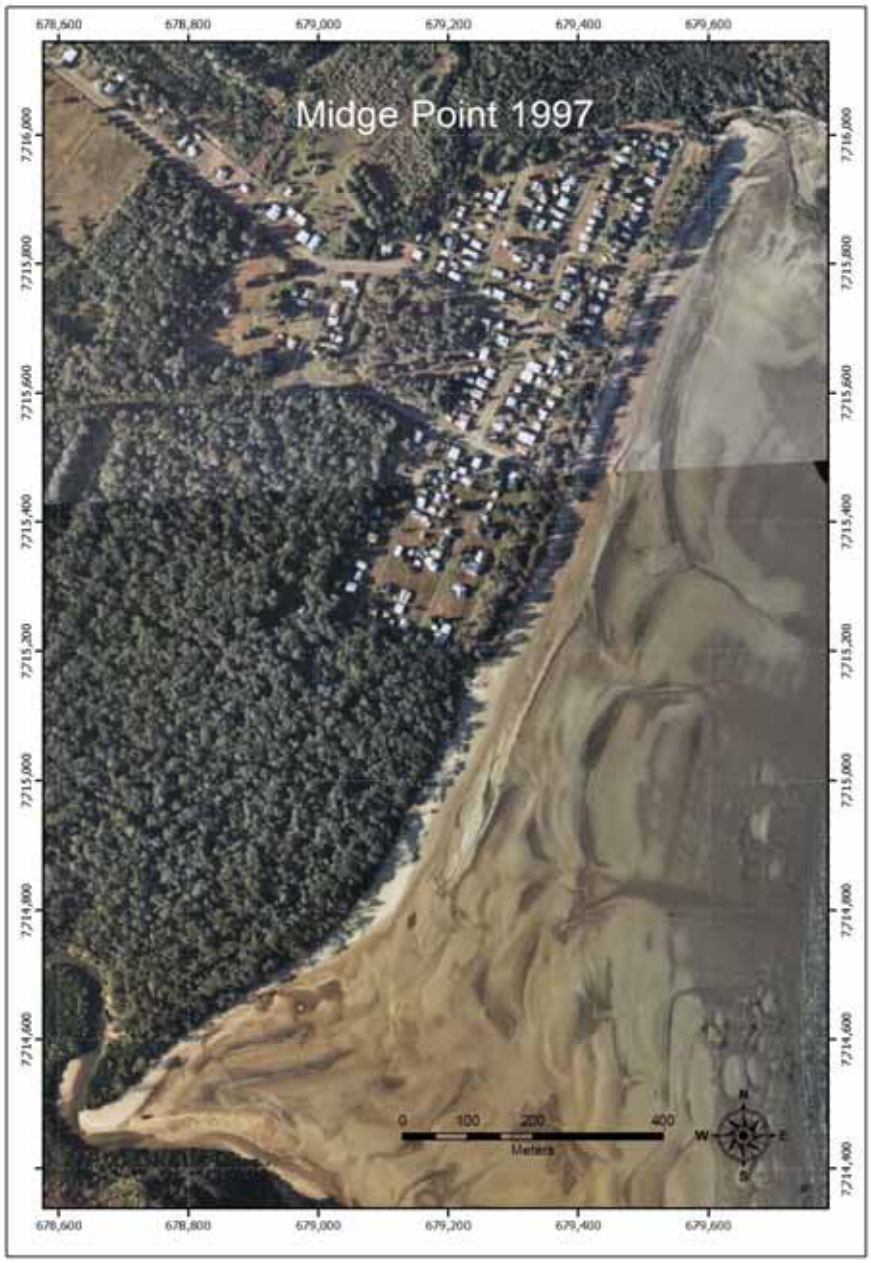


Figure 12: Aerial Photograph of Midge Point showing features consistent with a Tide Dominated Beach

3.5.3 BEACH DYNAMICS

While the 'beach' may appear to be stable over a period of years, the sediments that make up the beach are highly mobile, changing positions within the concept of the 'beach' as a response to each wave, tide, wind, or human action. The majority of these positional changes go unnoticed, but even within short geological time scales beaches are not stable and will change position and nature in response to a myriad of actions, including global geological changes and the rise and fall of the level of the sea.

Sediment mobilisation begins with the weathering process of the hills and mountains. The movement of that weathered material requires a force of complementary strength to transfer it from the land to the sea. That force is predominantly provided by rainfall, overland flow, and river discharge into the ocean. In the seasonally arid tropics rainfall is strongly seasonal. Hence, the movement of the weathered material through river and stream channels is also strongly seasonal. Therefore, the movement of the weathered material is strongly dependent on the size and weight of the individual weathered particles, and the flow velocity and periodicity of the river systems.

While the seasonality of supply is controlled by the ability of the river to move the sediment, the removal and transfer of the sediment through the marine system is a response to tidally induced currents and waves, with the continuum only interrupted by climatic variabilities that may not be in concert with terrestrial events. Thus, wave action and tidally and/or wave induced currents may remain independent of fluvial flows and continue to remove and transfer sediment away from any given point with the only major influence on transfer being the ratio between grain size and energy exhorted. Regardless of whether new sediment is made available to the coastline (e.g. not during long periods of drought), the energy of the operative marine forces will continue to exert energy on previous depositions. These forces will transfer sediment from Point A to Point B as long as sediment is available for transfer under the physical conditions operating at any particular time. The result will be visible as erosion of the sediment supply.

The dominant processes responsible for moving sediments along a coastline (waves and currents) can be divided into six individual processes, three associated with wave action and three with the influence of currents:

- Wave action associated with the ebb and flow of tides (tide driven waves),
- Wave action associated with localised winds (wind driven waves),
- Wave action associated with high energy wind events (cyclones and storms),
- Entrainment by tidally induced currents,
- Entrainment by currents induced by trade winds, and
- Entrainment by currents induced by oceanic circulatory systems.

Inside the Great Barrier Reef lagoon the strength and persistence of the south-easterly trade winds forces sediment along the Queensland coast in a north-westerly direction (i.e. parallel to the coast). During the short winter period when the south-easterly trade winds weaken, the dominant wind direction is from the north-east. During this period, which coincides with the extended North Queensland dry season when the majority of the streams cease to flow, sediment movement along a beach reverses, clogging the mouth of the ephemeral streams. Sediments are subsequently cleared from their temporary storage area by renewed river and stream flow, and then return during the summer period of the south-easterly trade winds.

Hence, sediment movement through the marine waters is neither linear nor consistent. Each sand grain becomes loosely associated with a sediment body that is transferred in a series of stop start motions that is driven by the action of the processes associated with the physical parameters of the marine system. Some of the sands pushed on to the shore by the forward moving action of the waves are dragged back again by the less powerful action

of the receding wave. Waves seldom impact a beach at a 90° angle. Tide driven waves push onto the coast from an angle that is dependent on a number of factors including location in relation to the amphidromic node, the presence of islands and reefs, the morphology of the sea bed, and the strength of the currents adjacent to the coast.

Waves and currents, both tidal and wind driven, are refracted (bent) as they enter shallow waters and/or pass around headlands and islands. One impact of this is the alteration of the direction of the longshore current. The second is the zigzag movement enforced on the sediment grains as they are pushed up the beach at the angle of the incoming wave and dragged down by the less powerful receding wave. The combined movement creates a zigzag pattern of sand deposition and entrainment along the shoreline. The current created by the movement of the waves hitting the coastline at an oblique angle enhances the movement of the sediment grains along the beach.

The processes described above are the "normal" long-term conditions under which beach dynamics operate in North Queensland. However, the majority of the work in transferring sediment from land to the sea, and subsequently along the shoreline, is done by the periodical occurrence of high energy events. High energy events (cyclones and storms and the rains associated with these events) move large quantities of sediment through the river systems to offshore storage areas for redirection back to the beaches by the "normal" processes of the waves and currents.

3.5.4 BEACH MORPHOLOGY

How and where the sediments are deposited is a function of:

(a) the size of the available sediment grains,
(b) the energy of the waves at any location, and
(c) the strength and direction of the oceanic and tidal currents.

Depositional features indicate the directional movement of the longshore drift in any area, with sediment accumulating on the updrift side of a barrier (e.g. headlands, groynes or breakwaters) and eroding on the downdrift side of the barrier.

Sediment grains are also moved onto and off the beach by the action of the waves, tides and currents. High energy waves push higher up the beach face, dragging the individual sand grains off the face of the beach for deposition as submerged offshore sand bars. Lower energy waves move the sand back towards the beach. During periods when wave energy is sufficient, the sand is pushed up the face of the beach and deposited as a berm along the top of the beach outside the reach of normal waves and tides. Waves of lower energy push the waves partially up the face of the beach before the wave collapses, partially dragging the sand grains back down the face of the beach.

Longshore drift works with the waves to create a zigzag movement of grains along the wave path. Hence, the sediment is moved along the front of the beach in a zigzag movement that creates a distinct grainsize depositional pattern along the length of the beach.

The morphology of the beach, therefore, reflects the interaction between:

- Wave height, length and direction,
- Current direction and velocity,
- Sediment characteristics and availability, and
- Location and size of natural and/or constructed formations adjacent to the marine/terrestrial interface.

The normal morphological shape of the beach can be interrupted at any time by any change in any of the parameters listed above, including changes in wind direction, velocity, or duration, as well as the man made construction of groynes, jetties, boat channels, or the manipulation of river flow. The life span of the altered morphology will last only slightly

longer than the alteration responsible for the interruption. For example, once the abnormal event passes, the waves and currents will return to normal, the sediments will be returned to the beaches, and the beach profile will be realigned in accordance with the dominant action of the waves and currents.

The dynamics and shape of the beach are largely dependent on the ability of the sediments to be moved through the water column by the energy of the waves, the tides and the currents. The finer sands are more easily moved by the action of the waves and tides and tend to produce low gradient swash zones with a wide surf zone. Medium to coarse grained sands are less mobile and form steeper gradients with a narrower surf zone. This grain size variation translates to different beach formations even if the action of the waves and/or the tides, is identical. Therefore, fine, medium or coarse grained sediment accumulations will produce three very different types of beaches even if all other factors are equal (Short 2005). Conversely, different wave energies arriving at identical accumulations of fine, medium, or coarse grained sediment will also produce different beach types. And of most significance to the formation of the Midge Point beach, different wave trajectories and different wave energies will interrupt the normal dynamics of the beach to create or reshape what is considered the "normal" alignment.

The development of most beach formations along the Queensland coast is generally accepted as beginning around 6,500ybp when the melting of the ice sheets had more or less stabilised (Hopley 1982). Along the Australian Coastal Shelf it is also believed that around 4,000ybp modern sea level was approximately 2m higher than the present level (Hopley 1982), prior to falling to its current level approximately 3,000ybp While the timing and height of historic sea level fluctuations are constantly being refined, it is generally accepted that around 18,000ybp the sea level was around 140m lower than its current height. During this period the high islands (e.g. the Whitsunday Group) would have been merely hills and hillocks on the coastal plains. As sea levels reached a high point (approximately 2m higher than current level) around 4,000ybp, many of the coastal hills would have been islands similar to those now seen off shore. Declining sea levels are accompanied by a progradation of the coastline, creating a series of beach ridges and dunes from the newly deposited and reworked sediments in the wake of the receding waters. The remnants of these dunes are retained on the current landscape.

3.5.5 BEACH STABILISATION

Beaches are constantly changing landscapes, responding to changes in sea level, wave conditions, tidal conditions, sediment supply and sediment export. Natural maintenance of a beach profile relies on the geomorphology of the coastline and a precarious balance between sediment supply and the energy and direction of the wind, the waves, and the currents to push the sediments on to and along the coastline in the direction of the dominant wind and/or tidal current dependent on the dominance of either at any particular time. All natural ecosystems are dynamic, varying in response to natural changes in the weather and climate and any modifications caused by those alterations. When any one parameter is removed, or altered, the remaining parameters respond rapidly to the change in an attempt to achieve a new equilibrium. The face of the new equilibrium will differ from the original and will only present as a problem when the new status threatens the needs of an established community.

One essential concept of beach stability is the trapping efficiency of the coast line, an indication of the amount of sediment that could become trapped in the bay. For example, an area with a trapping efficiency of 10% would (in the long-term) trap 10% of the sediment introduced into the bay itself, allowing transfer of the remaining 90% down-drift along the coast. Therefore, if the trapping efficiency of a bay is too low, sand deposition along the coastline is unlikely to occur. Similarly, if the trapping efficiency of a bay is low, and the source of sediment supply is removed, erosion of previously deposited material may occur, possibly resulting in the landward migration of the beach and the reconfiguration of the assemblage of sedimentary facies inherent in any bay system.

The inference from the above is that beaches rely on the availability of new material to replace material lost to the system as part of the dynamic processes listed above (Section 3.5.6 Beach Erosion). Under natural conditions, sand removed from beaches by wave energy is temporarily stored off-shore and supplemented by the transport of material from the creeks and rivers, maintaining a more or less steady supply of material to rebuild the beach profile when weather and climatic conditions are favourable. When the ability to deliver new material is removed, the off-shore storage bank is quickly depleted and can then only rely on material taken from the beaches during high energy events. In most instances this transitional sand, held temporarily in off-shore storage banks, is moved away from the area by the normal processes of long-shore transport. Interruption of supply is predominantly controlled by two factors:

1. Anthropogenic interference (e.g. construction of dams, weirs, groynes, harbours, etc.), and/or
2. Climatic variability (e.g. long periods of below average rainfall when movement of sediment through the river systems is diminished).

A third factor that is not covered by the interruption of supply is long-term climatic variability and the impact this has on sea level and consequently on the location of the coastline. An accreting coastline follows a fall in sea level. An eroding coastline accompanies a rise in sea level. In populated areas the initial representation of an eroding coastline is noticed as a change in beach formation at popular locations.

However, it must be remembered that while beaches may appear stable to the casual observer, they are, in fact, constantly changing, both in the short-term and in the long-term, as a response to a myriad of variabilities, both natural and man induced.

Anything and everything will influence the shape of the beach profile. In most instances the change is crucial to beach renewal and great care needs to be exercised before any attempt is made to modify a perceived change. The highly mobile environment of the beach sediments means that any attempt at 'rectifying' a perceived change will induce a change in some other area along the beach profile. Similarly, if a perceived change can be attributed to a specific incident, all attempts at remediation must be addressed to that incident. If the change is of sufficient distress to the local population, it is imperative that the local population understands that any modification designed to rectify the distress will have consequent impacts in some other location, and that these implications must be taken into account when assessing the implementation of a Shoreline Erosion Management Plan.

Intervention for any reason will not produce a permanent solution to the problem and continual intervention will be essential. Consequently, infrastructure designed to change the balance of processes occurring on a beach can only do so for a limited time before failing or not being applicable to the changed conditions. Subsequently mitigation measures to minimise erosion at Midge Point must be designed and implemented with a certain lifetime in mind. This is known as "The Asset Life".

3.5.6 BEACH EROSION

While the causes of erosion are many, they can be divided into those that are natural and those promoted by human actions.

3.5.6.1 Natural Causes of Erosion

- Changes in wave climate such as an increase in wave height, change in the angle of wave approach or increased frequency of high magnitude waves. These changes influence the amount of energy able to affect the shoreline and can alter the main direction of sediment transport.
- Reduction in the amount of sediment delivered to the coast from river catchments.

- Rising sea level may increase water levels and allow greater wave energy to erode the shoreline. It is commonly asserted that under rising sea level, sand is removed from beaches and transported offshore (NTFA n.d).

Sea level rise is currently considered the most likely cause of beach erosion and shoreline retreat. However, coastal erosion as a response to sea level rise has not been detected in Australia (Smith 2010). The main reason for this is considered to be the wide availability of sand in the coastal shore face (the area seaward of the foreshore and to a distance beyond where the wave breaks) (Smith 2010). To date the most common experience of acute coastal erosion in Australia has been linked to transient erosion due to storm events involving large waves and abnormally high water levels, especially when storm surges coincide with spring tides (Smith 2010).

Hence, while a rising sea level associated with the effects of Global Warming (or Climate Change) may be a problem, it is probable that climatic variability associated with a changing climate and consequent changes in wind/wave regimes, may be of greater significance for coastal erosion. On a less dramatic scale, the inter-annual changes in weather patterns associated with ENSO events can alter the wind, wave and sea level patterns of coastlines.

Air over the Pacific Ocean generally circulates in a regular pattern. Hot, moist air rises over the wet, tropical Indonesian region and then travels eastwards at a height of about 10-15 kilometres. As it moves it cools and dries out, and finally it descends as cool, dry air near the Pacific coast of Peru. Consequently, this part of South America will be dry (La Niña). At the Earth's surface, the winds move back towards the western Pacific (from east to west) to complete the circulation of air over the Pacific Ocean (i.e. the Walker Circulation).

As the surface winds blow, they drag some of the surface waters of the ocean along with them. The result is that during La Niña events the sea level on the western side of the Pacific Ocean (the Australian side) is slightly higher than the eastern (South American) side. The difference is slight (less than a metre) but it can be detected. When the Walker circulation breaks down, the reverse occurs (El Niño), sea level is higher on the eastern side of the Pacific Ocean (the South American side).

The warm waters building up against the continental coast line cause additional changes to sea level. As sea surface temperatures rise, the waters expand (rather like heating water in a saucepan), adding an additional rise to the waters pushed against the coast line by the action of the winds. The warm air rises, reducing pressure on the water surface (low pressure system) and adding yet another facet to the potential for increased sea level in the relevant section of the Pacific Ocean.

Thus, alternation between El Niño and La Niña events causes changes in wind direction. Water levels along coastlines by can vary by ±500mm depending on the drag effect of the winds, and the pressure associated with the event. Under such conditions wind driven waves coming in from a different angle can remove sand from beaches not usually confronted by such activity.

Pressure systems vary according to heat exchange capacity between the ocean and the atmosphere. El Niño associated changes (i.e. the build-up or decline of warm waters along the coastline) create their own pressure cells above the water mass. In the southern Hemisphere, wind circulation associated with low pressure systems is clockwise and anti-clockwise when associated with a high pressure system. The cells created by ENSO events along a coast line may be small, and embedded within the general circulation, but their impact on local beaches could be huge. While this may appear irrelevant, climatic predictions indicate that variabilities in the normal expectations of ENSO activity could increase. Should this be the case, coastlines and beaches adapted to one cycle of activity interspersed with short periods of irregularity, could find the period of irregularity greatly increased, exposing vulnerable beaches to abnormal periods of erosion.

The net result is that waters can reach considerably further up beach during a period when La Niña is dominant. If coastal waters are warmer than usual, and a low pressure system sits above the area, it is probable that sea level could increase by >80cm. In coastal areas where the back beach area is flat, the inland distance covered by this 80cm rise would be considerable.

3.5.7 HUMAN INDUCED CAUSES OF EROSION

A wide range of human activities can promote erosion by altering wave and tide processes and/or the supply of sediment to the coast:

- Sand extraction;
- Construction of breakwaters and groynes that can interfere with the movement of sediment through the system;
- Construction of dams and weirs in river systems that restrict sediment transport to the marine environment;
- Construction of concrete aprons that alter tidal circulation and wave processes along the shoreline and change sediment transport patterns;
- Removal of mangroves, and the exposure of low energy shorelines to increased energy and reduced sediment stability.
- Dredging of channels to increase water depths and boat access at the shoreline that change wave energy and actor as funnels for the rapid removal of beach sediment with the outgoing tide.

The effects of sea level rise as a response to atmospheric increases in CO_2 receive considerable attention. Sea level rise as a response to changes in oceanic circulation (the El Niño effect) is similar to the rises associated with the phenomena known as global warming. However, the fluctuations caused by variations in atmospheric/oceanic circulation will continue regardless of whether climate change (the predominant driver of global warming) continues or not. Therefore, the fluttering rise and fall of waters along the coast line induced by atmospheric/oceanic circulatory patterns, sits on top of any effects global warming may have on the general height of the ocean.

It is this complex interplay of winds, waves, ocean currents, eddies and tides that entrain and transfer the sediments that shape and reshape the coastline. At any point in time the coastline will reflect the dominance of any of the above actions. At Midge Point the high tidal range exaggerates these dynamics in comparison to areas of lower tidal variability, and if the high tide coincides with any of the other functions responsible for the placement or removal of sand along the shoreline, the exaggeration is increased. Hence, the "current" shoreline represents little more than a single snapshot in time.

The above transfer pattern infers that during periods of low flow, sand availability to the beaches from the creeks and rivers entering Repulse Bay will be limited. If the period of reduced flow is extended to years (i.e. during cyclical periods of reduced rainfall), the beaches will be forced into an erosional phase as sediment transfer along the coastline outcompetes the supply of new sand. However, it must not be presumed that the formation of extensive wetlands at the mouth of a river system act to starve the beaches of sediment. In contrast, it is essential to the maintenance of a sediment store for future recycling.

4 METHODOLOGY

4.1 LITERATURE REVIEW

To the best of C&Rs knowledge, all available literature was sourced and reviewed. While very little information directly relates to Midge Point, considerable information is available for the wider terrestrial and marine areas that can be used to gain an understanding of the dynamics controlling the Midge Point area. The knowledge gained from the literature review was used in conjunction with the acquisition of physical data and modelled interpretation of the processes operating within Repulse Bay, which, when synthesised, verify the specific features of Midge Point.

4.2 DATA ACQUISITION

4.2.1 COMMUNITY CONSULTATION

All methods used to gain knowledge of variability over time carry an element of uncertainty. Historic records extracted using sequential aerial photographs can only provide a snapshot in time, regardless of the quality of the photography.

Geomorphological interpretation of deposited sedimentary sequences can provide a longer record, but can be muddied by anthropogenic disturbance, or advents unknown to the geomorphologist.

Collection of physical properties impacting on an area can seldom be extended beyond days or weeks for a very short period of any year, and hence can also only be regarded as specific to the time of collection.

Community knowledge provides a more complete record for a short period of time, but can often be blurred by interpretation, retelling of the story, or the purpose for the telling. Nevertheless, used in conjunction with the three scientifically acceptable means of assessing change, community knowledge is invaluable for filling in the gaps and uncertainties in a data set. For example, community knowledge can provide localised temporal and physical information that is lost from the generic record of events.

The Midge Point local community was consulted specifically to gain in-sight into the response of the beach to manipulation by tides, winds, waves, currents and floods under both normal and high energy situations. No individual statements were forthcoming and all information was relayed during open meetings. The general consensus from the community was:

- Considerable change in sand distribution in the inter-tidal zone;
- Significant loss of sand and shoreline vegetation at the southern end of the beach;
- Loss of beachfront along the northern end of the beach; and
- Creation of an undercut back-beach scarp at the northern end of the beach.

Information gathered from the local community was evaluated in accordance with the interpreted geomorphological history of the area, the records retrieved from historic aerial photographs, and the field based measurements undertaken in the marine and terrestrial environments.

4.2.2 GEOMORPHOLOGICAL ASSESSMENT

A full geomorphological assessment of the Midge Point area and the surrounding region was undertaken as a method of determining the natural processes applicable to the area, and subsequently to evaluate whether the erosion noted at Midge Point could be attributed to anthropogenic influences both at the site and/or at distance from the site. Climatic variabilities were considered as well as any other natural variabilities that may be attributed to the noted variances in coastal dynamics.

All literature relevant to the area was gathered, together with supplementary literature relevant to the processes of coastal erosion in similar geomorphological and/or climatic settings.

The site was visited on a number of occasions to ground-truth statements made by the local community. Site visits were also undertaken during periods of storm activity to witness the patterns of wave action and sediment removal and deposition during high energy conditions. Site visits undertaken during periods of storm activity were also used to ground-truth equipment deployed to study wave action and tidal movement offshore from Midge Point.

The Geomorphological Assessment was found to be of significant consequence to the coastal dynamics of Midge Point.

4.2.3 BEACH MORPHOLOGY

The beach length and profile were surveyed using Real-Time Kinematic GPS (RTK GPS). Transects were taken along the terrestrial length of the Midge Point Beach every 20m. This survey also extended offshore, using a boat, depth stick and RTK GPS, with the accuracy of this section of the survey at approximately $\pm$ 300mm.

The offshore and beach RTK GPS surveys were compiled in conjunction with Acoustic Doppler Current Profiler (ADCP) data from offshore surveys to create a digital elevation model of the Midge Point coastline.

These field-based studies were referred back to morphological sequences extracted from the literature review, photographic interpretation, geomorphological evaluation of the entire site and its hinterland, ground-truthing during the event, local resident information, and subsequently compared to 2010 LIDAR data acquired through Mackay Regional Council.

4.2.4 HISTORIC AERIAL PHOTOGRAPHY

Assessment of historic aerial photography is commonly used to trace changes to beach profiles and vegetation patterns. Geographic Information Systems (GIS) allow historical aerial photographs of differing scales to be over-laid and alterations and changes to various features identified. Using this technique with historical aerial photographs obtained from DERM, the historical changes in vegetation have been traced along the Midge Point Beach between the eastern most headland and Yard Creek.

Available aerial photographs were obtained and evaluated for:

(a) Geomorphological development of the Midge Point region over time;

(b) Recent (last 50 years) changes in shoreline location;

(c) Wave patterns controlling sediment movement along the near shore zone;

(d) Hydrodynamic movement of oceanic waters into the near shore zone;

(e) The morphological definition attributed to the shoreline, beach system, and the intertidal zones;

(f) Historical hinterland changes in the Midge Point region and throughout the wider landscape;

(g) Natural and/or anthropogenic changes to coastal and estuarine areas to the north and south of the Midge Point community.

This is discussed further in Section 5. The aerial photographs that were analysed included:

- 1961
- 1970
- 1984
- 1991
- 1997
- 2002
- 2004
- 2009
- 2012 (Bing maps)

4.2.5 WAVE HEIGHT AND WAVE PERIOD

To quantitatively measure wave height, fieldwork was conducted over two periods in 2011, (28th and 29th of March and the 4th and 6th of May). Throughout these periods, pressure transducers were deployed within the wave zone of the beach at Midge Point to measure the period and height of the waves.

During the first period of fieldwork, the transducers were deployed over the full period of fieldwork and programmed to record for a period of three minutes every hour and a half. Stormy conditions were experienced and recorded during this period, with wave heights reaching approximately 0.7m and considerable wave set-up + wave run-up observed.

During the second period of fieldwork, the transducers were deployed continuously reading every 0.25 seconds to adequately define the fine scale wave profile common to the beach. This period was used to represent 'normal' conditions that occur on the beach outside of abnormal wind conditions and are representative of the majority of the year.

The pressure transducers were deployed in an equilateral triangle with the long-axis parallel to the beach. This was performed to allow C&R the ability to track individual waves in three-dimensions as they travelled over the pressure transducers. On both field trips the transducers were deployed in 0.5m of water at low tide.

Additional field trips to Midge Point were undertaken throughout 2011 and early 2012 to qualitatively gauge wave height and correlate this to wind conditions experienced at Hamilton Island and Proserpine at similar times. King tides were also observed in late January 2012.

The results from the field based investigation were evaluated against the historical geomorphology of the Midge Point area, including:

(a) Beach profile,

(b) Location and alignment of the alternating beach ridge / swale systems,

(c) Migration of Yard Creek, and

(d) Geomorphology of the coastline and intertidal zone.

4.2.6 TIDAL CURRENTS

A boat mounted Acoustic Doppler Current Profiler (ADCP) was used (supplied and deployed by *Hydrobiology Pty Ltd*) to measure depth and speed of currents throughout the water column below the boat. The ADCP was run in transects into and out of the beach from the eastern end to the western end, with a further transect conducted into the mouth of Dempster Creek. The survey was undertaken over a two day period between the 4th and 6th of May 2011.

The field based investigation was evaluated against tidal currents inferred by:

(a) The literature review,

(b) Coastline geomorphology, and

(c) Historical records retained by aerial photographs.

The ADCP current data and transducer pressure data were used to identify bottom velocities induced from tidal currents as well as waves. This information was evaluated against:

(a) Visible evidence within the intertidal zone,

(b) Records retrieved using historic aerial photography, and

(c) Palaeo-geomorphological records retained within the beach ridges and swales.

(d) Tidal data from the Laguna Quays gauge as well as the Mackay Harbour gauge were analysed to determine the maximum tide height and other tide statistics.

4.2.7 SEDIMENT SAMPLING

During field trips various test pits and auger holes were installed on the upper beach, lower beach and into the foredune, throughout the study area to characterise sediment grain size and any noticeable changes in stratigraphy.

4.2.8 ELEVATION INFORMATION

Mackay Regional Council has provided 0.25m contours derived from LIDAR undertaken in 2009 for the Midge Point beach area. The LIDAR was undertaken at low tide and therefore the contour coverage detects elevations in a large section of the intertidal zone. The topographic data were interpolated in ArcGIS 9.3.1.

C&R Consulting sub-contracted AME Surveys to undertake a beach survey in April 2011. This survey data provides a representation of the beach, but at a lower resolution than the 2009 LIDAR coverage provided by MRC. The survey extends from slightly behind the crest of the foredune to the low-water mark at the time of survey. The survey data were provided to C&R in the form of spot elevations, and an interpolation of elevations across the beach using triangulation as well as manual contouring methods. The spot elevations and contours were input into ArcGIS 9.3.1 and interpolated using the same regime as undertaken for the 2009 LIDAR data.

4.3 THIRD PARTY INFORMATION

The Department of Environment and Heritage Protection (DEHP) provided the results of an aerial photograph analysis undertaken at Midge Point. This analysis was undertaken by using methods similar to those outlined in Thieler et. al. (2009). The method allows the user to calculate shoreline rate-of-change statistics form a time series of multiple shoreline positions. The extension was designed to aid historic shoreline change analysis.

Transects are generated normal to the shoreline and/or the dune system. The change of the dune is then analysed at each transect along the beach system. The results are then summarised in a spread sheet program, which also allows for a large variety of statistics to be generated and analysed.

For the purposes of this analysis, transects were spaced at 50m intervals along the entire Midge Point beach front. These transects were then used to quantify the amount of lateral change in the beach's foredune between aerial photograph intervals.

Once the lateral change of the beach's foredune was determined for each aerial photograph interval, the volume of sediment movement was estimated from Equation 1 using the definition of parameters outlined in Figure 13.

Equation 1: Equation to estimate sediment change volume from lateral dune changes

$$Q = r(h1 + 0.5h2)$$

h1 = dune height (approx 5m); and
H2 = closure depth (0m)
r = lateral retreat for photograph interval

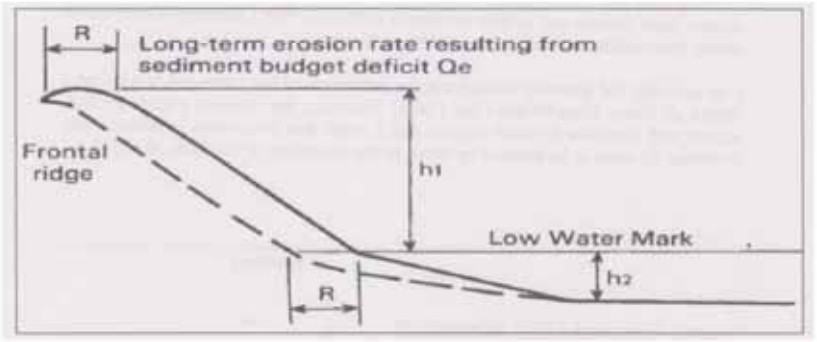


Figure 13: Graphical depiction of parameters outlined in Equation 1

5 PHYSICAL PROCESSES ANALYSIS

5.1 GENERAL

The coastal environment is in a constant state of flux as it responds to the ever-changing influences of waves, tides, ocean currents, winds, and the supply of sediments. These complex and dynamic coastal processes have combined over many thousands of years to shape the physical environment of the Midge Point coastline.

This section of the Midge Point Shoreline Erosion Management Plan defines and, where possible, quantifies the natural processes contributing to the existing and, as closely as can currently be determined, future erosion threats to the Midge Point beach system.

5.2 REGIONAL SEDIMENT SUPPLY AND TRANSPORT MECHANISMS

Prior to assessing the mechanisms of sediment transport and erosional processes of Midge Point it is essential to keep in mind the regional perspective of sediment supply and transport given in Section 3. In summary, Section 3 contributes the following information:

- Several large rivers (e.g. the Proserpine and O'Connell Rivers) and creeks (e.g. Dempster and Yard Creeks) deliver substantial quantities of sediments to the broad region of Repulse Bay.
- The hinterland associated around Midge Point is conducive to the supply of a variety of sediment types and sizes for transfer through the rivers and creeks to the broad region of Repulse Bay.
- Stored sediments in the coastal dunes of Cape Conway and the Conway National Park are periodically made available to redistribution within Repulse Bay.
- Sediments made available to the western coastline of Repulse Bay are filtered by the extensive mangrove and wetland systems prior to redistribution into Repulse Bay under appropriate flow conditions.
- Anti-clockwise current movement within Repulse Bay transfers entrained sediments to the rocky headland at the northern end of Midge Point where opposing currents (predominantly the East Australian Current running in a north-westerly direction parallel to the Queensland coast) limit the southerly movement of the sediment. Sediments are consequently willowed out in the protected area of the Midge Point headland and rock formation and redirected along the Midge Point coastline towards Yard Creek.
- Wave action transports sediments along the beach in an on-shore / off-shore action in agreement with the angle of the waves.
- The presence of the rocky headland to the south of Midge Point beach, and the combination of tidal flows and freshwater flood flows through Yard Creek combine to encourage sediments to settle out in the quiet waters between the headland and the mangrove colony prior to redistribution when flow conditions through Yard Creek are strengthened.
- The beach face consists of fine sands with grain sizes generally finer than 1.5mm.
- The 2011 site inspections indicated that the sediments of the intertidal flats had been stripped of the coarser materials. The remaining sediments were compacted fine silts.
- Tidal currents are usually only sufficient to initiate and sustain movement of the finer offshore sediments during periods of high tidal range.

- The degree of tidal variability is essential to the degree of beach face made available to the action of wave run-up. The amount of wave energy available to the beach is determined by the depth of water over the shallow intertidal

5.3 COASTAL DYNAMICS

The development of the Midge Point Beach has always been intermittent. Historically controlled by sea levels, at a finer scale the availability of sediment is equally critical to the status of the beach system at any time. Similarly, erosion of landscapes to produce sediments, and the transport of those sediments to and through river channels and along shorelines, is dependent on the ability of the weather system, or the climate of an area, to provide the necessary mechanisms of removal and transport. Those same physical processes are responsible for the removal or deposition of sediments along the shoreline.

Sand transported southwards around the Midge Point Headland would have accumulated on the submerged palaeo-coastal plain between the Midge Point Headland and the headland to the south of Yard Creek. Site inspections undertaken during 2011 indicated the presence of these features. Ambient wave conditions in the high tidal regime of Midge Point may have sufficient energy to move the smaller particles from these submerged sand banks and onto the foreshore of Midge Point, but it would require storms or periods of higher south-easterly wave energy to carry the sand onto the Midge Point shore. Nevertheless, it is also these same activities that remove the unconsolidated sediments from the beach system back to the intertidal zone.

Consequently, throughout the historical development of Midge Point, there would have been periods when sediments were deposited and periods when they were removed. It is doubtful that a steady state has ever prevailed and the best that can be discerned from the data is that the system is dynamic and that steady state can only be assumed over a far longer period than the European history of Midge Point.

Evaluation of available historical aerial photographs indicates that periods of erosion and accretion have been taking place at Midge Point since at least the Holocene Still stand, approximately 6000ybp – 3000ybp (refer Figure 7). Evidence of dune progradation during that period, and repeated as sea level slowly receded to its current level, is preserved as a series of beach ridges and dune systems visible on aerial photographs. In contrast to that time frame, the fluctuations evident in the current set of aerial photographs (1974 to 2009) are little more than a snap shot in time. Nevertheless, that snapshot in time is of greater relevance to the Midge Point community than events through geological history.

Estimations of shoreline movement based on variation from an arbitrary baseline using accessible and appropriate aerial photographs, were provided by DEHP. The location of these transects, read at 50m intervals at right angles to the arbitrary baseline, is shown in Figure 14 and Figure 15. The mathematical results are given in Table 1 (Midge Point Settlement Frontage, and Table 2 (Midge Point south Frontage).

The shoreline variation derived from the data indicates that the shoreline in front of the settlement (northern end of the beach, Transects 3 to 7) retreated by approximately 6m between 1974 and 2009 (Figure 19). In contrast, the remainder of the beachfront from Transect 8 to Transect 26 increased by up to 15m during the same period (Figure 20, Figure 21, Figure 22 and Figure 23). The southern section of the beach (Transects 28 to 32) retreated with the rate of retreat increasing with proximity to Yard Creek (approximate net retreat = 50m)

Table 1: Midge Point Settlement Frontage: Transects 2-19 Shoreline change (m) for each photo interval.

Transect	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Avg
1974-78	-0.48	-2.76	0.75	0.95	0.92	0.34	1.59	3.69	3.66	3.46	2.76	4.24	3.43	5.23	4.81	6.33	4.75	**2.57**
1978-81	7.07	9.85	0.58	1.90	1.76	2.02	2.59	4.89	4.25	4.31	7.60	5.78	8.94	7.86	1.54	0.73	3.20	**4.40**
1981-85	0.24	-6.30	5.10	0.32	2.37	0.20	0.29	0.25	-0.06	2.16	-0.14	0.28	0.72	0.46	2.42	1.04	1.61	**0.65**
1985-93	-12.77	-8.51	-14.58	-14.45	-13.18	-5.20	-5.96	-1.68	-3.77	-4.74	-8.60	-9.17	-9.73	-7.22	-2.11	-1.50	-1.94	**-7.36**
1993-97	-2.88	-0.18	0.75	5.69	3.47	-0.31	-1.82	-1.55	-0.46	-6.18	4.85	3.71	3.27	0.48	0.96	-0.02	-2.48	**0.43**
1997-2002	6.46	8.13	7.10	1.92	2.70	4.88	3.26	-0.60	0.03	4.82	-5.27	-2.44	-0.26	1.68	-2.31	-1.52	1.71	**1.78**
2002-09	2.24	-2.59	-2.49	-2.42	-4.04	-0.80	1.79	-0.77	3.94	2.76	4.15	8.02	1.76	5.74	5.70	7.43	4.75	**2.07**
Net 1974-2009 (m)	**-0.11**	**-2.37**	**-2.80**	**-6.08**	**-5.98**	**1.14**	**1.74**	**4.23**	**7.59**	**6.59**	**5.35**	**10.41**	**8.14**	**14.23**	**11.01**	**12.51**	**11.59**	**4.54**

Note: Distance between Transects equals 50m

Table 2: Midge Point South Frontage: Transects 22-32 Shoreline change (m) for each photo interval

Transect	23	24	25	26	27	28	29	30	31	32	Average
1974-78	7.32	7.71	4.72	5.48	7.72	8.24	7.82	3.32	3.08	9.86	**6.53**
1978-81	-2.99	-3.03	-5.82	-7.98	-8.68	-9.74	-10.46	-9.81	-10.34	-8.54	**-7.74**
1981-85	-0.85	1.43	3.06	8.67	1.22	-1.01	-8.34	-0.97	-5.58	-16.07	**-1.84**
1985-93	-1.69	-5.18	-5.93	-8.34	-9.38	-11.79	-11.21	-14.73	-11.79	-9.88	**-8.99**
1993-97	5.21	0.34	-3.21	-3.65	3.32	1.74	5.02	-0.31	-10.14	-5.72	**-0.74**
1997-2002	6.94	8.27	10.39	8.77	3.55	7.34	-1.56	-0.36	-3.55	-7.61	**3.22**
2002-09	-0.48	1.99	1.19	3.80	1.95	3.04	0.87	-5.62	-2.31	-11.29	**-0.69**
Net 1974-2009 (m)	**13.45**	**11.53**	**4.40**	**6.75**	**-0.31**	**-2.18**	**-17.87**	**-28.47**	**-40.63**	**-49.25**	**-10.26**

Note: Distance between Transects equals 50m

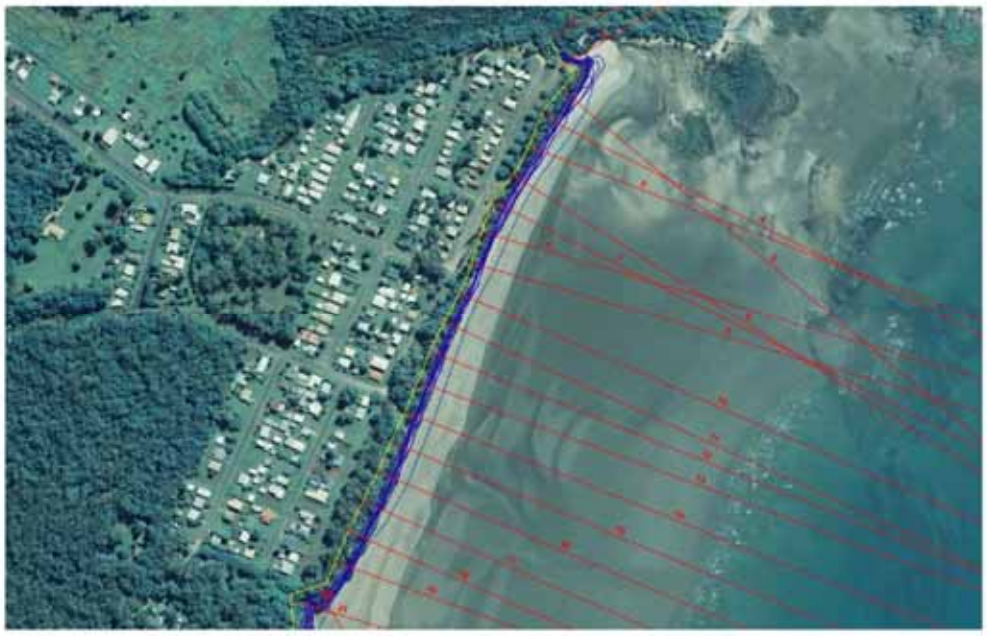


Figure 14: Midge Point North Erosion Estimate Transects

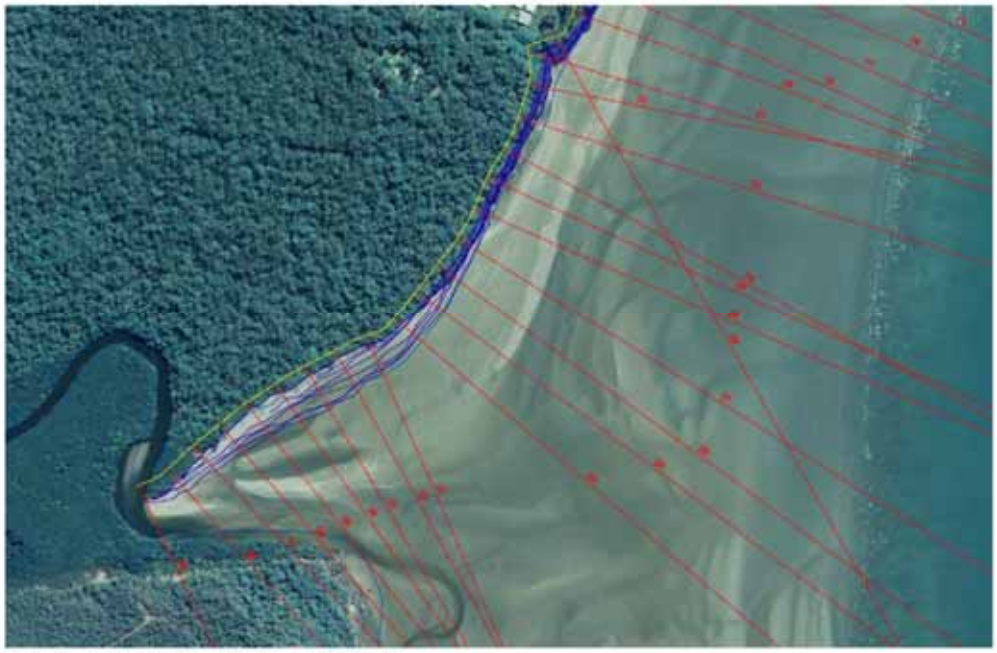


Figure 15: Midge Point South Erosion Estimate Transects

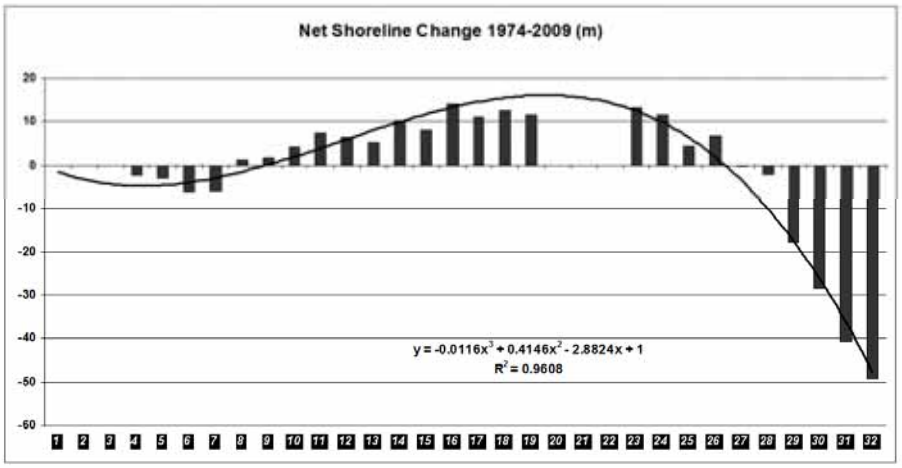


Figure 16: Net Shoreline Variation between 1974 and 2009

However, while the shoreline in front of the settlement is relatively mobile, the periods of retreat and accretion over the 37 years of record (1974 and 20011- DEHP data plus C&R survey data for the years 2009 and 2011 for Transects 6, 7 and 8) fluctuate with an almost identical window of retreat and accretion. For example, at Transect 5 (the transect with the greatest degree of variability in this section), shoreline variation alternated between:

- an increase of approximately 5m between 1974-78 and 1981-85,
- a retreat of nearly 20m between 1985 and 1993,
- a return to the 1974 level between 1993 and 1997,
- an additional increase of 7.1m between 1997 and 2002,
- a retreat to approximately 2.5m behind the 1974 beach line between 2002 and 2009. Survey data for 2009 and 2011 was not available for this site.

Within the data envelope of 35 years available for assessment the data for the northern end of the beach indicate that while erosion rates appear dramatic, there have been periods of recovery that returns the shoreline to close to the same location.

Hence, while the periods of retreat are of considerable concern to the residents of Midge Point, they would appear to be well within a normal cycle of advance and retreat. It is considered that the most practical way of dealing with this location is that practiced unofficially by the community in the 1990s – reclaiming sediment from the southern end of the beach and replacing it in the beach zone in front of the residences.

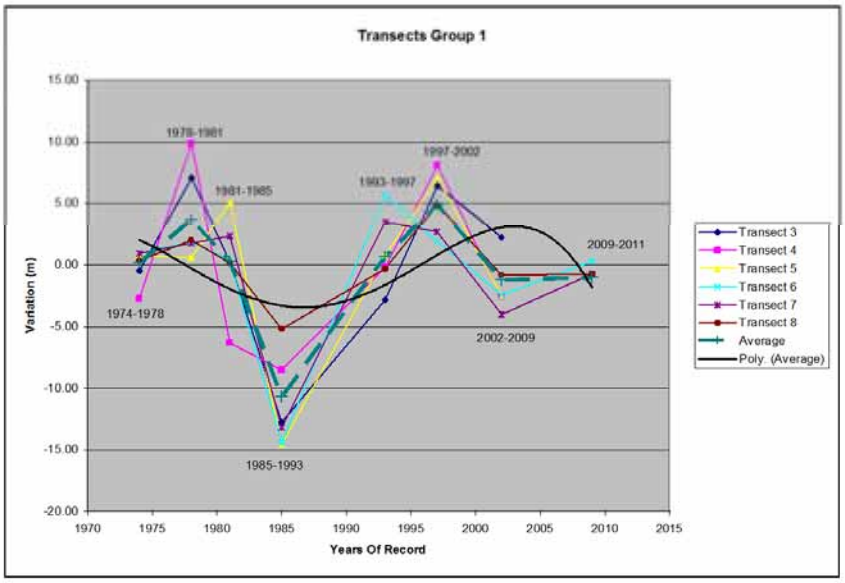


Figure 17: Sediment Variation at Transects 3, 4, 5, 6, 7 & 8 for the Periods indicated on the Graph.

Note 1: All sites show periods of accretion and retreat over the 37 year period 1974 to 2011.

Shoreline movement at the southern end of the beach (Transects 27 to 32) is highly mobile, as would be expected from the storage end of a highly active beach. In these locations, sediment deposition is similar to a sand spit where sediments are stored against an obstruction (hill face) and redistributed by both terrestrial and marine actions (e.g. waves, currents and terrestrial stream flows).

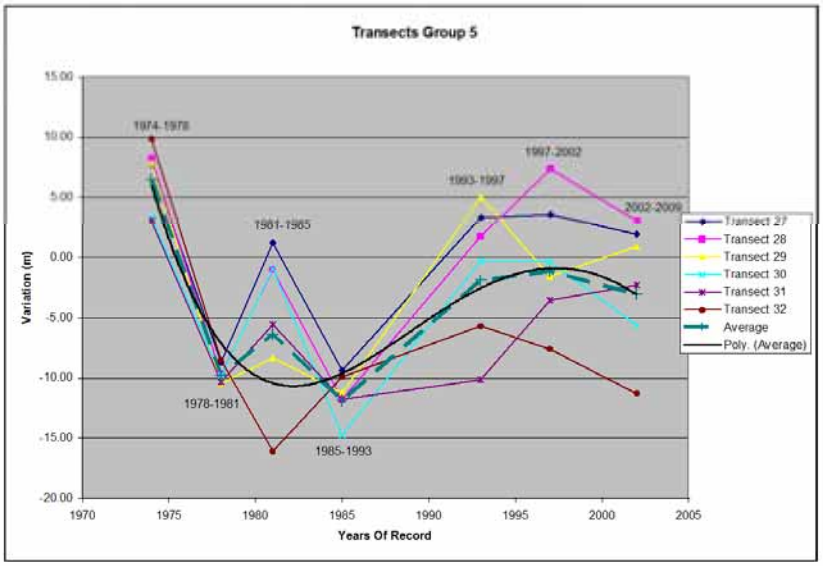


Figure 18: Sediment Variation at Transects 27, 28, 29, 30, 31 & 32 for the Periods indicated on the Graph.

Analysis of erosion/accretion along the beach from Transects 3 to 19 and 23 to 32 over the period 1974 to 2009, indicates that there are zones of erosion at the north and south ends of the beach, with a zone of accretion in the central zone. Null points occur approximately in the vicinity of Transects 8 and 9 and Transects 26 and 27. These null points are easily demonstrated by the third order polynomial indicated on Figure 16 where the initial x intercept is Transect 3 (the first Transect for which quantitative data are available). The R^2 value indicates a very high degree of confidence for this fit. The zone represented by Transects 3 to 7 is one of very minor sediment loss over the period 1974 to 2009. This zone is affected by flood flows from the unnamed creek to the north of the settlement, which, during high flow will transport sediment outwards. It is protected by the rocky outcrops on the intertidal zone, and a probable zone of emergent hard substrate, possibly associated with the activities along the Dempster fault. Detailed analysis of the data in this zone indicates that values are only negative because of the large negative values during the periods of high cyclonic activity during the periods 1985 to 1993 (9 cyclones) and 2002 to 2009 (3 cyclones). At all other periods during the 35 years of record, there was net accretion in this area. It should also be noted that the area between Transects 3 and 8 are the most common sites of beach access.

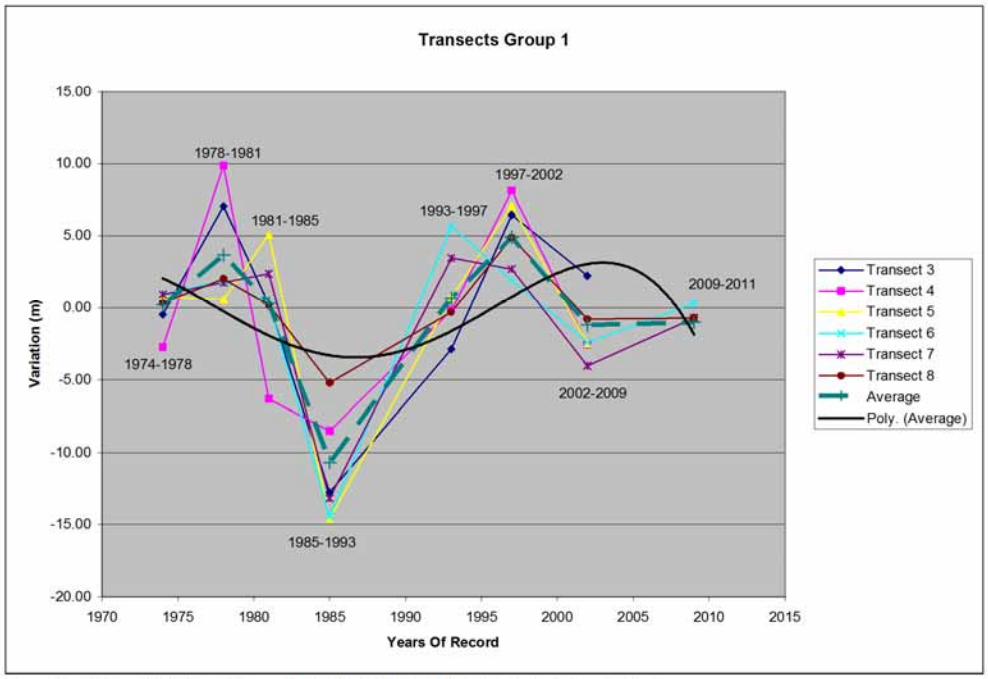


Figure 19: Sediment Variation at Transects 3, 4, 5, 6, 7 & 8 for the Periods indicated on the Graph.
Note 1: All sites show periods of accretion and retreat over the 37 year period 1974 to 2011.
Note 2: Transect 3 = Net gain over the 37 year period. Transects 4 to 8 = Net loss over the 37 year period with the greatest net loss of ~4.0m at Transect 7.

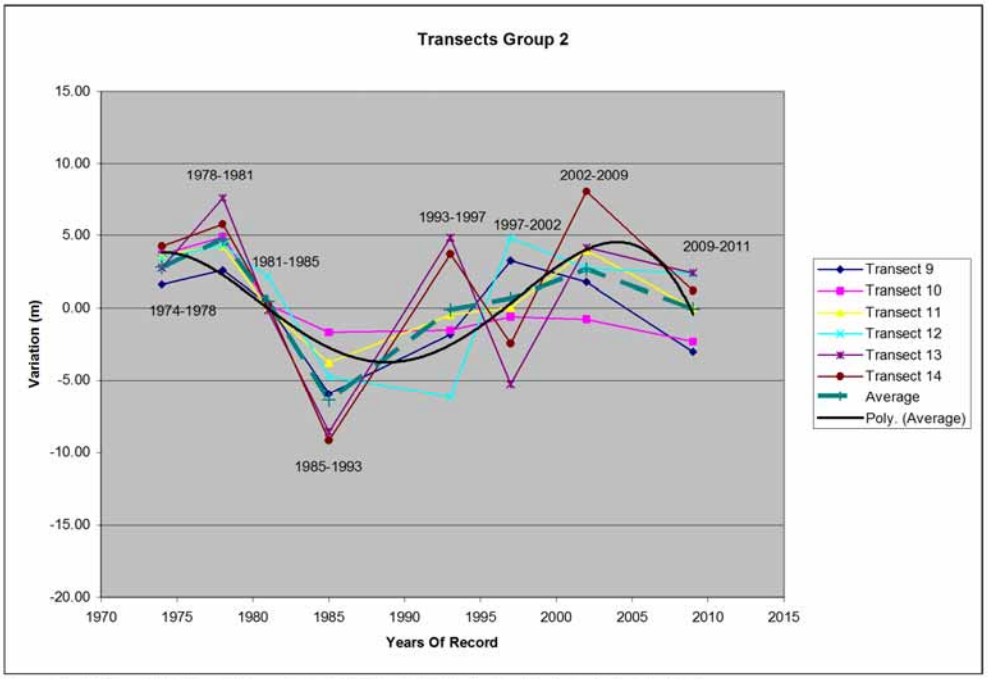


Figure 20: Sediment Variation at Transects 9, 10, 11, 12, 13 & 14 for the Periods indicated on the Graph.
Note 1: All sites show periods of accretion and retreat over the 37 year period 1974 to 20011.
Note 2: With the exception of Transect 10 all Transects show a net gain over the 35 year period.

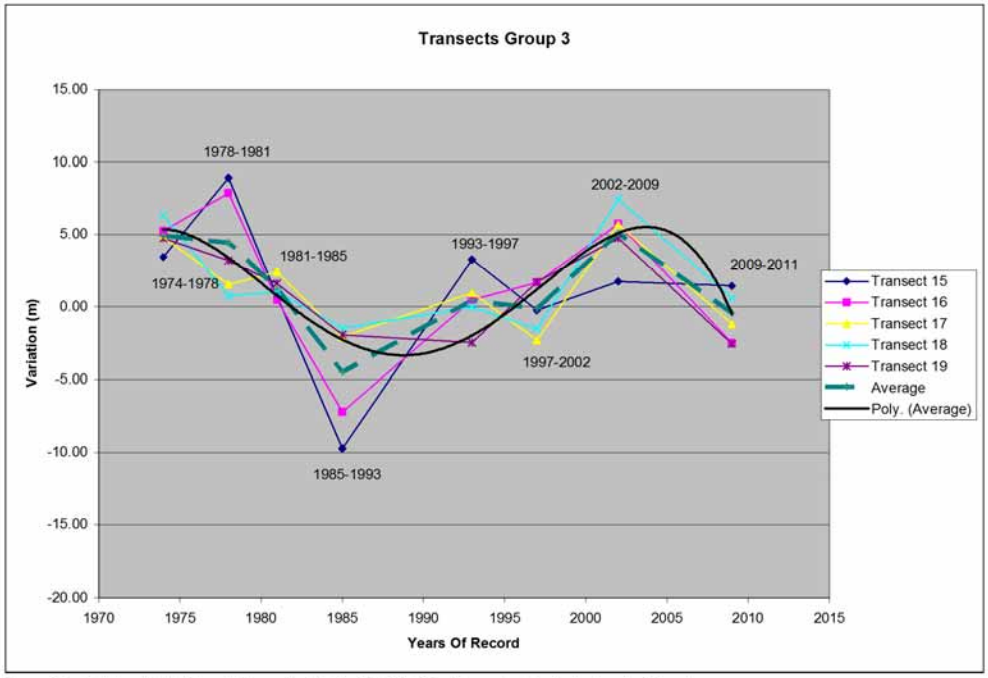


Figure 21: Sediment Variation at Transects 15, 16, 17, 18 & 19 for the periods indicated on the Graph.
Note 1: All sites show periods of accretion and retreat over the 37 year period 1974 to 2011.

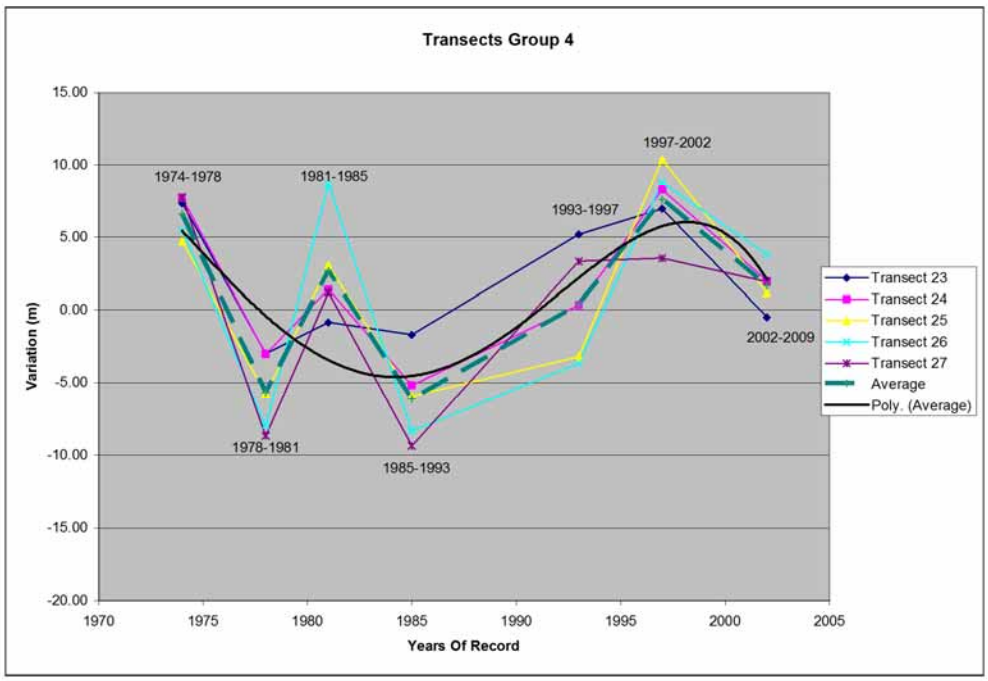


Figure 22: Sediment Variation at Transects 23, 24, 25, 26 & 27 for the periods indicated on the Graph.
Note 1: All sites show periods of accretion and retreat over the 37 year period 1974 to 2011.
Note 2: With the exception of Transect 23 all Transects show a net gain over the 37 year period.

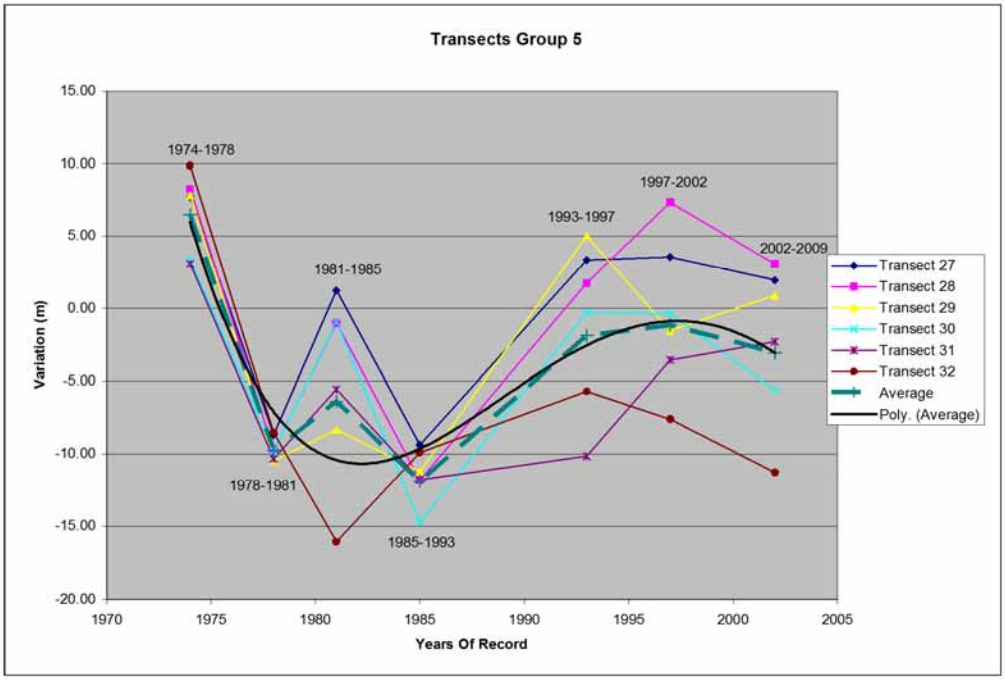


Figure 23: Sediment Variation at Transects 23, 24, 25, 26 & 27 for the periods indicated on the Graph.

Note 1: All sites show periods of accretion and retreat over the 3y year period 1974 to 2011.
Note 2: Transects 27, 28 and 30 = net gain over the 37 year period. Transects 30, 31 and 32 = net loss over the 37 year period.

A consistent zone of accretion ranges from Transects 8/9 to 26/27. During the majority of the 35 year period of record, there was net accretion throughout this zone. However, all points were consistently negative during the period of high cyclonic activity 1985 to 1993 and Transects 9, 10, 12, 18 and 19 were negative during the period 1993 to 1997 and Transects 13, 14, 15, 17 and 18 were negative in the period 1997 to 2002. No points were negative during the period 2002 to 2009. While the general loss for the period 1985 to 1993 can be attributed to high cyclonic activity, the losses for the other periods require further analysis with respect to potential high energy events. However, it is pertinent to note that during both of these periods, 5 cyclones passed within 400km of Midge Point. It is the passage of these cyclones that has reduced the accretion during the period 1974 to 2009, but the zone is still one of considerable net accretion in spite of the negative effects of the cyclones.

From Transect 27, values become systematically more negative towards Transect 32. For Transect 27, negative values are experienced only for the periods 1978 to 1981 and 1985 to 1993. In fact, for all Transects 23 to 32 values for these periods are all negative and correspond to 6 and 9 cyclones respectively within 400km of Midge Point. For Transect 28 there are 3 negative values. For Transect 29, 4 negative values. For Transect 30, 3 negative values. And for Transects 31 and 32, there are 6 negative values each. As would be expected, the net loss increases towards Transects 31 and 32.

For all Transects 23 to 32, positive values were recorded for the period 1974 to 1978, during which there were 7 cyclones within 400km of Midge Point. This suggests that there are other factors associated with sediment loss from the southern end of the beach between Transects 27 and 32. Spatial interpretation of the aerial photographs from this region strongly suggests that outflows from Yard Creek influence the distribution of sediments away from the beach in this zone. The fact that there is no apparent correlation with the number of cyclones suggests that strong flood flows in the creek may be responsible for this. Such flows may, or may not, be related to cyclones passing within 400km, but will be related to low probability rainfall events.

Consequently, it is considered that the following factors influence erosional / accretional features along the Midge Point beach:

- Access across the fragile top of the beach system may enhance the rate of beach erosion. This may be a contributing factor between Transects 3 and 8.
- Cyclonic events of appropriate intensity, orientation, and passage within approximately 200km of Midge Point.
- Geomorphological features of the beach itself, including headlands, islands, and rocky formations which serve to anchor and/or trap sediments which ultimately provide accretionary inputs to the beach itself.
- Creek outflows which, during periods of flood, push sediments away from the beach. These high flow events may be related to tropical cyclones or merely tropical lows passing inland from Midge Point, but causing flood flows in the creeks (e.g. Cyclones Charlie, Aivu and Ivor, all of which deposited large amounts of rain in the Mackay / Proserpine hinterland).
- At any one time all of these factors may act in concert, or even in opposition, along the length of the beach. Thus attributing the fine detail of any erosion / accretionary event to a single cause is extremely difficult and the effect at any time may be transient until the next erosion / accretionary driver occurs.
- The data 1974 to 2009 (35 years) represents only a small time slice in the evolution of a coastline that usually occurs over thousands of years.

5.3.1 CORRELATION WITH EXTREME EVENTS

The southern end of the beach is subject to greater changes in the location of the foredune (refer Figure 24 and Figure 25), with approximately 60m of vegetation retreat in the period 1970 to 1984, with a further retreat of approximately 25m between 1984 and 1991. During this period relatively minor changes were noted along the northern section of the beach. However, more recent changes between December 2010 and May 2011 (Figure 26) show that a large volume of sand was removed from the front of the foredune during this period.

The data also support the argument that high levels of erosion correspond to high energy climatic, or weather, events. Estimates of the total and yearly average sediment change show that the Midge Point beach experienced most erosion between 1985 and 1993 (refer Figure 24). During this period both the northern and southern areas of the beach lost between 1800 and 2000m^3 of sand. Nine cyclones crossed the coast within 400km of Midge Point between 1985 and 1993. Although this period showcases the most erosion, it is also the longest period between aerial photographic capture (8 years). In contrast, the average yearly rate of sediment change (also on Figure 24) was greatest for the period between 1978 and1981 at the southern end of the beach, with the highest average yearly accretion, as well as total accretion, estimated for the northern end of the beach during this period.

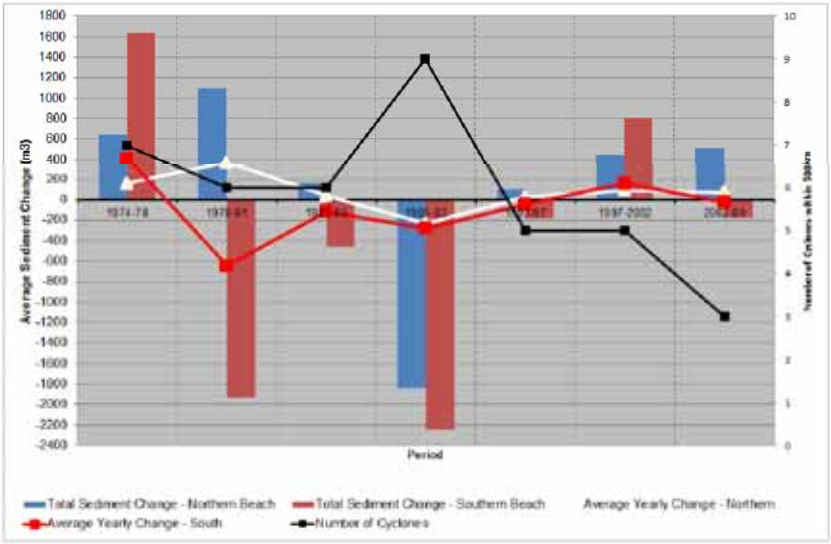


Figure 24: Average changes in the berm location since 1974 based on aerial photography

Analysis of beach profiles conducted by the Coastal Observation Programme Engineering (C.O.P.E) between 1990 and 1997 (Appendix 6) shows a drastically decreasing variability in the beach morphology over the seven year period, which is correlated to the 1993 to 1997 period indicated in Figure 24. In the early part of the survey there are considerable changes in the beach profile detected even intra annually. For example the approximate beach profile change between 03 July 1990 and 04 December 1990 is 20.6m^2 in the cross section. Assuming that the C.O.P.E profile represents a 50m wide stretch of beach, this equates to a change of 1,030m^3.

Figure 25: Historic vegetation front along the Midge Point beach

Figure 26: Erosion scarp, December 2010.

Figure 27: Erosion scarp, May 2011.

DATA ANALYSIS 62

Similarly, approximately 50m^2 (2,500m^3) was added to the beach profile between November and December 1991. This degree of sediment change (evident on the C.O.P.E beach profiles in Appendix 6) is probably from anthropogenic replenishment activities undertaken by locals during that period although this is not certain. The beach profile established by December 1991 is relatively stable through to May 1997, with only minor volumetric changes in the beach profile when compared to previous surveys.

Changes to the beach profile are highly seasonal, dependant on extreme events (Figure 24, Figure 25). A direct correlation between erosion/accretion and tropical cyclones is not clear. The period of the greatest average annual erosion is not correlated with the period of the most cyclones (Figure 24) but the period of the greatest net erosion is. The highest annual erosion rate occurred between 1978 and 1981 but the highest net sediment loss occurred between 1985 and 1993. In both periods a Tropical Cyclone crossed the cost in close proximity to Midge Point, Tropical Cyclone Kerry in 1979 and Tropical Cyclone Ivor in 1990. Both cyclones were weak when they crossed the coast near Midge Point, close to a tropical low rather than a cyclone. The period between 1985 and 1993 saw much more cyclones within 400km cross the coast to the north of Midge Point, causing the more severe parts of the storm to affect the study area. Without further site specific data it can only be surmised that storm events and cyclones in the period between 1978 and 1981 resulted in more severe effects at Midge Point than the period between 1985 and 1993.

According to local residents, the erosion rate at Midge Point has increased in recent times (i.e. the last decade). There have been 9 cyclones to cross the coast within 400km of Midge Point between 2000 and 2012. This is an intensity that is far less than what has occurred even since 1960. However, the severity and proximity of the recent cyclones may be an influencing factor on erosion at Midge Point.

5.3.2 IMPACTS OF CYCLONE ULUI

High resolution data of the beach shape were available from 2009 (Mackay Regional Council LIDAR acquisition) and 2011 (C&R Consulting topographic survey undertaken in April 2011). These data were able to be compared directly in ArcGIS to determine the locations and changes to sediment volumes across the beach. Cyclone Ului crossed the coast directly over Midge Point in early 2010 and caused large-scale erosion (according to resident's recollection).

The survey data were compiled into a three-dimensional representation of the beach. The 2009 data were subtracted from the 2011 data to reveal areas where the elevation of sediment (as recorded by the surveys) had changed. The results of this analysis are outlined in Figure 28. A number of transects were also constructed from the elevation data and are presented in Figure 29 below. Approximately 0.3 – 0.5m of material was lost from the intertidal zone (Figure 29). The transects reveal that the average change in sediment volumes across the upper beach was approximately 220m^3 per 50m wide transect. A plot showing the amount of lateral change in the foredune position between 2009 and 2011 (Figure 30) shows that transects 6-10 experienced retreat of the foredune crest. However the area between transects 12-15 experienced significant (i.e. between 1-2m) foredune advance.

A large volume of sediment was lost from the intertidal zone (approximately 353,000m^3) within the study area (Figure 28). It is expected that this sediment loss is caused primarily by storm conditions occurring during Cyclone Ului in April 2010 as large waves rolled across the intertidal zone.

There is a change of approximately 5,000m^3 in the area immediately in front of the upper beach (Figure 28). It is expected that this sediment is sourced from the upper beach and was washed offshore during Cyclone Ului, or other severe events (such as storms and / or king tides) during 2010. Some of this sediment *could* even be the material that was removed from the foredune evident in comparisons between Figure 26 and Figure 27.

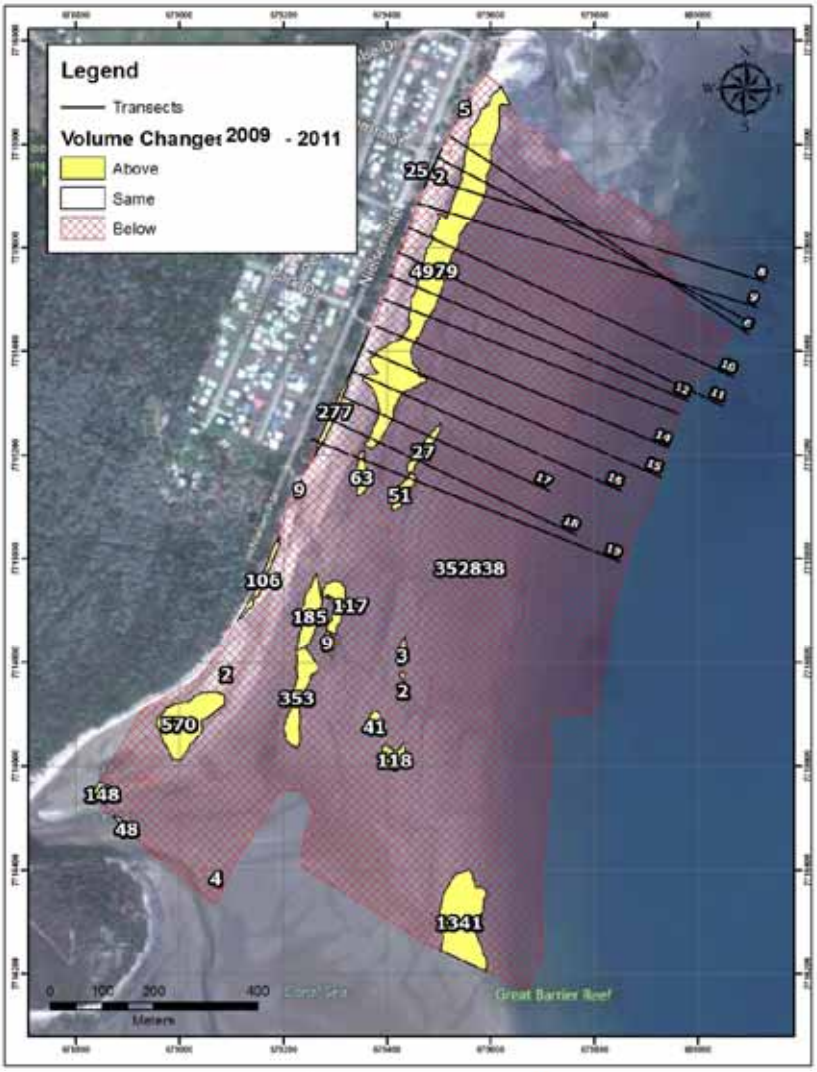


Figure 28: Volume changes (m^3) between 2009 and 2011

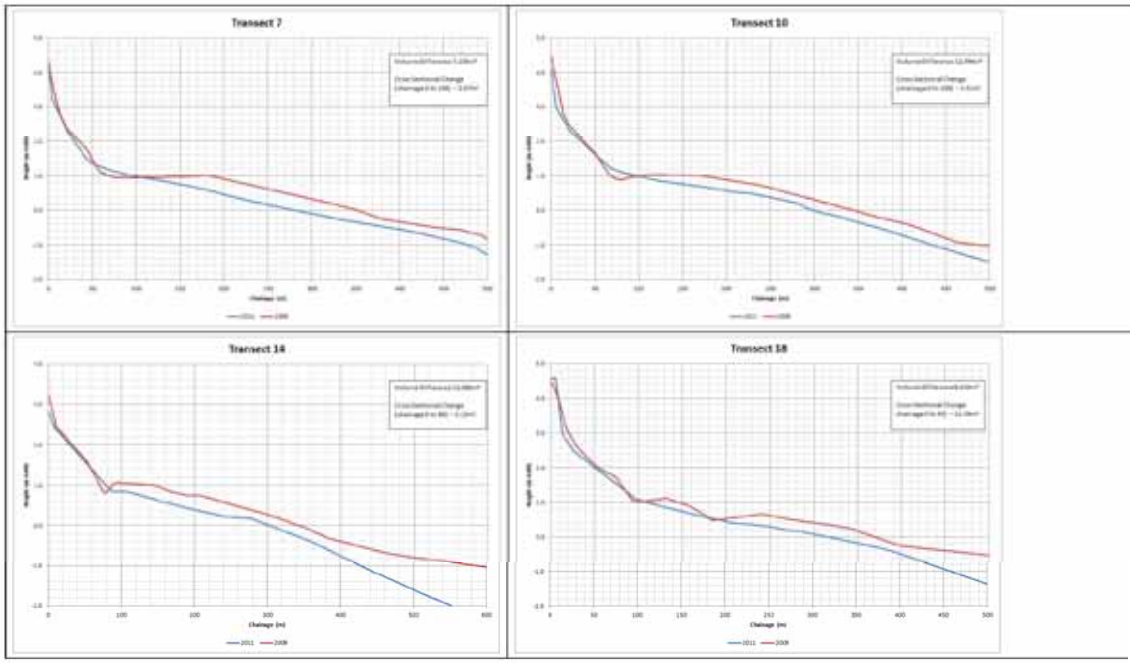


Figure 29: **Transect comparisons between 2009 and 2011 beach profiles**

65

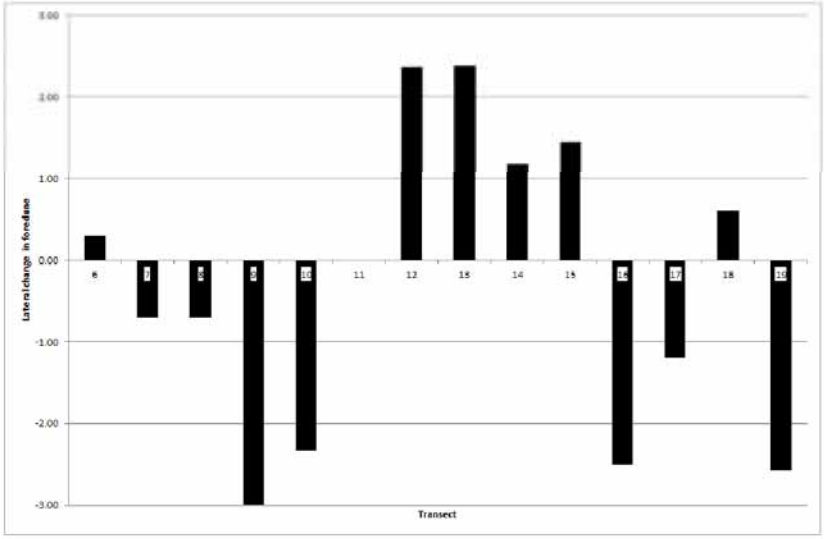


Figure 30: Lateral change in the foredune location per transect

5.4 EROSION PRONE AREAS

The *Coastal Protection and Management Act 1995* provides statutory erosion prone areas which are to be used to inform development decisions under the *Sustainable Planning Act 2009*. These erosion prone areas signify the width of the coast considered vulnerable to coastal erosion as well as tidal inundation in the next 50 years. Calculation of erosion prone area widths is based on:

- A short-term erosion component from extreme storm events;
- A long-term erosion component where gradual erosion is occurring
- A shoreline recession component due to sea level rise associated with climate change; and
- A dune scarp component, where slumping of the scarp face occurs during erosion

The statutory widths outlined in the *Coastal Protection and Management Act 1995* has been calculated as approximately 135m (from the foredune) under the erosion prone area mapping provided by DEHP for the Mackay Region. This distance has been mapped below in Figure 31. There are 82 residences within the statutory erosion prone area at Midge Point.

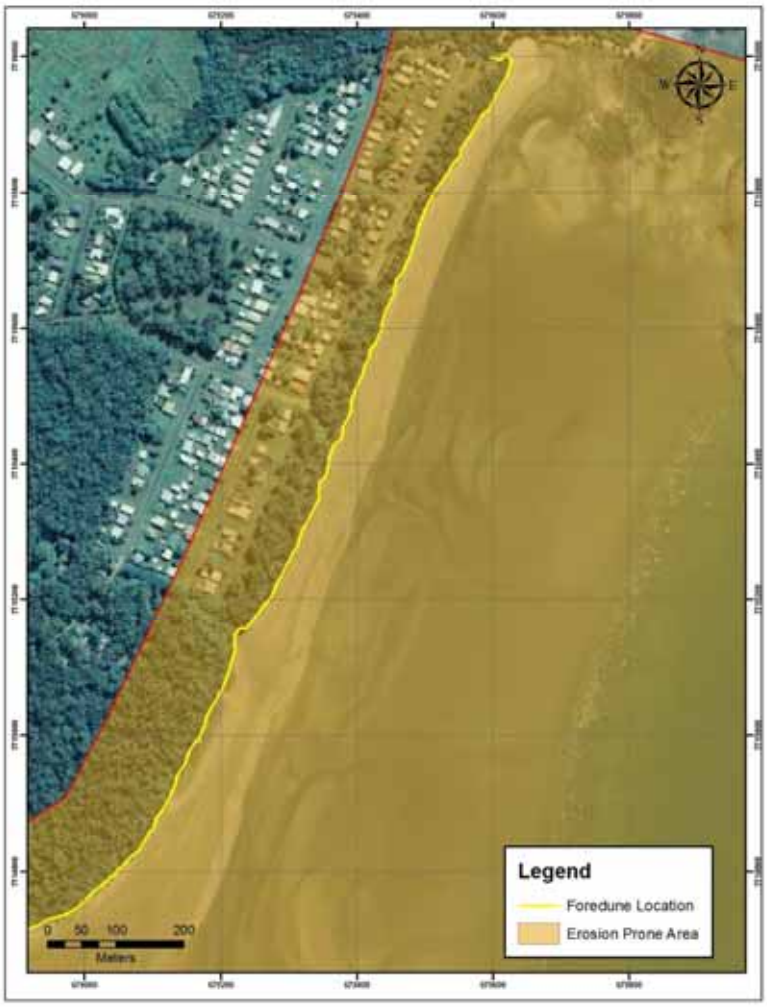


Figure 31: Erosion Prone area for planning purposes as outlined by the Queensland Coastal Plan Coastal Hazards Guideline 2012.

5.5 WINDS

Wind plays a critical role in the formation of waves in the coastal zone. The distance the wind has to act on the surface of the ocean (the fetch), together with the speed of the wind, determines the magnitude of the waves impacting a coastline. Wind direction determines the angle of wave approach to the shoreline. Varying wind patterns will cause similar variations to wave patterns along the coast.

The majority of winds along the eastern coast of Australia come from the south-east for the majority of the year. This generally produces a north-eastward movement of sediment along the coastline. However, winds from other directions also occur and greatly influence the wave regime. In some instances, winds from opposing directions can result in changes to the direction of sediment movement.

5.5.1 WIND DIRECTION

Wind data are not available specifically for the Midge Point area. Hourly wind data were consequently obtained from the Proserpine Airport (available only from 29/03/1996) and used as a surrogate interpretation of wind directions at Midge Point. Analysis of the hourly wind direction indicates that winds are fairly evenly distributed between northerlies, easterlies, south-easterlies and southerlies (Table 3).

Table 3: Wind directions.

Direction	Percentage Recorded
N	21%
NE	2%
E	17%
SE	26%
S	22%
SW	6%
W	2%
NW	3%

To further characterise wind direction and speed at Midge Point, the historical record was divided into four time increments over each day:

- 6:00am - Midday
- Midday – 6:00pm
- 6pm - Midnight
- Midnight – 6am

Wind speed and direction were plotted on four graphs for the above time increments (Figure 32 and Figure 33). Winds are generally from the south-east and from the north. However, Figure 32, Figure 33 and Table 3, show that winds from the north are predominantly from the NNW and can be fairly strong when compared to the remaining data set.

For the purposes of this study, winds have been modelled from the predominant wind directions (south, south-east, east and north-north west).

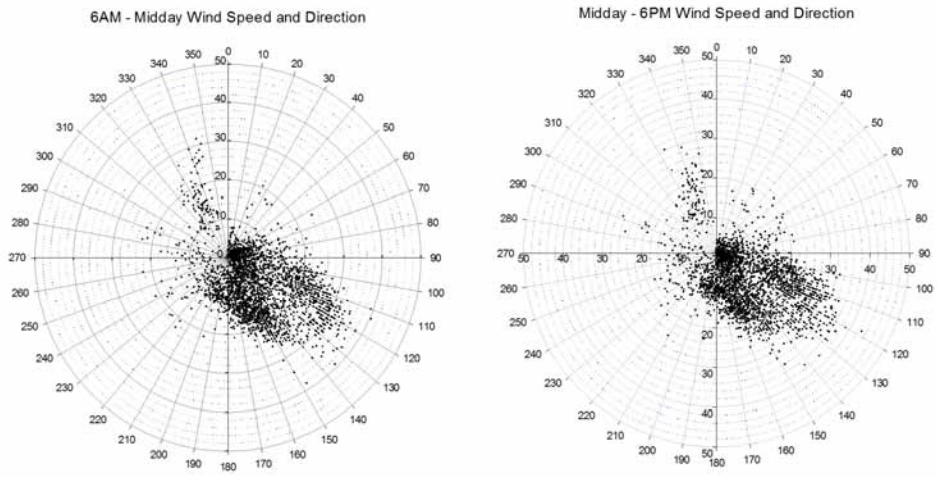


Figure 32: Wind speed and direction at Proserpine Airport, 6AM to 6PM. Wind speeds are in km/hr

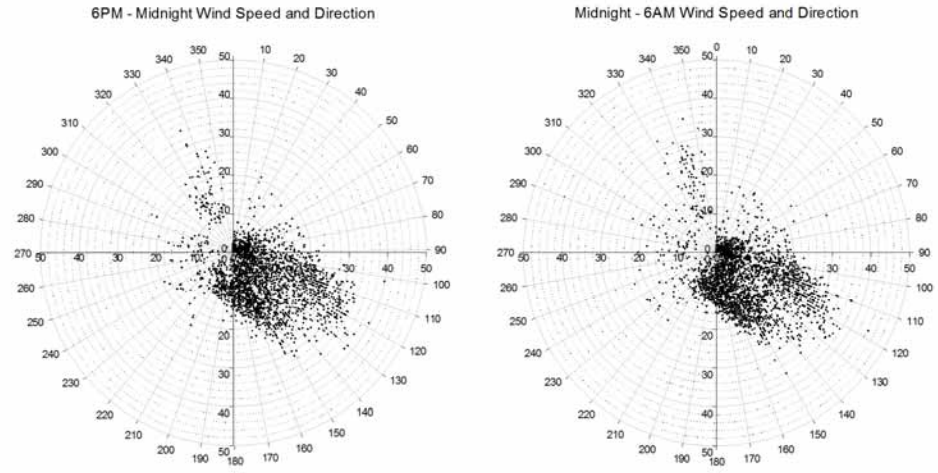


Figure 33: Wind speed and direction plots for Proserpine Airport 6PM to 6AM. Wind speeds are in km/hr

5.6 WAVE FETCH ANALYSIS

Wind generates waves by exerting a physical force on the surface of the ocean and near shore zone. The greater the distance available to winds to act on the water surface, the larger the wave. This measurement is known as wave fetch, and describes the relative effect of wind on wave generation.

The wind climate of Midge Point has been described in Section 5.5, page 63. In general, wind direction is from the south-east, associated with the trade winds prevalent along the eastern coast of Australia. However, on occasions wind direction is from the north-west and the north-east in the October period.

Processes outlined in the Coastal Engineering Manual and modified by the United States Geological Survey Upper Midwest Environmental Sciences Centre (Rohweder *et. al*, 2008) for application in ArcGIS were used to determine the factors influencing wind-fetch for Midge Point.

The predominant wind directions at Midge Point are from the east-south-east (approximately 100 degrees) to the south-east (to approximately 150 degrees). Wind fetch was determined for these two scenarios (Appendix 3) to determine if obstacles hinder wind-generated waves. This evaluation noted:

- The Smith Island group and the Brampton Island group form a partial barrier to wind fetch for Midge Point, when wind direction is predominantly east-south-east (i.e. at least 100 degrees).
- Slade Point and Cape Hillsborough affect wind fetch at Midge Point when wind direction is from approximately 140 – 150 degrees (south-south-east).

In reality, however, the wind directions are not uniform. Disturbances from the ocean induce turbulent wind patterns that cause winds to 'wrap around' the disturbance. Although features such as the Brampton Island Group will disturb wind generated waves, they will not greatly disturb the prevailing wind direction.

Other Shoreline Erosion Management Plans for the area (WBM Pty Ltd, 2006) have found that alternating wind directions between south-east (predominant) and north-north-east have been responsible for alternating longshore transport processes. This, however, is expected to be greatly reduced at Midge Point for the following reasons:

- The upper embayment of Repulse Bay (Conway National Park) limits the wind-fetch, and therefore the wind-generated wave height, for winds from the north; and
- Midge Point itself further limits wind fetch for winds from the north-north-west.

5.7 OBSERVED WAVE CONDITIONS

Many coastal environments along the Australian shoreline are shaped by wave action. High wind fetch distances and very few obstructions allow for transformation of deep ocean waves into shallow-water waves that impact on the coastal zone. The Great Barrier Reef produces a significant obstruction to deep water waves that are moving towards the east coast of Australia. The obstruction provided by the reef system results in many waves breaking on the outer margin of the reef. It is then only the action of the wind on the surface of the water between the Great Barrier Reef and the eastern coastline that generates waves. This results in significantly lower wave heights in Northern and Central Queensland when compared to the rest of the coastline of Australia.

Nevertheless beaches in this sheltered area of the Australian coastline are also shaped by the energy waves exert on the beach. The beach morphology in this region often reflects waves generated by tropical cyclones and storms. These waves are considerably larger as a function of the higher wind velocities applied to the water surface.

This section of the report attempts to characterise the wave climate that may be possible during 'calm conditions' and 'storm conditions' so that extrapolation can be made towards what would occur during cyclone-level events. Two field trips were undertaken to Midge Point to gauge the wave climate. One field trip was undertaken between 28-30 March 2011 during stormy conditions (Figure 34 and Figure 35) when strong winds occurred (in the order of 70km/hr winds with gusts up to 80km/hr. from the south-east) and another field trip was undertaken between 02 – 05 May 2011 during calm conditions (Figure 36). Numerous follow-up field trips were made throughout 2011 and 2012, and qualitative observations of wave height were recorded.

Figure 34: Storm debris on the upper beach of Midge Point from a storm between the 28th and 30th March 2011.

Figure 35: Severe wave conditions experienced between 28-30 March 2011.

Figure 36: Calm wave conditions experienced during calm/normal winds.

5.7.1 STORM CONDITIONS

Wave conditions during a storm experienced on the 28-30 March 2011 resulted in wave heights between 0.74 m and 0.36 m. Wave height during the storm was linked to wind speed and wind gust speed (Figure 37), where the wave height plot closely follows the wind speed plot.

Wave lengths also varied between 16.5m and 5.5m during the period. Wave period was directly observed and varied between 7 seconds and 3.5 seconds. The wave breaking zone was several hundred metres wide with waves breaking 2-3 times as they approached the shore.

A very strong southerly / south-westerly current was observed by the field staff during these storm conditions when equipment was retrieved on the 29th March. This observation does not fit with regional longshore transport models and theories of a northwards longshore drift along the Queensland coastline.

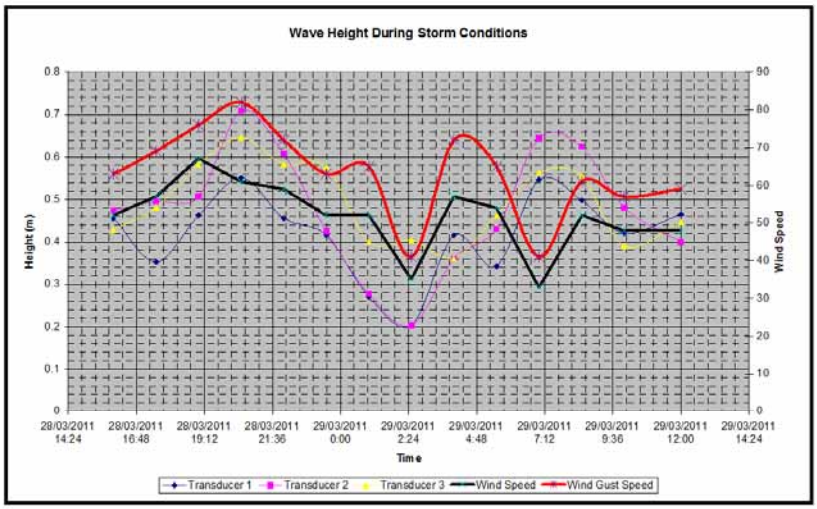


Figure 37: Wave height and wind speeds during storm conditions on the 28-29 March 2011

The collected data were used to calculate further wave parameters particularly useful for investigation of sediment transport. A number of wave theories, which explain the dynamics and inter-relationship of various wave characteristics, exist and have varying degrees of complexity. A plot of the relevant wave characteristics on Figure 38, developed by the US Army Corps of Engineers (2011), reveals that Stokes 2nd Order wave theory applies to the wave characteristics recorded on-site during storm conditions (H/gT^2 values between 0.0006 and 0.004) and d/gT^2 values between 0.001 and 0.02).

Water particles beneath waves exhibit an elliptical motion (called the orbital motion). The orbital velocity can be calculated according to the equation presented below for 2nd Order Stokes Waves.

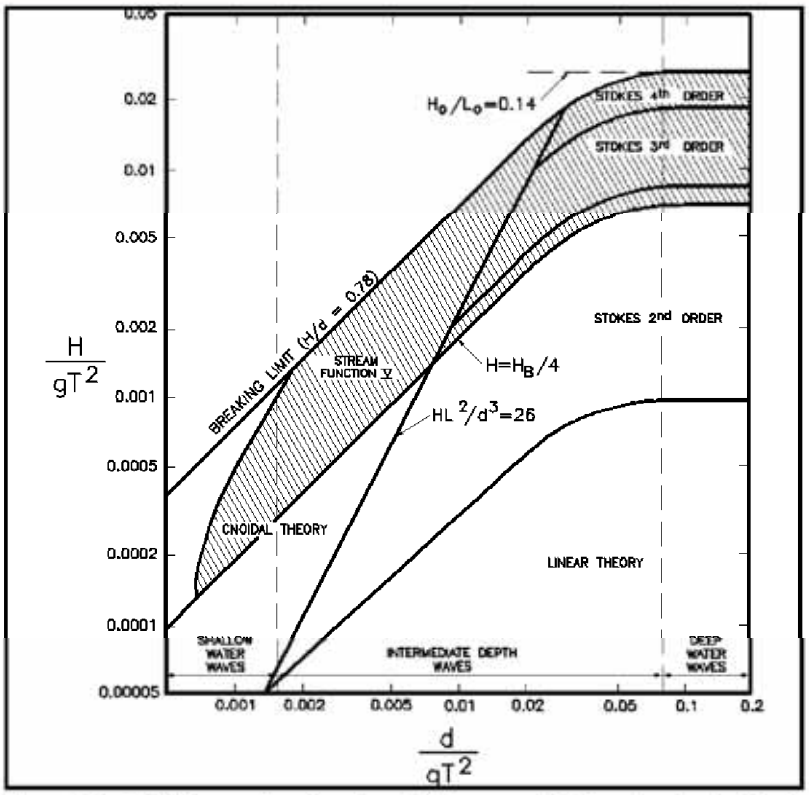


Figure 38: Suitable wave theories dependant on wave height and water depth ratios to wave period (USACE, 2011). H = wave height; T = wave period; d = water depth; g = gravity

Equation 2: Average horizontal drift velocity equation under 2nd Order Stokes Waves

$$\bar{U}(z) = \left(\frac{\pi H}{L}\right)^2 \frac{C}{2} \frac{\cosh\,[4\pi(z+d)/L]}{\sinh^2\,(2\pi d/L)}$$

U(z) = Average drift velocity

H = Wave Height (m)

L = Wave Length (m)

C = Wave Celerity (m/sec)

d = water depth (m)

Equation 1 allows estimation of the *mass transport velocity* beneath 2nd Order Stokes Waves. Consequently the wave parameters measured at Midge Point during Storm Conditions were input into the equation. Theoretically the equation can be used to calculate the mass transport velocity for any depth beneath the waves. However, for the

purposes of this study, the velocity 1cm above the bed was used as an indicator for bottom velocities.

During the conditions experienced at Midge Point, the U(z) values calculated varied from between 0.0007m/sec (0.7mm/sec) to 0.11m/sec (110mm/sec) with an average velocity of 0.016m/sec (16mm/sec). These velocities are relatively small and are not likely to induce sediment transport.

The conditions at Midge Point were used to construct a model of U(z) values for varying water depths and using conditions using extrapolated observed data. The following details and assumptions are applicable:

- A maximum wave height of 0.8m was assumed (the mean wave height recorded of 0.461m + 3x standard deviations of 0.114m);
- Wave period data (used to calculate wave length and celerity) were input as the minimum observed (3.25 seconds) and the maximum observed (approx. 7.7 seconds);
- Wave length was calculated based on the assumed wave height of 0.8m and the minimum and maximum wave period data. This provided a minimum wave length of 9.1m and a maximum wave length of 21.5m;
- Wave celerity was calculated using wave height data only and is approximately 2.8m;
- The minimum and maximum Stoke's drift velocity were then calculated for varying depths ranging from 0.1m to 5m with a wave height of 0.8m. The results are presented in Figure 39.

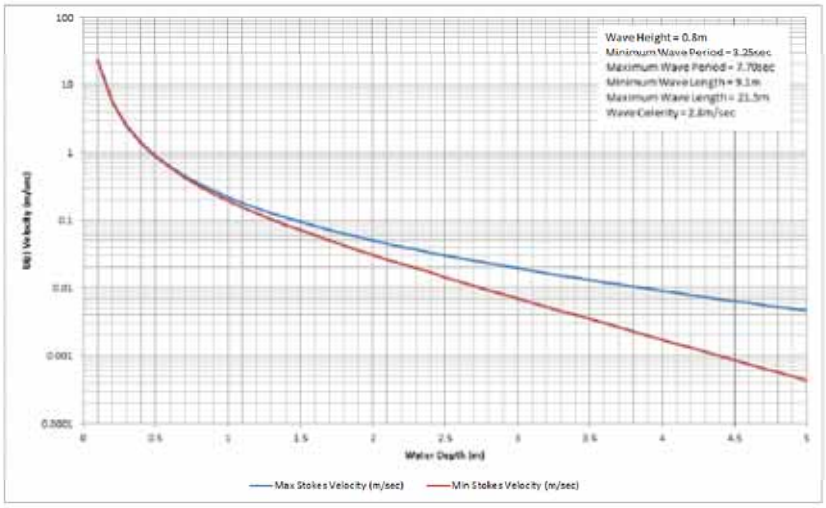


Figure 39: Maximum and minimum orbital velocities expected with 0.8m waves

During cyclonic conditions these values are expected to be much higher. DEHP Storm tide monitoring at Laguna Quays has indicated that the peak wave height reached 6.3m and the wave period reached 10 seconds during Cyclone Ului. The wave height values are more than 6 times that experienced during storm conditions at Midge Point, and the wave period approximately double.

Development of a wave propagation model for this region was outside the scope of works of this study. It is anticipated that wave refraction and shoaling at Midge Point is relatively straight forward. The dominant wind directions are normal to the orientation of the beach –

i.e. wave crests will approach the beach generally between 60 and 120 degrees orientation to the beach. Minor interference to linear wave progression is expected from offshore islands. Wave refraction was observed in the field at the southern end of Midge Point near the mouth of Yard Creek, and particularly at offshore flats at the mouth of Dempster Creek at low tides. At high tides (including King tides) the evidence of wave refraction in these areas is greatly reduced, obviously from the increased water depth.

5.7.2 CALM CONDITIONS

Wave height experienced during calm conditions is sufficiently small to result in very little bottom velocities. Wave heights during these conditions can range between 0.1 and 0.5m, with 0.5m waves experienced during especially windy times, bordering on storm conditions.

These wave heights will generate very small bottom velocity values. Furthermore the waves will only exert any influence on the bed in very shallow conditions. Wave processes will have little role in shaping

Ideally wave recording instruments would be deployed for long periods of time (i.e. 2 week periods for several times per year). However time, budget and equipment memory constraints for this project did not allow for this to occur. Instead, several field trips were made following these two initial periods of wave recording so that qualitative observations could be made of the wave climate based on the initial quantitative survey. It was observed that the typical wave climate at Midge Point is similar to conditions experienced during the 'calm' recording period (i.e. wave heights between 0.1 to approximately 0.3m height). The size of these waves are inconsequential to sediment transport.

5.8 WAVE MODELLING

A series of preliminary wave propagation models were prepared to further understand the wave processes applicable at Midge Point. This modelling was undertaken to determine whether less robust quantitative and qualitative observations could be supported from common modelling approaches.

5.8.1 REGIONAL WAVE PARAMETER ESTIMATION – ST-WAVE

The STWAVE (STeady State spectral WAVE) model was developed by the US Army Corps of Engineers Coastal and Hydraulics Laboratory (CHL). The model simulates depth-induced wave refraction and shoaling, wave breaking and wave growth from wind inputs. The model was used in the 'half-plane' configuration, meaning that energy reflected back into the model domain from the land was not considered.

The STWAVE model was used as a regional model to determine the interaction of wind, waves and offshore islands on the wave climate at Midge Point. The model uses a series of boundary conditions, where a number of factors can be specified in differing groups, depending on the wave spectra used. The JONSWAP spectrum was used to calculate wave group characteristics based on wind parameters input into the model. This spectrum was developed by correlations between wind and wave frequencies in the mid-Atlantic and is one of only a few (and the default) regional spectra available to the STWAVE model. The input wind parameters were:

Storm Conditions

- Wind speed of 20m/sec (72km/hr), similar to what was experienced at Midge Point in March 2011
- Wind directions of 110 degrees and 150 degrees as two different models

Since the STWAVE model was undertaken to determine regional-scale relationships, bathymetry was represented by a fairly coarse (100m) grid. This allowed for quick run-times. However, a finer-resolution grid (5m), created from Mackay City Council 2009 contour information, was embedded into the coarse resolution grid around Midge Point to enhance the resolution of the calculations in the study area (Figure 40).

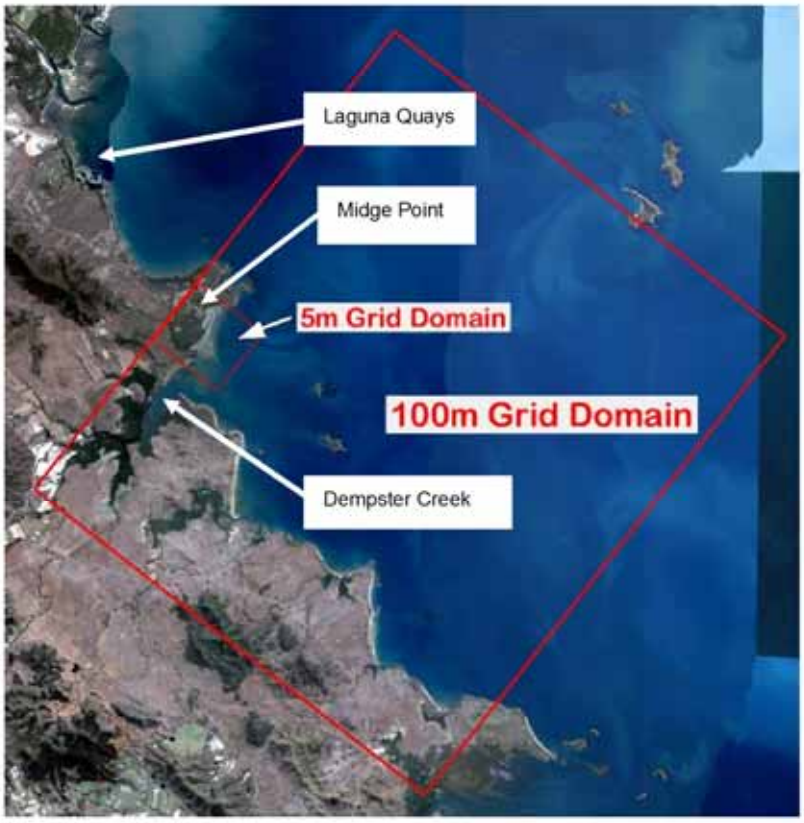


Figure 40: STWAVE model extents

Results of the coarse regional modelling and fine-scale local model are shown below in Figure 41. It is evident that the offshore islands interfere with wave propagation at Midge Point, causing the wave approach angle to the beach to be from 110 degrees, regardless of variances in wind direction. Offshore wave heights are between 1.2 to 1.4m, when the wind blows from 110 degrees. However wave heights are significantly less (i.e. between 0.8-1.2m) when the wind comes from approximately 130 degrees (Figure 41).

Although it would appear otherwise in Figure 41, the wave approach to the beach at Midge Point during lower tides is approximately at 90 degrees to the beach. The shoreline outlined in the model below has been generated from 10m contours (i.e. is fairly coarse), and represents a height of 3.0m AHD, roughly the level of King Tides. When the aerial photograph is examined, showing the intertidal area, the wave approach angle at Midge Point is roughly normal to the beach face.

The modelling results show wave heights of approximately 0.4-0.6m in waters with a depth between 0.3m and 2m as experienced during 'Storm conditions' at Midge Point.

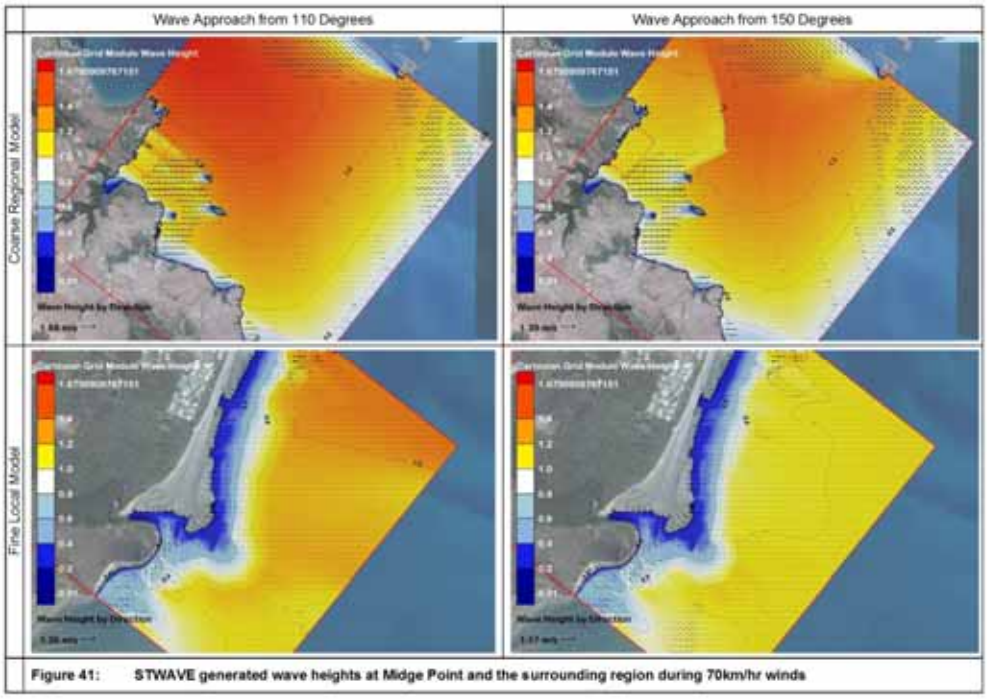


Figure 41: STWAVE generated wave heights at Midge Point and the surrounding region during 70km/hr winds

80

5.8.2 FINE-SCALE NUMERICAL MODELLING - BOUSS 2D MODEL

The BOUSS-2D model is a comprehensive finite difference 2D solution for the Boussinesq equations, which are uniformly valid from deep water to shallow water and can simulate wave refraction, shoaling, reflection, energy dissipation resulting from wave breaking and the development of rip currents and longshore currents caused by wave breaking. This model is unique and differentiated from most wave propagation models (like other models such as STWAVE, and, more commonly used in Australia, SWAN) that use a steady-state solution. BOUSS-2D is much more intensive than other wave propagation models because it models **each** individual wave in two spatial (x and y) dimensions as well as a third dimension (time). The results of the model can then be used to create a three-dimensional grid which shows wave shapes, refraction and shoaling, average velocity and average velocity direction. Subsequently the BOUSS-2D model was used at a high resolution to evaluate site-specific processes caused by / acting on, the bathymetry at Midge Point.

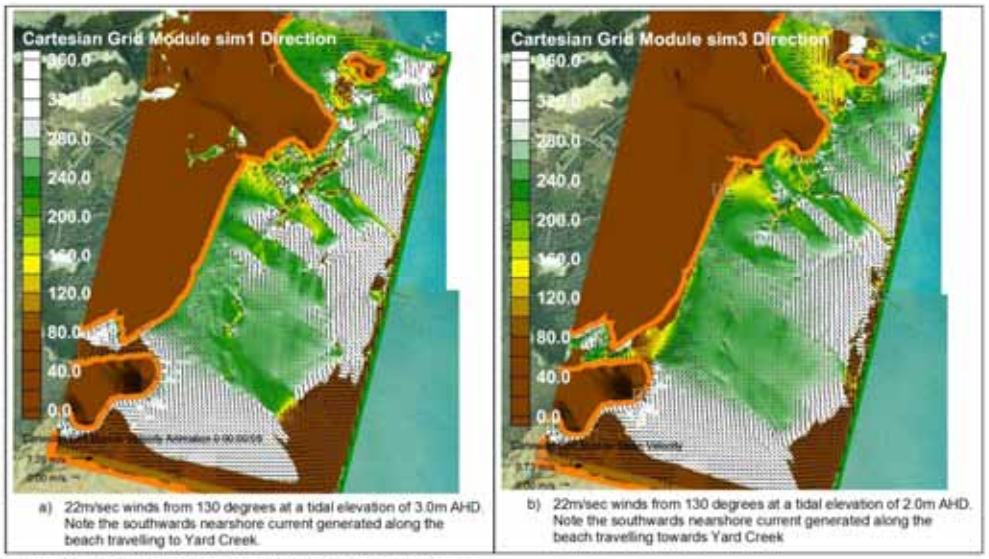
The following parameters were specified for the Bouss 2D model:

- The seaward boundary condition was designated as a "Wave Maker". Many different wave scenarios were specified and evaluated in the model. Each scenario had the following universal characteristics
  - Bouss 2D synthesised the waves as "Irregular, unidirectional" waves according to the JONSWAP Spectrum. Input parameters included:
    - Various wind speeds (in m/sec) at 10m above the sea surface with fetch distances of 300km.
    - The minimum wave period was specified as 3.01 seconds. The maximum wave period was limited to 25.0 seconds by the model.
- A Chezy coefficient (resistance exerted by the bed) of 30 was assumed;
- The model was run for one hour with a timestep of 0.5 seconds on a 10m grid

The above parameters were applied to all simulations run using BOUSS 2D. The variables for each simulation are outlined below. The average velocity direction, as well as maximum velocity, generated by the wave climate modelled at Midge Point are outlined below in Figure 42 to Figure 45

Table 4: BOUSS 2D modelled scenarios

Scenario	Wind / Waves		Tide height
	Magnitude	Approach Angle	
Simulation 1	Wind: 22m/sec Fetch 300km	130 degrees	3.0m AHD
Simulation 2	Wind 22m/sec Fetch 300km	110 degrees	3.0m AHD
Simulation 3	Wind 22m/sec Fetch 300km	130 degrees	2.0m AHD
Simulation 4	Wind 22m/sec Fetch 300km	110 degrees	2.0m AHD

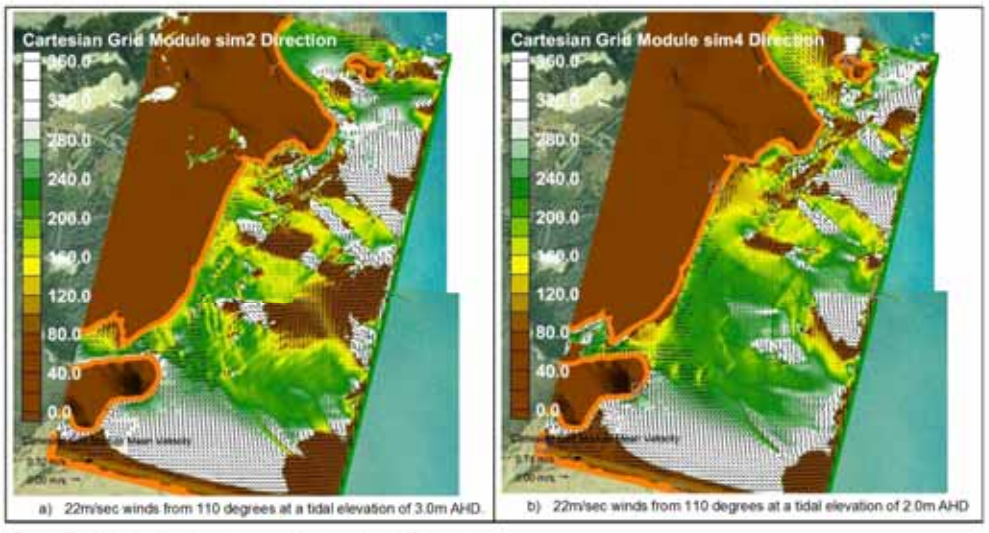


a) 22m/sec winds from 130 degrees at a tidal elevation of 3.0m AHD. Note the southwards nearshore current generated along the beach travelling to Yard Creek.

b) 22m/sec winds from 130 degrees at a tidal elevation of 2.0m AHD. Note the southwards nearshore current generated along the beach travelling towards Yard Creek

Figure 42: Velocity directions generated from winds at 130 degrees

82



a) 22m/sec winds from 110 degrees at a tidal elevation of 3.0m AHD.

b) 22m/sec winds from 110 degrees at a tidal elevation of 2.0m AHD

Figure 43: Velocity directions generated from winds at 110 degrees

83

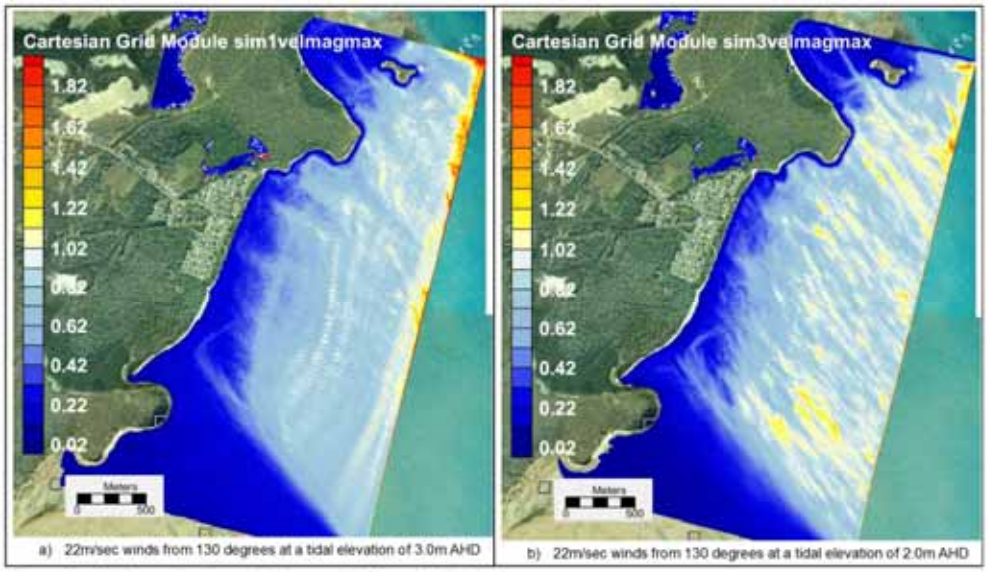


Figure 44: Maximum velocity magnitude generated from winds at 130 degrees

84

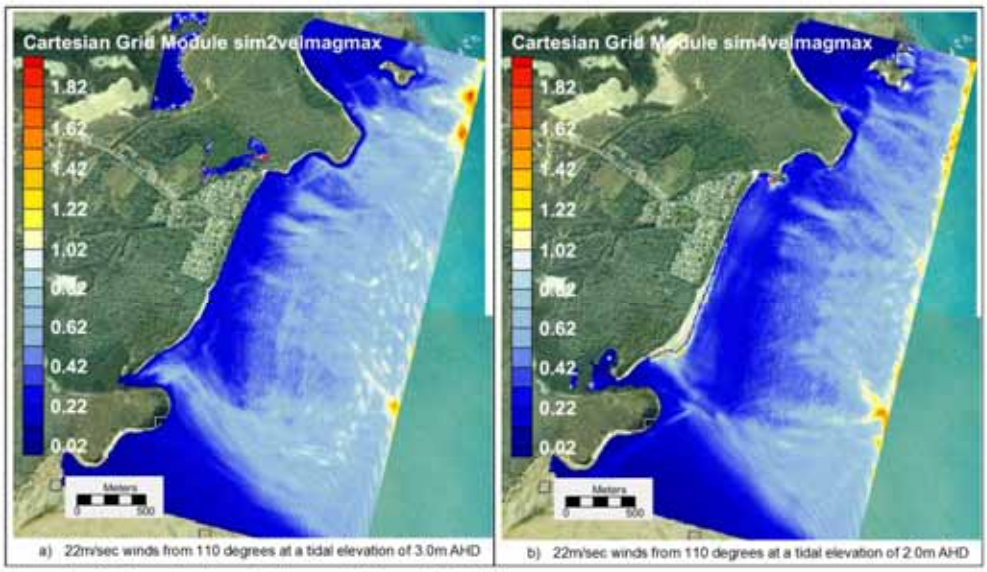


Figure 45: Maximum velocity magnitude generated from winds at 110 degrees

85

The modelling results show:

- There is a distinct southwards and offshore current (velocity direction) generated by large, wind driven waves from winds of at least 70km/hr (20m/sec) (Figure 42 and Figure 43)
- This southwards current is more prevalent when waves approach from 130 degrees (as experienced in the field during storm conditions) as opposed to 110 degrees ((Figure 42 and Figure 43)
- There is little difference in wave-generated currents between tidal elevations of 3.0m AHD and 2.0m AHD when waves approach at 130 degrees (Figure 44)
- There is a significant difference in wave-generated currents between tidal elevations of 3.0m AHD and 2.0m AHD when waves approach at 110 degrees (Figure 43)
- Wave generated velocities in the mouth of Yard Creek (assuming minimal discharges coming from the creek) are considerably larger when waves approach the beach from 110 degrees compared to 130 degrees (Figure 44 and Figure 45)
- Wave generated velocities are greater, higher up the northern beach, when waves approach from 130 degrees as opposed to 110 degrees (Figure 44 and Figure 45). This creates a stronger southward current (Figure 42 and Figure 44) than when waves approach from 110 degrees (Figure 43 and Figure 45)
- The significant offshore wave height (not shown in Figure 42 to Figure 45) is approximately 1.5m.

5.8.3 FINE SCALE NUMERICAL MODELLING - BOUSS 1D WAVE ANALYSIS

BOUSS can also be used in one dimension to undertake modelling based on beach transects. The graphical output of the one-dimensional analysis conveys the processes operating along the beach much easier than the two-dimensional outputs. Furthermore, the runtime for one-dimensional analysis is much quicker than for the two dimensional modelling as undertaken above.

One dimensional analysis was undertaken to determine the various responses and velocities occurring at Midge Point based on various tidal heights. One dimensional analysis is undertaken along one transect. In this analysis, the approach angle of the waves does not matter as the waves can only propagate in one direction, along the given transect. The location of the transect analysed is provided in Figure 48 below.

Figure 46: Location of the 1D transect modelled

The one-dimensional analysis identifies areas where sand is readily lost and/or subject to rapid transport. It also allows rapid and quick identification of changes to wave processes between transects taken of the beach at different times under the same wave conditions and/or assumptions.

Table 5: BOUSS 1d simulation configurations

Scenario	Wind Parameters	Tide	Topography
Simulation A1	Wind: 22m/sec Fetch 300km	3.0m AHD	High resolution LIDAR 2010
Simulation A2	Wind 22m/sec Fetch 300km	2.0m AHD	High resolution LIDAR 2010
Simulation A3	Wind: 22m/sec Fetch 300km	1.0m AHD	High resolution LIDAR 2010
Simulation A4	Wind 22m/sec Fetch 300km	0.0m AHD	High resolution LIDAR 2010
Simulation A5	Wind 5m/sec Fetch 300km	3.0m AHD	High resolution LIDAR 2010
Simulation B1	Wind: 22m/sec Fetch 300km	2.0m AHD	Survey Data 2011

Scenario	Wind Parameters	Tide	Topography
Simulation B2	Wind 22m/sec Fetch 300km	1.0m AHD	Survey Data 2011
Simulation B3	Wind: 22m/sec Fetch 300km	0.0m AHD	Survey Data 2011
Simulation B4	Wind 22m/sec Fetch 300km	3.0m AHD	Survey Data 2011

Not all simulation results outlined above are shown in this report. However those simulations which could shed light on meaningful processes operating at Midge Point are described below.

The 1D results are shown in Figure 47 below. Note that the water surface elevation is not plotted at the correct tidal elevation compared to the transect; but waves plotted on the transects occur in the correct x-axis position for the defined tidal elevation.

5.8.3.1 Model Results

The 'mean velocity' plot for each simulation outlined in Figure 47 confirm that the net water / particle movement from wind-driven waves is offshore (i.e. negative velocities). However waves occurring at tidal elevations at 1.0m AHD cause the water movement / particle movement to be onshore (i.e. positive velocities) (Figure 47 c) and f)). The model results also confirm the 2D results which estimate a wave height of approximately 1.5m generated from 22m/sec (70km/hr) winds.

It is evident that high tides reaching 3.0m AHD or higher have been responsible for the changes in the beach profile since 2010 when Figure 47 a) and d) are compared. Wind generated velocity peaks between chainage 1400 and 1600, right in the vicinity of denudation in the transect near the upper beach. This supports the conclusions made later in the report that erosion at Midge Point is not in the form of lateral erosion of the foredune / scarp, but more so vertical erosion and denudation of the beach profile. Even seaward of the velocity peak, wave driven velocities occur at approximately 0.1m/sec, enough to transport silts to gravels.

Denudation of the beach profile between 2010 and 2011 has resulted in a net increase in velocity applied to sediments in front of the erosion scarp from the same tidal and wave conditions (refer Figure 47 b) and e)). Waves generated by 22m/sec winds would apply a velocity of approximately 1.0m/sec to sediments in front of the foredune / scarp in the 2010 beach profile. Loss of sediment from this location since has caused wave-generated velocities to slightly increase to 0.15m/sec, increasing the probability of sediment loss from this location.

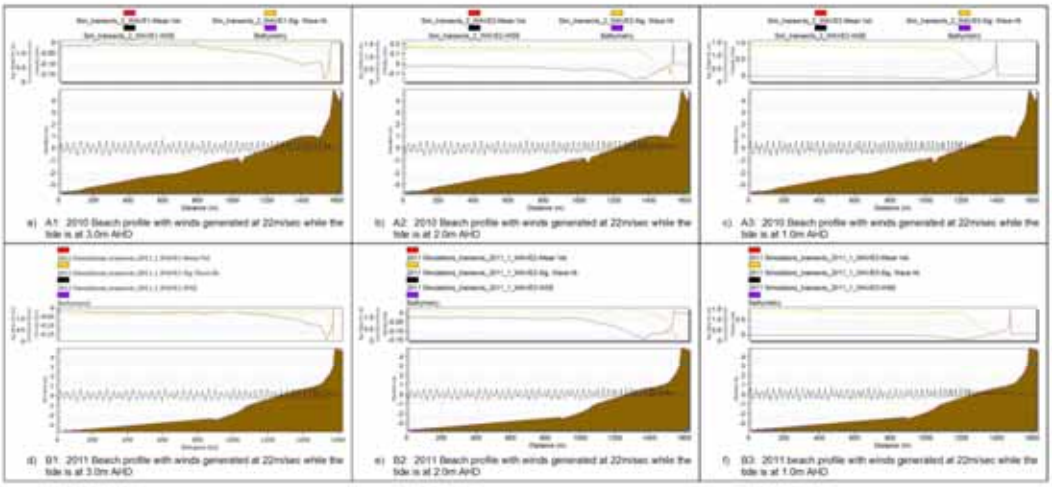


Figure 47: Boussi 1D model results for storm conditions

5.8.4 WAVE MODELLING CONCLUSIONS

Various wave models (STWAVE, BOUSS 2D and BOUSS 1D) were developed for Midge Point at a variety of different scales and to examine a variety of different scenarios. The results of the modelling were used to test, and further examine, the storm conditions observed at Midge Point between 28 to 30th March 2011, so that meaningful extrapolation to extreme events can be made. The results of the modelling show:

- Offshore islands create interference for wave propagation at Midge Point when winds come from the predominant directions between 110 to 150 degrees (Figure 41). This interference causes wave approach angles to the northern end of the beach to be from 110 degrees, regardless of variances to the direction of south-easterly winds.
- 22m/sec (approx. 70km/hr) winds generate an offshore wave height of approximately 1.5m according to all models. This is then propagated onto the beach and subject to local variations.
- Wave approach angles of 110 and 130 degrees produce a south-westerly and southerly current (Figure 42 and Figure 43). This is responsible for a net transport of sediment from the northern end of the beach to the southern end of the beach, and, fits qualitative observations of a southerly current during storm conditions at Midge Point.

5.9 TIDES

5.9.1 INTRODUCTION

Areas around Mackay have a large tidal range, with Mackay having a tidal range of approximately 6m. The tides of the area are semi-diurnal[3]. The tidal regime in the region is significantly influenced by the shallow waters of the continental shelf and the Great Barrier Reef Lagoon, causing tidal amplification that reaches resonance near Broadsound. Throughout the entire Mackay Coast area there is a noticeable asymmetry to tidal movements (EPA, 2004). Generally the ebb tide (outgoing tide) runs for approximately 6.3hours and the flood tide (incoming tide) runs for 6.2 hours. This causes peak ebb velocities approximately one hour after high-water and peak flood velocities approximately one hour after low water (EPA, 2004).

Tides run in a spring-neap cycle with the higher tides experienced on an approximate two week cycle. Spring tides generally occur when the sun and moon are in alignment (either the new moon or the full moon). Neap tides fall between these periods, when the gravitational pull of the moon and sun are not in alignment. The general spring-tide and neap-tide cycle for Mackay for the period of 26 February 2011 and 27 April 2011 is shown in Figure 48.

[3] High tides occur twice in any given 24 hour period

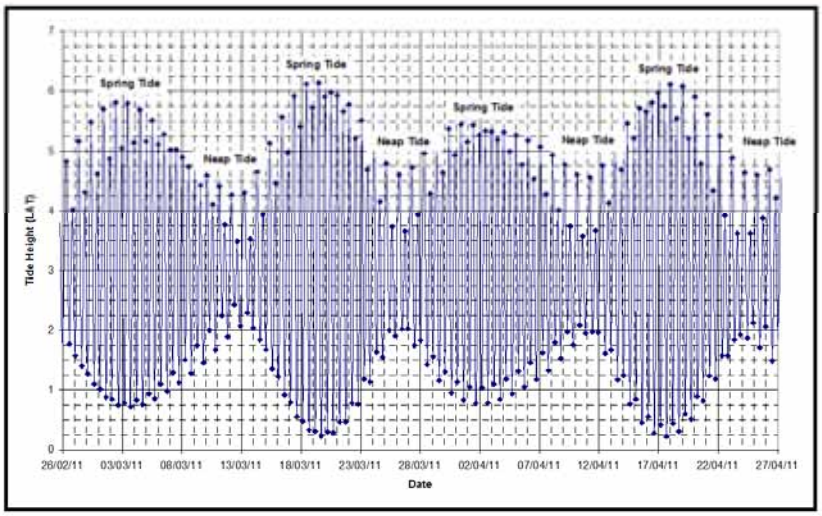


Figure 48: Spring and neap tidal cycles at Mackay.

5.9.2 TIDAL VELOCITIES

Analysis of tidal velocities is undertaken to determine the ability for tidal currents to maintain sediment entrainment once transported offshore by wave action. An Acoustic Doppler Current Profiler (ADCP) works by separating the water column below the sensor into a series of 'cells'. The sensor then provides the average readings (velocity and direction) of these 'cells'. The size of the 'cells' will be dependent on the depth of the water column. A deeper water column will result in larger cells whilst a shallower water column will result in relatively small cells. This analysis examines the velocity and direction of the 'bottom cells' during multiple transects undertaken at Midge Point.

The ADCP data (refer 4.2.6, page 46) have been analysed for patterns in bottom current speed and direction with a view to characterising the velocities acting on the bottom sediment under the tidal regimes (including waves at the time) observed.

A frequency diagram shows the number of times a certain value, or range of values, occurs throughout an entire record. This allows quick analysis of the maximum values, the average values and also shows the most commonly occurring values. A frequency diagram of the bottom velocities found at Midge Point during the survey is plotted below as Figure 49. From this analysis it can be seen that velocities from 0.15m/sec to 0.25m/sec were the most frequent in all ADCP transects. There are considerable number of bottom velocities encountered between 0.5 and 0.75m/sec (Figure 49) while the maximum encountered was approximately 1.5m/sec where there were three recordings.

The average bottom velocity is approximately 0.21m/sec. However the average of the frequency curve produced in Figure 49 corresponds to 900 (i.e. a velocity that is encountered 900 times in the ADCP data). Velocities between 0.45m/sec and 0.5m/sec are associated with this frequency in the record. This can be taken to mean that the average velocity that occurs from tidal currents acting on the bottom of the bed is in the vicinity of 0.45m/sec, since this is the average of the entire distribution of cells.

The spatial relationship of the frequency results shows the increased number of points with relatively high velocities at the mouth of Dempster Creek (Figure 50) compared to those directly adjacent to Midge Point, became apparent. These high values are found in the

mouth of the creek itself, as well as in the off-shore sub-surface channel created by the extensive silt deposit at the mouth of the creek (Figure 50).

The results from Dempster Creek were removed and the following statistics from the amended dataset are provided:

- Velocities between 0.15m/sec and 0.25m/sec are still the most frequently occurring;
- The maximum velocity encountered dropped from 1.5m/sec to 0.8m/sec; and
- The average bottom velocity is approximately 0.2 to 0.3m/sec

It is anticipated that velocities reported on the bottom 'cells' by the ADCP are purely from tidal currents and have minimal interference from orbital water motions beneath waves. Wave heights were approximately 20 to 30cm at the time of ADCP survey, characterised by the 'calm conditions' identified in Section 5.7.2.

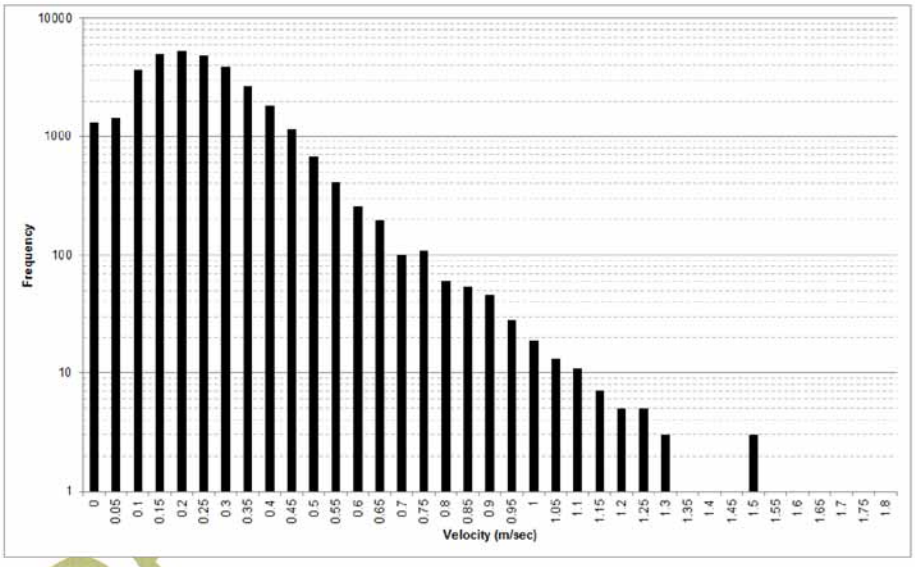


Figure 49: Frequency diagram of bottom velocities experienced in the ADCP Survey.

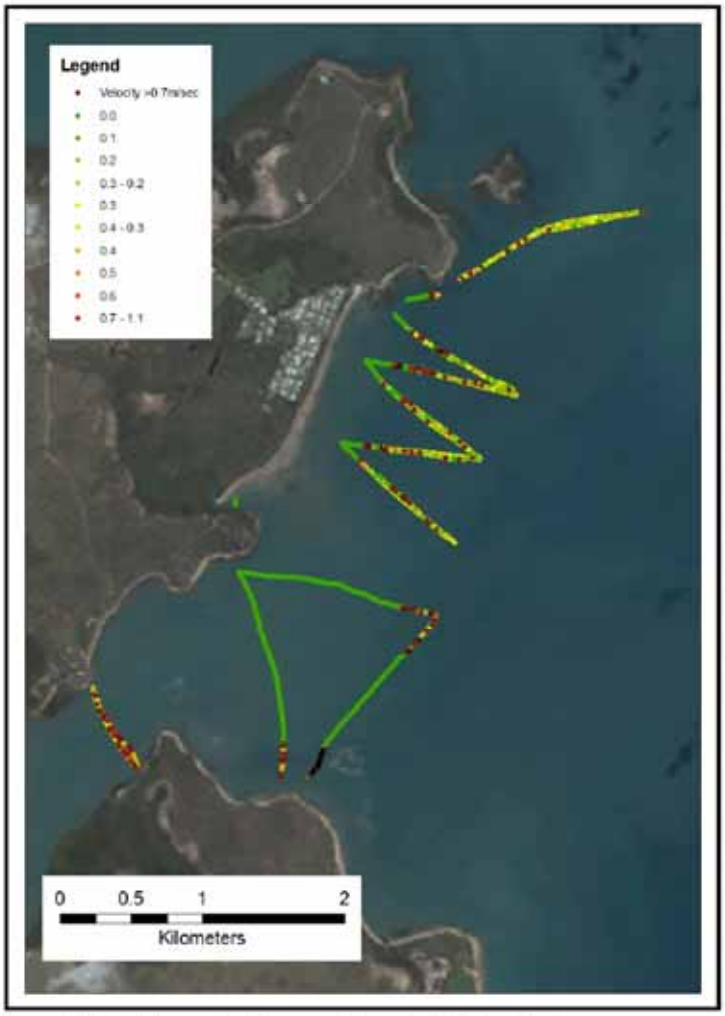


Figure 50: Bottom velocities experienced at Midge Point.

5.9.3 TIDAL VELOCITY MODELLING

A brief tidal inundation model was undertaken at Midge Point to quantify the velocities present under relatively extreme conditions. The January 2009 King-Tide was modelled in CMS Flow, a component of the Coastal Modelling System (CMS) developed by the US Army Corps of Engineers.

The model was developed for a similar extent as the BOUSS-2D model. The model projected a water surface elevation into the grid from input data along the entire south-eastern boundary of the 2m grid. The input data was a conceptual tidal elevation curve in AHD generated from predicted tidal levels at Laguna Quays for the 2009 event (recorded data were not available).

The maximum velocity along the inter-tidal zone reached approximately 0.2m/sec (Figure 51). Velocities at the mouth of Yard Creek were much higher (i.e. up to 2.25m/sec), as expected (Figure 51).

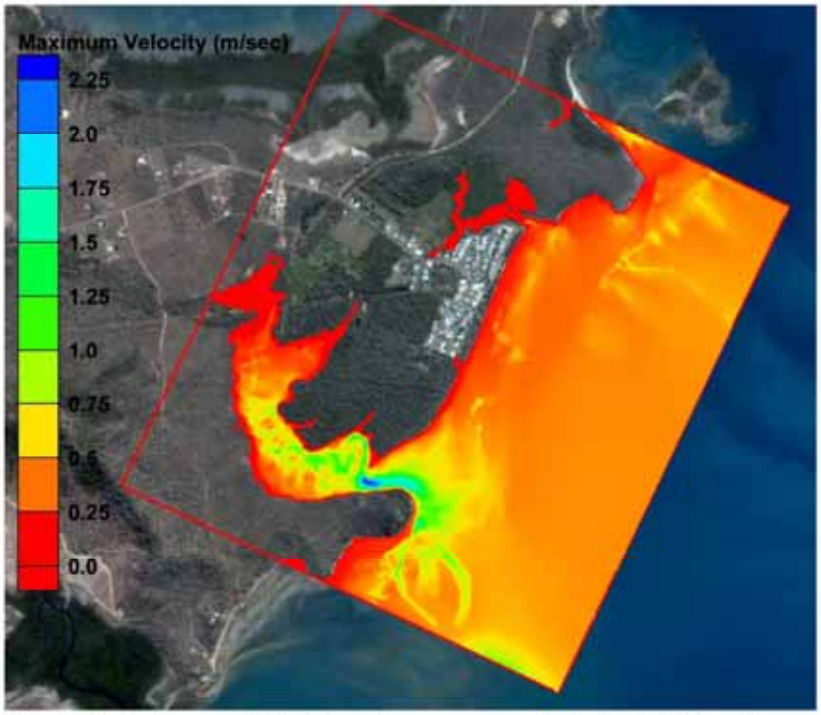


Figure 51: Maximum velocities from tidal movements during the 2009 king-tide

5.10 STORM SURGE INUNDATION

Tidal range at Midge Point is approximately 6m in one year. Combined with a particularly low beach profile at low tide, this creates extremely rapid in-coming and out-going tidal movements that are exaggerated during the period of Highest Astronomical Tide (HAT) (approximately 3.33m AHD). This indicates that during a period of Highest Astronomical Tide, the height of the tide has to rise, and then fall, by 6.0m in a 12 hour period. The heights of HAT and the Mean Sea level (MSL) are given below in Table 6 and also in Appendix 5. Tidal heights are often measured in metres above the Lowest Astronomical Tide (LAT) otherwise known as gauge datum whilst heights on land are measured in the Australian Height Datum (AHD). The conversion between AHD and LAT has also been given below in Table which shows that 0m AHD is equivalent to 2.80m LAT at Midge Point.

Table 6: Tidal characteristics for Midge Point.

LOCATION	HAT	MSL	AHD
Laguna Quays / Midge Point	6.13m LAT 3.33m AHD	2.78m LAT -0.02m AHD	2.80m LAT

Storm surge occurs when low-pressure systems associated with tropical cyclones or severe weather patterns reduce the ambient pressure placed on the sea surface by the overlying air allowing the water surface to rise above its normal condition. Storm surge poses substantial risk to coastal infrastructure, particularly if coinciding with a high tide, and/or HAT (i.e. King Tides). The cyclone season in tropical northern Australia is typically coincident with King Tides, or the highest tides of the year. Two to four metre increases in sea level are not unusual during storm surge activity.

Sea levels are not static and 'locked' but are constantly changing through time. Sea level rise as a result of anthropogenically influenced climate change is currently a hotly debated topic in both Australia and the rest of the world. Regardless of whether anthropogenic influences are causing sea level rise, natural causes are also contributing to sea level rise. Data gathered from Mackay from 1975-2004 indicate an approximate rise of 1.2mm/yr. in the mean sea level, some 36mm over the length of the entire record. This gradual sea level rise may be the source of changing beach regimes.

Modelling undertaken by Hardy *et. al.* (2004) to gauge the level of storm surge impact (inclusive of cyclones) for an AEP of 0.02 (1 in 50 year) and 0.01 (1 in 100 year) respectively (Table 7 and Figure 52) provide a still water level of 3.54 and 3.56m AHD. Adding storm surge, tide and an 0.8m greenhouse gas allowance raises these levels to 4.37m AHD and 4.39m AHD for the 0.02 and 0.01 AEP respectively. With an 0.5m sea level rise scenario the values correspond to 4.07 and 4.09m (Table 7).

Considering Mackay has a higher tidal range than Midge Point it is expected that the values at Midge Point are slightly lower than what would be calculated at Mackay. Data from Hardy *et. al.* (2004) has been used to predict storm surge inundation for other areas in the Mackay Council so this approach is being used.

DERM Storm Tide Monitoring shows that the level of 'storm surge' generated by Cyclone Ului was approximately 2.45m at Laguna Quays above the predicted tide at the time that the cyclone crossed the coast. This resulted in the actual tide exceeding HAT by 0.4m (tide reached 6.7m above LAT or 3.7m AHD).

Table 7: Tidal statistics for Midge Point (Laguna Quays). Source: Hardy *et al.* (2004).

	Annual Exceedence Probability	
Parameter	Return Period 1:50 (0.02 AEP) *(Estimated from Hardy et al 2003)*	Return Period 1:100 (0.01 AEP) *(From Hardy et al 2003)*
Storm Surge + Tide	~3.54m AHD	3.56m AHD
Storm Surge + Tide + 0.3m Greenhouse Allowance	~3.87m AHD	3.89m AHD
Storm Surge + Tide + 0.5m Greenhouse Allowance	~4.07m AHD	4.09m AHD
Storm Surge + Tide + 0.8m Greenhouse Allowance	~4.37m AHD	4.39m AHD

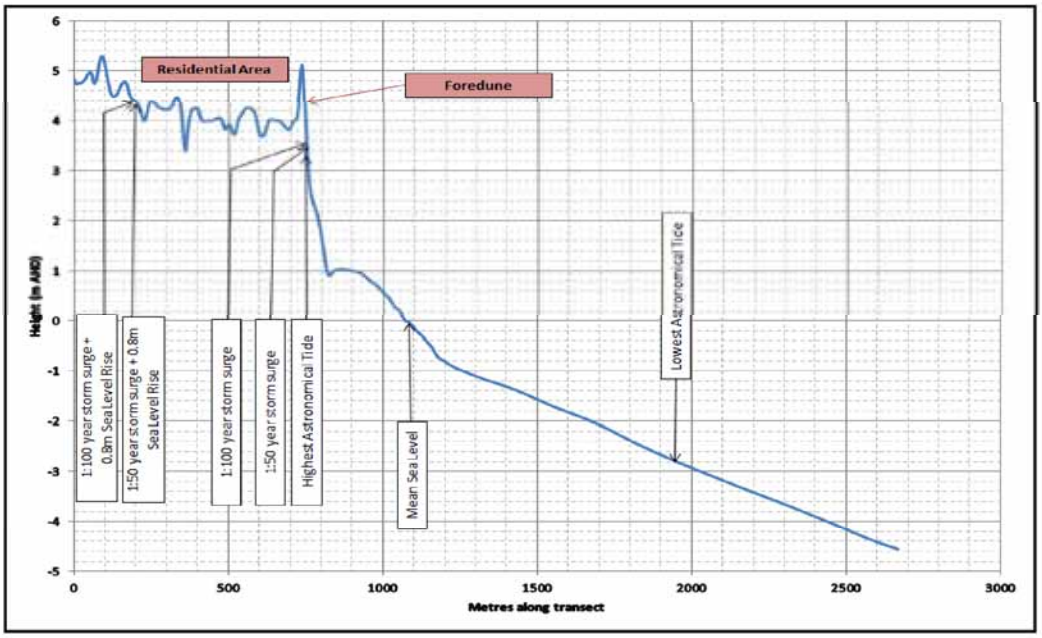


Figure 52: Cross section through the beach showing critical tide levels

98

The exceedence probabilities outlined in Table 7 only apply to the still water level, consisting of sea level rise, tidal actions and storm surge. During a storm, wave set-up[4] and wave run-up[5] greatly increase the level to which waters can reach. Observations during this study suggest that wave set-up and wave run-up are substantial contributors to the location of wave action along the beach profile at Midge Point. During storm conditions experienced between the 28-30 March 2011, the highest water level reached approximately 3.5m AHD (the base of the current erosion scarp) between a neap-spring tide cycle. During a later field visit on 02-05 May 2011 during a spring tide, the high tide reached only approximately 1.5m AHD .This shows the influence of wave set-up, wave run-up and storm surge can have at Midge Point.

BOX 1: Wave Setup and Wave Run-up Calculations

Wave Setup = 0.232 x Wave Breaking Height

Wave Run-up = beach slope / ((deep water wave height / deep water wave length)^0.5)

Wave set-up and wave run-up under 'storm conditions' (28-30 March) encountered during field monitoring have been calculated to approximate 0.2m and 0.16m respectively using the equation outlined in Box 1. The combination of these values (0.36m) provides the conditions encountered during a typical storm. Cyclonic conditions will far exceed this value with wave set-up and wave run-up expected to increase to approximately 0.5 – 0.8m.

5.10.1 EXISTING PROTECTION FROM STORM EVENTS

It is not feasible to design mitigation measures to account for all possible scenarios along a beachfront. A level of risk needs to be assigned for any given piece of infrastructure, whether this risk is from overtopping or failure. That is, the infrastructure is designed to withstand a certain 'exceedence probability'. In commonly repeating systems, such as rainfall, tidal movements and storm surges, an annual exceedence probability outlines the chance of a specified event occurring in any one given year. This is calculated using all available records. However, the exceedence probability can be quite misleading if error and uncertainty have not been considered. For example, the limited data set available for tidal heights (30 years) in Australia creates a large uncertainty around the 0.01 AEP. Therefore if only 30 years of data have been collected, the accuracy of the 1 in 100 (0.01 AEP) event is not high. There are not enough data available to calculate the 0.01 AEP storm surge level for many areas along the Australian coastline.

At Midge Point, the residential area is currently provided with a natural buffer to storm surge inundation by the berm or foredune. A transect taken along the foredune to determine areas where this natural protection may be lacking (Figure 53) indicated that the foredune is above 5.0m AHD, in front of the residential area. However, this protection greatly declines towards the south-western end of the residentially occupied area where a drainage line, located just to the south of the existing caravan park, empties straight onto the beach. As expected, the western, unoccupied end of the beach is provided with less protection from storm surge from the foredune, averaging a height of approximately 4.5m AHD.

However, the sparsely vegetated foredune at the front of the settlement is made of lightly compacted sand grains that have been placed in-situ by the action of the waves. It is easily disturbed when any of the processes associated with beach dynamics (e.g. storm waves, changes in sea level height, changes to the angle of the incoming wave, or continued access across the dune) are changed. Once disturbance has begun, erosion will continue for as long as the offending process continues. Natural variations to the beach dynamic process are often abrupt intermissions of severe action, and, left alone, the long-term shape of the beach recovers rapidly to a situation relatively similar to the

[4] The process by which the average water surface slopes up towards the beach in shallow waters
[5] The process by which water is pushed against the beach, higher than the still water level, by the action of waves

previous morphology. If the erosion has a long-term component (e.g. a rise in sea level, a minor change in the direction of the dominant winds, or continued human breakage of the foredune), the erosional scar will increase as the action continues.

It should also be noted that height surveys taken along the main road leading away from the foredune, indicates that the settlement has been constructed on a slightly elevated section of the bay. This suggests that foredune breaching during high energy events (e.g. wave set-up on an elevated water level height) could allow waters to intrude into low lying areas of the settlement. If flooding from intense rainfall events also occurs concurrently with this process there could be serious implications for anyone who has not evacuated from Midge Point.

It is recommended that a risk analysis should be undertaken of the area and that this risk analysis should include an identification of the worst possible scenario for the foreseeable future, and that this should be used to construct an efficient, timely evacuation plan.

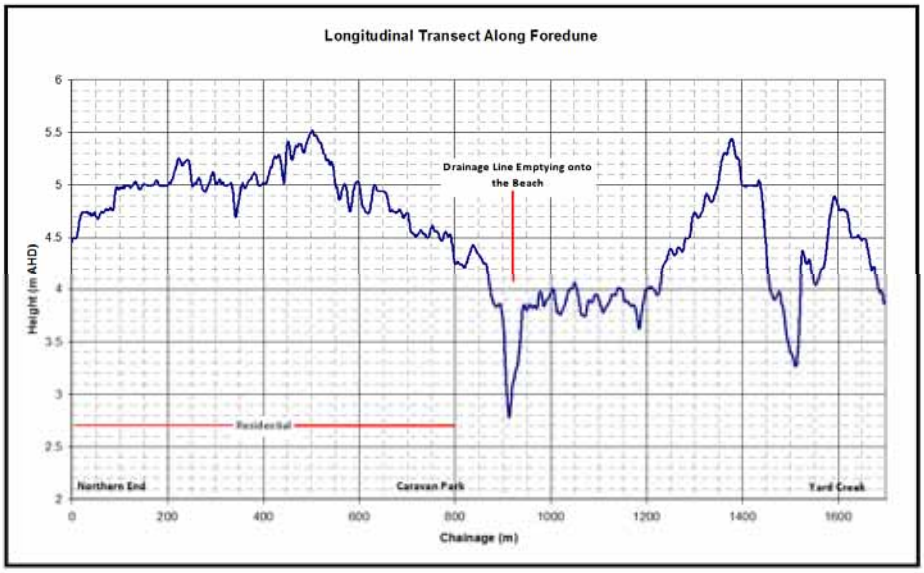


Figure 53: Longitudinal transect along the foredune

5.11 TIDAL AND WAVE VELOCITY COMPARISON

This section compares the bottom velocities calculated between wave data during storm conditions (refer Section 5.7.1, page 73) and bottom velocities encountered from tidal currents (refer Section 5.9.2, page 91) to determine the predominant force transporting sediment to and from the intertidal zone.

Tidal velocities and wave velocities compared have been from two differing sets of conditions (typical conditions and storm conditions respectively). This has been purposely undertaken since the orbital velocities applied to the bed from waves during typical conditions are not high enough or affect substantial portions of the bed to cause large scale sediment transport.

Table 8: Bottom velocity comparison from tidal data and wave data.

Tidal Velocities: (Typical Conditions)	Most Frequently Occurring	0.20m/sec
	Average	0.21m/sec
	Maximum	0.8m/sec
Bed Velocities: (From Waves) (Storm Conditions)	Minimum	0.05m/sec
	Average	0.26m/sec
	Maximum	1.11m/sec

Table 8 indicates that the *average* velocities applied to the bed from tidal currents and waves is roughly similar (0.21m/sec from tidal and 0.26m/sec from waves). However investigation of these statistics in greater detail indicates that the tidal velocities experienced adjacent to the Midge Point Beach are generally higher than bed velocities applied from waves. The minimum bottom velocity from tidal currents is approximately 0.2m/sec. The minimum bottom velocity from wave orbits is approximately 0.05m/sec. This shows that there are likely to be more areas subjected to extremely low bed velocities from waves than tides. This indicates that if sediment liberated by wave action in the intertidal zone have a high probability of being transported far offshore by a combination of wave and tidal currents.

Therefore, given the general direction of the winds in the vicinity of Midge Point, and the domination of the tidal currents in an area of high tidal variation, the formation and stabilisation of the beach in front of the settlement of Midge Point is predominantly controlled by the action of the tides, tidal currents, and the tidal and wind driven action of the waves.

6 MANAGEMENT OPTIONS

6.1 INTRODUCTION

In proposing options for Midge Point it must be emphasised that 'documented' solutions are site dependent, and are strongly influenced by local hydrodynamic effects and aesthetic values of the site. Thus, solutions considered successful in one location may not transfer to the specific conditions of another site. Further, those 'solutions' may have secondary effects on a down-flow area that may or may not have formed part of the decision making process at the time of instigation, or may or may not have been recognised at the time of documentation.

The historic and current geomorphology of Midge Point have been considered in the context of a beach system that has been developed and maintained by a particular set of processes specific to the area. Following the analysis of hydrologic and oceanic conditions contributing to the coastline erosion reported by the residents of Midge Point, a series of management options have been considered for the Midge Point beach.

The management options considered are documented below as an indication that all options have been considered. The options must be read in the knowledge that anything can influence the shape of the beach profile at any singular point in time.

Table 9: Coastal Management Options

Category	Typical Examples
Hard Engineering	• Groynes • Sea Walls and Rock Armouring • Detached breakwaters
Soft Engineering	• Vegetation • Sand Scraping • Beach Nourishment • Wooden structures
The Do Nothing Approach	• Evaluate consequences of doing nothing and weigh the costs against mitigation options.

In most instances changes in beach morphology are critical to beach renewal and great care needs to be exercised before attempts are made to modify changes to a shoreline. The highly mobile environment of the beach profile means that any attempt at rectifying "change" will induce a consequent change in some other area along the beach profile.

Similarly, if a perceived change can be attributed to a specific incident, all attempts at remediation must be addressed to that incident. If the change is of sufficient distress, it is imperative that it is understood that any modification designed to rectify the distress will have consequent impacts in some other location. This has been stated many times throughout this report. It is reiterated here to stress that the beach must be recognised as a living system. Intervention for any reason will not produce a permanent solution to the problem and continual intervention will be essential.

Consequently, infrastructure designed to change the balance of processes occurring on a beach can only do so for a limited time before failing or not being applicable to the changed conditions.

Subsequently mitigation measures to minimise erosion at Midge Point can only be designed and implemented with a certain lifetime in mind. This is known as "The Asset Life".

In the current climate even greater care will need to be taken. Debate continues on the likelihood of anthropogenic contribution to underlying climate change. The Queensland Government has withdrawn the requirements for Coastal Management Plans along the Queensland coast, placing responsibility into the hands of the individual Local Governments. The majority of Local Governments have chosen to maintain the direction that an 0.8m rise in sea level has to be considered, with some Local Governments leaning strongly towards a 1.0m rise. The time limit against which this figure is predicted has not been uniformly accepted by Local Government Agencies. For the purpose of this SEMP, and to allow individual "Asset Life" considerations to be made, an 0.8m rise in sea level is included in this assessment. An 0.8m sea level rise on top of the Highest Astronomical Tide at Midge Point may be alarming, but not to consider this possibility would be negligent and remove Local Government and individual rights to make their own decision. Therefore, C&R believe an 0.8m sea level rise must be fitted into the management options for the Midge Point beach.

Funding sources that may be available for the instigation of the chosen method of beach stabilisation, and the necessary Legislation that must be considered, are detailed in Appendix 7 and 8 respectively.

Hard Engineering approaches have been requested by the local Midge Point community. While these approaches are discussed, it is the opinion of C&R Consulting that there are better, less expensive, and more socially acceptable methods of beach management available for the areas of greatest importance to the Midge Point community.

It is the considered opinion of C&R Consulting that no attempts should be made to restrict movement of the highly mobile "tail" of the beach (the southern section of the beach). Fluctuations in these areas is as essential to the health of the beach as it is to the entire ecosystem of Midge Point. Further, this area acts as a temporary sand trap for the sediments transported along the Midge Point beach. During the 1990s sediments held in this area were used by the locals to repair damaged beaches in front of the settlement. It is probable that this may be the optimum management solution for the currently damaged beach area in front of the settlement.

6.2 HARD ENGINEERING APPROACH

Hard engineering approaches such as groins and sea walls consist of structures that act as land protection barriers. These structures do not address the causes of erosion and quite often accentuate and accelerate erosion on the seaward or landward side. Hard defence options typically protect the landward side from erosion (except in extreme events) but in many cases the erosion problem is transferred to another section of the beach or shoreline. It has been demonstrated that in the long-term hard defences often transfer the problem to the seabed immediately in front of the structure, or to other areas along the coast (Linham and Nichols, 2010).

Beaches are not locked in position throughout time. They are ever changing systems responding to a series of differing pulse disturbances (such as floods, cyclones, etc.) and steady-state disturbances (such as sea level changes). Hard defences serve to 'lock' the beach in place over a period of up to 50 years and cause the dynamic system to adjust around the structure. This can have unforeseen consequences such as changing flood levels and protection elsewhere or transferring the erosion problem to another location.

Further discussion regarding the different types of hard defences is provided in the relevant sections below.

6.2.1 SEAWALLS

Seawalls are hardened walls placed parallel to the coastline on the shoreward side of the eroding feature or infrastructure requiring protection.

Seawalls do not address the cause of the erosion and can accelerate erosion on the landward side of the structure. Beaches dissipate wave energy, whereas seawalls reflect this energy back into the coastal zone, increasing scouring in front and down drift of the seawall. The reflected wave energy tends to increase the steepness of the beach directly in front of the wall, subsequently increasing the height of the waves breaking against the structure (USACE, 2011).

The natural location for a seawall at Midge Point would be along the erosion scarp at the top of the beach to prevent regression of this scarp both into and beyond the fore-dune. However, seawalls are commonly overtopped during high energy events and the sand behind the wall is removed. If the soil profile is wet, and is kept wet for an extended period (e.g. an extended period of rainfall when the soil profile become saturated, or continual rainfall during the periods of high tides) the sediments at depth become saturated and flow as a fluid. Removal from their position at the landward side of the barrier is common as the saturated sediments seep under the wall. At Cungulla, North Queensland, the unofficial placement of concrete slabs as a seawall lead to beach collapse in the first high energy event after placement.

Seawalls are typically built of concrete, timber, steel, rock, gabions, or geotextiles and have either a vertical, curved, stepped or sloped face. Recently rock armouring ('rip-rap') has been employed for seawalls to reduce the amount of reflected wave energy in the backwash zone as the permeable rock wall dissipates the wave action. This has proven effective when situated below the low tide mark (e.g. port or marina walls), but where the seawall is placed at the top of the beach, the wash zone where the rock wall meets the sand causes accelerated erosion processes and undermining of the wall can be ongoing.

Timber piles can be used to create seawalls, generally because they are comparatively inexpensive, and because they are easier to repair if damaged during high energy events. Where coppers logs are used, the structure will benefit from deep placement into the firm base below the beach sediments. Horizontal beams placed to at least 0.5 metres below the finished sand surface of the front beach and extending to a minimum of at least 0.25 metres above the preferred base of the back of the beach assists stabilisation of the sands behind the structure.

Access steps constructed as social access points eliminate unintentional damage to the structure and damage to sand accumulation in front of the wall. The steps should be engineered to hold the sands in place on either side, in front of, and behind the step structure.

6.2.1.1 Applicability to Midge Point

A seawall installed at Midge Point would harden the eroding front of the foredune and increase the level of protection to coastal residential properties under "normal", low-energy conditions. However, to be effective the seawall would need to stretch along the entire length of freehold land at Midge Point. This includes the caravan park to the south and to the end of Nielsen Parade at the northern end of the beach, a distance of approximately 1200m.

The detrimental impacts of installing such a seawall at Midge Point may include:

- Increased erosion of beach material in front of the sea wall, effectively removing the small amounts of sediment that accumulate above the cohesive base that comprises the majority of the intertidal zone;
- Increased erosion at entrances to the beach (i.e. boat ramps and other such access points);
- Increased erosion rates beyond the eastern and western ends of the seawall. This could include increased erosion in the mouth of the unnamed creek to the immediate north-east of the residential area of Midge Point;
- Removal of sand from behind the seawall during extreme events (severe storms, cyclones, and king tides).

However, the possibility of reduced foredune erosion in front of the residential area at Midge Point during low- to medium-energy events may be sufficient incentive to consider the installation of a seawall at Midge Point.

6.2.1.2 Cost Estimate

The cost for the installation of a seawall (including material sourcing) has been estimated at approximately $1000 per metre. Construction would need to extend from the north-eastern end of Neilsen Parade to the Caravan Park to the south, an approximate distance of 1100metres. Hence, the minimum cost of a coppers log seawall would be around **$1,100,000**. Costs would be considerably higher if the seawall protection was staggered and a second seawall was installed to protect the existing residential allotments from storm surge inundation in accordance with the now extinct Queensland Coastal Plan guidelines for possible sea level rise.

Cost estimations of installing rock seawalls can range between $1,000 per metre to $5,000 per metre (for a 8m high wall including toe depth). This creates a similar price to the timber walls, but with a much higher risk of cost spiralling up to $5,000,000.

6.2.1.3 Limitations

High tidal ranges, and the accumulative potential for large storm surges, limit the effectiveness of sea walls by exposing the lower tiers to frequent inundation on spring tides, consequently increasing the potential to wash out the sand behind the wall and slow the establishment of vegetation.

If a staggered sea wall is the preferred option for Midge Point, it must be noted that the vegetation is the main stabilising agent at this location. The revetments only provide structure. The terraced structure will need to be heavily vegetated with a variety of natural vegetation with a wide range of root systems to trap and hold the sands. If lawned areas are to be used, watering will need to be intensive to maximise cover before the next wet season.

6.2.2 GROYNES

Groynes can be constructed of similar materials to seawalls but are generally orientated approximately perpendicular to the shore (USACE, 2011). This forms a cross-shore barrier that collects sand moving alongshore. The trapped sand results in an increased beach width on the upstream side of the groyne.

When groynes are used in this manner they shift the impact downstream. In some locations, the downstream impacts have been reduced by the installation of a series of groynes at reducing lengths to provide a tapering effect along the beach. Nevertheless, nourishment on the downstream side of each groyne is generally required.

Groynes only capture sand moving along the shore. They do not reduce cross-shore sand movement (i.e. sand being moved from the upper beach to the intertidal zone) during storm events when the off-shore directed wave-driven currents can cause increased sand movement from the beach into deeper coastal waters, consequently accelerating cross-shore sand movement.

In Section 3.4.1 *Beach Dynamics*, the transfer of sediments along a beach by the process of longshore drift was described. The overarching process of coastal dynamics will not cease when groynes are constructed. Waves usually approach a coastline at an angle, pushing sediment grains up the beach at the angle of wave attack. The sediment grains still roll back down the slope at right angles to the coastline because this is the steepest gradient. In this way the sediment grains are transported along the coast in a zig-zag movement consequent to the angle of wave run-up. Following groyne construction the sediments are trapped on the upstream side of the groyne. The opposing end of the small, artificially constructed embayment (i.e. within the groyne field) is subsequently derived of sediment (Figure 54) The end result is a scalloped effect that remains open to sediment removal to deeper waters during high energy events.

Figure 54: Scalloped beach front following groyne construction.

6.2.2.1 Applicability at Midge Point

The erosive power of waves at Midge Point disturbs sediment at the fore dune and along the inter-tidal zone. The dissipation of this wave energy removes items that resist erosion (e.g. vegetation), allowing the strong tidal actions at the beach to transport the sediment from the intertidal zone to deeper depths and gradually around to a significant sediment store at the mouths of Yard Creek and Dempster Creek.

In the Midge Point environment, the installation of groynes will not mitigate the cause of erosion, and may result in the additional trapping of sediment off-shore and/or in the intertidal zone. Spring tides, and wave action from storms and tropical cyclones, will still be able to disturb and remove sediment across the intertidal zone and the foredune. Consequently, groynes will result in the net movement of sediment from the foredune and upper beach area into the intertidal zone.

6.2.2.2 Cost Estimate

Costs have been estimated at $1,000 per metre for a lower elevation structure than seawalls.

6.2.2.3 Potential Capability at Midge Point

This method of erosion control is not recommended.

6.2.3 DETACHED BREAKWATERS & ARTIFICIAL REEFS

Detached breakwaters are structures installed parallel to the beach in the intertidal and offshore zones. Their purpose is to dissipate wave energy (Figure 55 and Figure 57). The structures are typically short, and do not extend for great lengths (USACE, 2011), requiring many structures to be installed to mitigate large-scale erosion. Typically the gaps between breakwaters are similar to the lengths of the structures themselves.

The structures intercept wave energy, causing waves to break against them. This will subsequently cause the wave energy to be reflected from the off-shore side of the structure and can cause local scouring (USACE, 2011). The lee side of the structure will subsequently be a zone with a low wave energy therefore favouring deposition.

Installation of multiple detached breakwaters can substantially alter currents in the inter-tidal zone. These impacts may alter the breach behaviour so that the form and shape of the beach will be adjusted. Tombolos and salients can form as a result of the installation of detached breakwaters, therefore causing the beach morphology to increase in sinuosity as sediment deposition increases behind the breakwaters causing 'spits' to form (Figure 55).

Figure 55: Tombolo formation behind detached breakwaters (Environment Agency UK, 2011).

Figure 56: Nearshore breakwaters installed in Scotland.
(A) Shortly after construction.
(B) Seven years after construction with stable backshore vegetation (Scottish Natural Heritage, 2000).

The sinuous pattern formed by the beach profile behind detached breakwaters can reduce the amount of sediment transported by longshore drift. The rippling effect created in the direction of longshore drift is claimed to increase the sediment trapping efficiency of the beach thus increasing the potential for deposition.

Sediment accumulation behind a detached breakwater is dependent on a number of factors. As the tidal range increases the size of the sediment accumulation will decrease (Environment Agency UK, 2011). However the effects of the size of the tidal range on the overall sediment accumulation behind the breakwater decrease if the detached breakwater protrudes above the water surface throughout the entire tidal cycle (Environment Agency UK, 2011). Sediment accumulation at the most up-drift breakwater will be higher than compared at the most down-drift breakwater if waves approach at an oblique angle to the breakwater structure. This is similar to the current situation at Midge Point.

Numerical modelling undertaken by the UK Environment Agency (2011) for a range of different configurations of detached breakwaters, generally indicated that sediment accumulation behind the breakwater was dependent on the height of the offshore breakwater. This also correlated to the height of the beach behind the detached breakwaters (Environment Agency UK, 2011).

Longshore gradients in wave height and transport are created by the installation of detached breakwaters. This causes erosion at the down-drift lee of the last detached breakwater (USACE, 2011; Environment Agency UK, 2011).

6.2.3.1 Considerations for Midge Point

Installation of a series of detached breakwaters may be a beneficial tool to mitigate erosion at Midge Point, but the majority of erosion is caused by extreme events where storm surge and high wave energies eat away at the fore dune. Detached breakwaters installed to dissipate some of this wave energy, especially in the vicinity of the north-eastern end of the beach where erosion is beginning to threaten public and private infrastructure may work,

but to be effective the detached breakwaters would need to be installed at a distance from the foredune.

Installation too close to the foredune would result in the breakwaters being out of the water during low-tide events resulting in a detrimental impact to the visual and recreational amenity of the beach.

Installation too far from the beach could result in the requirement that the heights of the structures are greater, therefore requiring additional material, drastically increasing the costs for installation, and significantly reducing the opportunity for sediments stored offshore to access the beach line.

It is also highly probable that a tidal run would be induced behind the breakwater, consequently leading to greater erosion.

Consideration has been given to the potential locations and height requirements of offshore breakwaters at Midge Point. The levels of various tidal events (such as Mean Sea level, HAT and the 1:50 storm surge + sea level rise scenario) have been plotted in Figure 52 and Appendix 5. To be effective the offshore breakwaters need to be installed at a level of at least Mean Sea level (-0.02m AHD) and must be able to minimise wave energy at high tides, king tides and during certain storm surge events. The offshore breakwaters would need to be constructed to a level of 3.33m AHD to properly mitigate wave energy during King Tides. This would result in the creation of a walled structure approximately 3.3m high in the intertidal areas. At low tides these structures would be fully exposed, drastically decreasing the visual and recreational amenity of the beach.

6.2.3.2 Cost Estimate

Cost estimates for detached breakwaters are approximately $1,500 per metre. However since the structures installed at Midge Point would need to be relatively high, it is assumed that a more representative cost would be approximately $2,000 per metre.

Since the detached breakwaters are not continuous (like a seawall), it has been assumed that a 600m structure would be required at Midge Point. This places the capital expenditure estimate to $1,200,000.

6.2.3.3 Applicability to Midge Point

Not recommended.

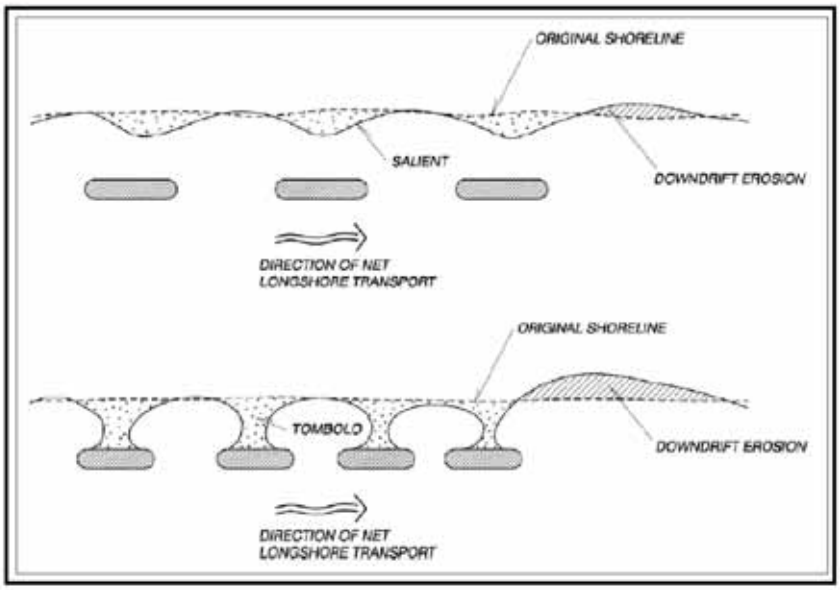


Figure 57: Potential impacts of detached breakwater installation (from USACE, 2011).

6.3 SOFT ENGINEERING APPROACH

Providing sufficient data and knowledge are available, processes within dynamic and complex systems can be guided to result in changes that are beneficial to the stakeholders. Soft engineering approaches attempt to manipulate the system to avoid the negative impacts generally associated with the hard engineering approaches. While soft engineering approaches usually require continual ongoing maintenance It is considered that a soft engineering approach, possibly coupled with very limited hard engineering, is the only practical option for Midge Point. A soft engineering approach is inexpensive, and can be modified with time to suit the varying conditions and subsequent needs of the beach.

6.3.1 BEACH NOURISHMENT

Beach nourishment is the process of artificially replacing sand stocks on the beach by mechanical means post-storm or following any period of sediment loss. This is an accepted coastal protection measure used frequently overseas (UKCHM, 2010) and at high profile environments along the Australian coastline (e.g. the Townsville Strand, Gold Coast, New South Wales, South Australia etc.). In most instances, in order to match grain size and compositional characteristics, the sand needs to be imported from areas external to the site. Consequently, transport costs can severely limit its use.

Beach scraping is the process where existing sediment in the beach profile is re-distributed to protect erosion prone areas. This is often undertaken after a storm event (UKCHMB, 2010) to replenish lost sediment.

Beach scraping is often used to re-profile the beach to enhance or dissipate (depending on the goal of the activity) the beach's attenuation of wave energy. For example at Midge

Point, beach scraping has been undertaken to bolster volumes in the eroding fore dune before other soft protection measures (such as logs) were used to attempt to increase the area's resistance to erosion.

At Midge Point the sand is moved along the front of the beach and stored at the southern end of the beach in the vicinity of Yard Creek prior to being moved into deeper waters when current and wave activity is suitable. Interrupting this latter part of the cycle to replace the sediments along the northern beach is considered a viable and inexpensive option for Midge Point. This method of renourishment has been practiced by the local Midge Point community for many years and is considered the most inexpensive, viable, method of beach protection available to the community. However, while local intervention may have proved successful for many years, the requirements of the Mackay Regional Council may require the initiation of a more formal alternative.

To reduce the opportunity for beach nourishment works to interfere with ecological processes, sediments should be recovered **before** it has had time to stabilise in the new position and develop a distinct ecosystem. The depth of deposition in the southern section of Midge Point is currently unknown. This will need to be established prior to removal, but it is anticipated that sediment scraping to avoid interruption to the lower, established, sediment base will be the preferred method of removal.

Sediment scraping is specific to the collection site and can only be determined when the site has been fully assessed. However, it is considered that early removal of newly deposited material significantly minimises environmental damage. Newly deposited material can be determined on-ground by areas of 'soft sand' which have not had time to settle and compact. It is probable that this will remain a very small operation with renewal only required following high to medium-energy events.

The negative aspect of beach nourishment is that the process of collection and dumping will be ongoing, but periodic. The cost is relatively low, with the number of replacements varying with the climatic cycle. Sand importation is occasionally chosen as a method of increasing the permanency of the replaced material (UKCHMB, 2010). Where this is the chosen option, material 1.5 times the grain size of the native beach sands (i.e. sediments 3mm in diameter) will assist in stabilisation (UKCHMB, 2010).

The beach profile is inherently linked to the size of the sand grains making up the beach. Generally the smaller the grain size, the shallower the beach and the larger the grain size, the steeper the beach profile. This seldom applies to the entire beach profile in one uniform process. At Midge Point the upper beach is relatively steep and has a relatively large grain size (medium to fine sand) whilst the lower beach profile is relatively flat and has a small grain size (fine sand to silt). This pre-erosion profile should be maintained where possible.

Where available wave and tidal energy are unable to move sediments across or along a beach, either because their size or density is too great, wave energy will be reflected from the beach, potentially creating edge waves in the near shore zone, drastically increasing the erosion rate in this area.

Beach nourishment is often carried out by placing the new material into a single upstream location, leaving the profile reshaping process to the action of the waves and currents. However, changes to the shape of the beach profile can affect other areas of the beach leading to increases in erosion or sedimentation in other areas. For example, increasing the steepness of the beach profile can cause the beach to become reflective with a much larger portion of the wave energy reflected back into the intertidal zone. Decreasing the beach profile can increase the rate of erosion of the foredune or increase the sediment trapping efficiency of the beach in the intertidal area, potentially decreasing longshore drift and causing erosion down drift. Thus, in the initial period of nourishment it is recommended that placement should mimic pre-erosion profiles as closely as possible.

During a beach nourishment programme large quantities of relocated material may be lost. If the retrieval process is established at the end of the wet season (predominantly the storm season), the replaced material is given a far better chance of survival. This process will occur as the beach profile adjusts to an increased volume and settles into an equilibrium with the current processes. Generally an extra 20 to 40% of material will need to be placed on the beach profile than anticipated to assure against these losses (UKCHMB, 2010).

In specific instances, beach nourishment is accompanied by hard engineering approaches such as groynes, submerged reefs and seawalls. Hard engineering methods were discussed above and are not recommended for Midge Point. Further, it is considered that such structures will mar the current aesthetic value of the sea-scape, and will not contribute to the minimisation of erosion. In addition, the surface sands associated with the Midge Point beach front are neither cohesive nor heavily compacted. Hence, it is considered that any hard engineering changes to the beach front will exacerbate the erosion processes.

6.3.1.1 Applicability to Midge Point:

It is considered that Beach Nourishment is the most suitable method of erosion control available to Midge Point.

6.3.1.2 Key Aspects for Beach Nourishment or Scraping

As previously established, sediment transport events at Midge Point are episodic in nature and occur with extreme events (king tides, storms or tropical cyclones). This periodic nature is evident in Figure 24 where there are distinct cycles of advance and retreat of the foredune. Subsequently any beach nourishment programme should respond to sediment loss from the beach on an event by event basis.

Monitoring

Changes to the beach profile on an event by event basis are currently not known. It must be stressed that any beach nourishment programme must be accompanied by a thorough beach monitoring programme, with the aims to:

- Establishing changes in the beach profile over the course of several events;
- Designating 'trigger levels' of sediment loss from the beach to prompt nourishment
- Place nourishment material in the correct place to ensure the best beach profile
- Monitor the effectiveness of nourishment and revised loss rates

The monitoring programme would consist of repeat topographic surveys along the beach. It is recommended that transects are spaced at intervals of approximately 100m along the beach (approx. 16 transects). Survey pegs should be installed behind the foredune to act as permanent reference points for the beach profile surveys. Beach profile surveys should extend from the survey pegs to mean sea level at least.

Methods

It is anticipated that sediment would be obtained from the southern end of the beach and deposited at the northern end. Unlike contemporary beach nourishment programmes, which rely on longshore drift to redistribute the sediment, it is recommended that replaced sediment is positioned directly along the required areas. Trucks / skips that transport material from the southern end will be able to dump contents in long linear strips, which can then be pushed up against the erosion scarp or reshaped into a suitable profile by tractors / excavators. The precise location of suitable stores of sediment will need to be confirmed by the monitoring programme and/or inspection as outlined above.

Sediment Sourcing

The southern end of the beach occurs at a much shallower profile than the northern end (Figure 58) indicating that there are significant stores of sediment in the southern end in the intertidal zone that may be redistributed to the northern end. This will create a partially closed loop of material, as sediment will be anthropogenically removed from the southern end and placed at the northern end of the beach, and gradually redistributed back to the southern end.

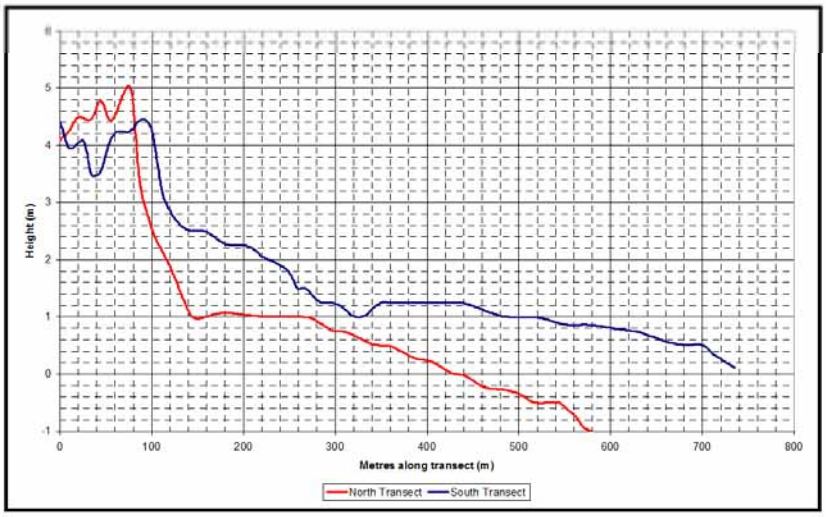


Figure 58: Beach Profile differences between the north-eastern and south-western sections of the beach.

Clay (<0.002mm) and silt grains (0.002 – 0.063mm diameter) have a higher cohesion to each other than larger grains (such as sand between 0.063 and 2mm diameter). For example, 1% clay sized grains may represent 50% of the surface area available for cohesion. Higher velocities will be required to cause erosion of silts to overcome this cohesive power. However silts will remain suspended in the water column for longer periods because of their small grain size. For this reason sands are readily removed from the beach profile at Midge Point leaving behind the cohesive sand/silt layer that forms the intertidal zone.

Many sources of coarse sand are from riverine sediments. These sediments are often 'lighter' than beach sediments of similar weights. This can cause increased erosion and transportation of sediment from the beach. Sources of marine / estuarine sediments in this size are not available from the local area (offshore deposits at Midge Point or Dempster Creek) with the sediment store at the mouth of Yard Creek and Dempster Creek consisting of sediments with a grain size classification of 87% between 0.075mm (fine sand) and 0.15mm and 12% between 0.15mm and 0.3mm (fine to medium sand). If anthropogenically redistributed to the Midge Point beach these sediments would be quickly removed by wave and tidal action.

Alternative Supplies

There is a coarse sand/gravel layer approximately 0.2m beneath the ground surface in sediments north of the Midge Point boat ramp as indicated in Figure 59. Furthermore landholders have indicated that there is also a coarse layer at 1.0m depth that an artificial channel has also been excavated to historically.

Figure 59: Coarse sand/gravel layer approximately 0.2m below ground level.

There are at least two distinct coarse layers encountered in the exploration pits, one being comprised of up to 37% gravel (>2mm, <6mm) and 67% sand (>0.06mm, <2mm), and the other being comprised of 18% gravel (>2mm, <6mm), 78% sand (>0.06mm, <2mm), 3% silt (>0.002mm, <0.06mm) and 1% clay (<0.002mm).

In the location of augering and exploration pits the thickness of these layers was only minor (approximately 0.15-0.2m). Very fine silty material was found underneath these layers which are not considered suitable for erosion protection.

Implementation

Beach nourishment at Midge Point is not a solution to the causes of erosion, but merely a preservation / mitigation strategy to reduce the rate of sediment loss from the system. The beach will need continual 'topping up' with sediments following extreme events.

Beach nourishment at Midge Point should focus on supplying sand to the base of the erosion scarp. This sand should be sourced from the southern area of the beach. If possible, creeping vegetation such as *Canavalia rosea* should be planted and maintained on the current foredune. This will enable the vegetation to rapidly spread onto new areas once sediment has been anthropogenically deposited.

Beach volume changes at Midge Point occur as a response to intense weather events. In some periods (i.e. between 1978-1981) up to 1100m^3 is deposited onto the beach; while in other periods (i.e. 1985-1993) up to 1800m^3 of material can be lost from the beach. The average annual sediment change, estimated from aerial photograph interpretation, is a growth of approximately 551m^3/year in the northern half of the beach. Subsequently this does not reflect the processes of erosion occurring at Midge Point and it is unfeasible to suggest an annual beach nourishment rate. Rather, beach nourishment should be undertaken on a campaign basis in response to extreme events or cyclone activity.

A preliminary nourishment of 7,200m^3 is recommended. This will replace the volume of sediment lost from the upper beach between 2009 and April 2011 (refer Figure 29). This value has been calculated by averaging the cross-sectional change of the upper beach in the transects provided in Figure 29; multiplying this cross-sectional change across a distance of 1,100m (the settled frontage, including the caravan park), and then multiplying by a factor of safety (or assumed losses) of 150%. Interestingly, more than half of this volume could have been obtained from sands re-deposited onto the lower beach in April 2011 (refer Figure 28). However it is likely that this sediment has now been removed or redistributed across a larger area.

6.3.2 DUNE REHABILITATION

Dunes exist as a sediment 'store' for the beach whereby excess material is available to buffer wave and tidal energy during extreme events. Dunes are formed by a number of processes in the coastal zone:

- Deposition of windblown sediment from the beach
- Deposition by receding sea levels from decreases in mean sea level in the past

The latter process has formed the foredune, and a series of beach ridges, at Midge Point (refer Section 3.4 of the report).

This involves the reconstruction of protective dune formations that have previously been washed away during storm events. Sand for the rehabilitation can be sourced from storm over wash areas and/or external sites as long as the quality and grain size are similar to that typically present. While dune restoration is able to reduce the impacts of sediment transfer, it is essential that native vegetation is employed to stabilise the dune system to ensure future erosion processes are reduced (US Army Corps of Engineers 2011). The reconstructed dunes may require netting and/or "snow fencing" to be installed around them to limit the effect of wind-blown sand removal until planted vegetation matures (US Army Corps of Engineers 2011). At Midge Point the main agent for removal of sediment from the dunes is not wind-blown transport, but king tides and high energy wave action creating an erosion scarp at the shoreward side of the system.

The current parklands between residential houses and the erosion scarp (Figure 60) are sparsely vegetated with only a few shade trees and heavy grass. This is primarily for aesthetic reasons for the residents along Nielsen Parade.

Figure 60: Parklands between the erosion scarp (off picture to the left) and current residential area (off picture to the right).

Heavy vegetation in this area will significantly slow the rate of scarp retreat as vegetation grows and roots establish through the foredune and swale area behind. This will drastically slow the rate of foredune retreat, especially after vegetation establishes and the sand is stabilised by root systems. This will create a 20m wide strip of land that has a high resistance to erosion.

The vegetation along the foredunes in front of the settlement is predominantly non-remnant. Revegetation using a combination of the species noted in the generic list of recommended species for dune revegetation on Mackay Beaches (Sarina Shire Beaches Management Guidelines for Coastal Zones, Regional Ecosystem 8.2.1, 8.2.2, 8.2.6a revegetation recommendations and field observations) include coastal vines (*Ipomoea pes-caprae*, *Vigna marina* and *Canavalia rosea)*, coastal grasses, and small to larger trees suited to coastal environments (e.g. *Melaleuca* spp., *Corymbia tesselaris, Acacia leptocarpa*), that would be particularly suited to providing the combination of root systems needed to aid in the holding and trapping of the loose sands of the front beach area. Table 10 outlines the species especially useful for revegetation programmes on foredunes and/or upper beaches in area where the sands are particularly mobile.

Based on an assessment of wind resistance following Cyclone Yasi, Calvert (2011) suggested the following species were particularly suited to withstanding high winds:

- *Calophyllum inophyllum* (Alexandrian laurel). This species did not experience any damage at Bushland or Forest Beaches during Cyclone Yasi, or at Midge Point during Cyclone Ului. The most damage noted for this species was to large branches in Cardwell during Cyclone Ului
- *Pandanus tectorius* (Coastal screw pine). This species experienced damage to the branches, but the main trunks were relatively unaffected by the winds. This species, however, is 'messy' and is seldom favoured by local residents.

Selective planting from the variety of species mentioned in this section and in Table 10 will increase the resilience of the area to foredune erosion by providing a variety of root systems that can work together to hold the highly mobile beach sediments. Selective planting will also decrease the impact of winds on residential properties by buffering the force of the high-speed winds.

6.3.2.1 Cost Estimate

A preliminary costs estimate has been undertaken on the following basis using rehabilitation rates outlined in Schirmer & Field, 2000:

- Area to be rehabilitated = approx. 5ha (council reserve between Nielsen Parade & the erosion scarp)
- Project management costs = $400/ha
- Removing weeds = $200/ha
- Fencing = $1,100 / km for 3km
- Seeding / tube stock costs = $2,000 (approx.)
- Direct seeding / planting = $900/ha

Total Cost = $12,805

Seeding is an expensive option that is usually only used in highly exposed areas where protection is urgent. Neither the needs nor the voluntary work load of the community can be estimated. Site inspections suggest that only small areas of beach front will require immediate protection in the immediate future, and this is well within the community's, or the Council's, ability to meet these requirements. The pricings are included to provide both Mackay Regional Council and the local Midge Point community with an evaluation of the costings that would be required to seed the entire area. Breaking the costs down to

workable components is only possible when the costs involved are known. However, the plants suited to holding the sands together in the foredune area are mainly the creepers and these creepers are prolific bearers of pea, or bean, shaped pods containing multiple seeds (e.g. *Canavalia rosea)*.

The area between the frontal dune and the residential area is reasonably well vegetated and mowing would encourage the grasses of this are to thicken and encroach on to the bare areas behind the frontal dune. Considerable improvements will be noted during the growing season if the grasses are kept low, but they will not be sufficient if high energy events attack the beach prior to the implementation of other methods of shoreline protection.

Table 10: Suitable dune revegetation species for initial planting at Midge Point.

Botanical Name	Common Name	Suitability	Preferred Location
Ipomoea pes-caprae	Beach Morning Glory: A common pantropical creeping vine belonging to the family Convolvulaceae	This plant is suitable for revegetation purposes on the upper dune (foredune). It sends out long runners from the woody roots at the foredune towards the toe of the dune and is often one of the species acting in the role of primary succession. After significant disturbance this vegetation would be able to re-colonise relatively quickly and re-establish runners along the foredune from the woody roots.	Should be used one the foredune area.
Sporobolus virginicus	Marine Couch, Sand Couch, Salt Couch, or Saltwater Couch: A rhizomatous perennial creeping grass.	Salinity and inundation tolerant grass species that often acts to stabilise dunes and inter-tidal areas. Small growths of marine couch currently occur in the intertidal zone at the western end of Midge Point and seem to be marginally stabilising the beach.	Should be used on the foredune area and in front of the foredune on the upper beach profile.
Spinifex sericeus	Beach Spinifex or Coastal Spinifex: A stout perennial grass with strong creeping runners that produce roots	Beach spinifex is often used to stabilise foredunes from wind erosion. However it is often the dominant species colonising the seaward slope of many dunes. It is one of the primary agents used in dune revegetation	Should be used on the foredune area and on the upper beach profile.
Thuarea involute	Birds beak grass: Acreeping species of grass found in association with *Ipomea pes-caprae*	Pioneer species that uses long runners to help bind sand often found on foredunes. Currently being trialled for coastal revegetation (NQ Dry Tropics and Coastal Dry Tropics Landcare Group, 2010).	Should be used on the foredune area and the upper beach profile.
Casuarina equisetifolia	Coastal She-oak: The most widespread and well-known member of the family Casuarinaceae	A coastal tree readily found in dune environments. It often provides shelter for more fragile plants found growing beneath it. This species is also present in RE8.2.6 which dominates the dune vegetation of the local area.	Should be used on the foredune area and the upper beach profile. Trees from the Midge Point Beach Plan can be used to revegetate the buffer strip but the emphasis should be placed on this species for coastal biodiversity purposes. The tree species is readily uprooted and was uprooted at Midge Point during Cyclone Ului (Calvert, 2011).

⇄ MANAGEMENT OPTIONS

6.3.3 UPPER BEACH REVEGETATION

Section 7.3.3 focuses on increasing the density of vegetation in the buffer zone between the current foredune and residential allotments to ameliorate the retreat of the erosion scarp. This section focuses on revegetating the upper beach seaward of the foredune and potentially below the HAT mark. This is a method that has been used in some situations to:

- Stabilise existing sand reserves;
- Shield the foredune from wave action
- Increase roughness in the upper beach area to increase the probability of deposition

In one section at the south-western end of the beach, where there is a much gentler beach profile, colonisation by *Sporobolus virginicus* is underway by natural processes (Figure 61). *S. virginicus* is a relatively fast growing species that thrives when planted in clumps in coastal areas. Other species (such as those listed in Table 10) may also be suitable for revegetation efforts of the upper beach profile in front of the erosion scarp.

However, the south-western end of the beach is naturally mobile. Assessment of historic aerial photographs confirms that sediment deposition in this area has accreted and eroded since at least the beginning of the last period of higher sea level (approximately 4,000 ybp; refer Figure 8. Hence, while sediment deposition in this area is encouraged by the interaction of the tidal currents along the shoreline, the sediment grain size composition is mixed grain in this is stored and removed on a regular basis, revegetation in this area has significant risk of failure from the regular inundation by the high tides (at least once per month). But, if vegetation establishment is successful, it may help to reduce the rate of sediment removal.

Figure 61: Colonisation of the upper beach by *S. virginicus*: (A) December 2011 and (B) January 2012 during a King Tide.

This is evidenced in Figure 61 (A) where lower densities of *S. virginicus* occur below the high tide mark. The vegetation will increase the opportunity quickly re-establish after disturbance.

A more rigid structure to the vegetation community will be required to successfully stabilise any area. This must be provided by trees. These trees will diffuse wave energy that reaches the foredune, and will also act like small 'detached breakwaters', potentially causing salients (areas of increased sediment deposition) to form behind them. Beach-growing tree species that would be suitable include:

- Coastal Screw Pine *(Pandanus tectorius). P. cookii* also occurs in the adjacent Regional Ecosystem 8.2.6a.
- Various native palms (such as *Livistona decora*)

- *Casuarina equisetifolia* (occurs in the adjacent Regional Ecosystem 8.2.6a).
- Beach almond (*Terminalia catappa* and *T. muelleri*)

It is expected that these tree species would have to be planted via tube stock to have any chance at being viable. Furthermore these species should be planted after a ground cover has established (to stabilise the sand surface around the planted tube stock), and during the declining arm of a neap tide cycle.

However it is expected that any revegetation efforts in this area will be heavily susceptible to severe storm events, especially cyclones. Large wooden debris scattering the intertidal zone during these events will cause severe damage and uprooting. Therefore it may be feasible to transplant juvenile tree species into the upper beach below the foredune.

6.3.3.1 Upper beach revegetation strategies

Marine couch (*S. virginicus*) is currently protected from removal under legislation administered by the Department of Employment, Economic Development and Innovation (DEEDI). Development Permits seeking to remove marine couch are usually conditioned by DEEDI and the applicant is required to transplant the vegetation to another area. One possibility that Mackay City Council could pursue for the revegetation of the Midge Point foreshore is to direct some of these conditioned revegetation efforts to Midge Point.

7 SUMMARY AND RECOMMENDATIONS

7.1 SUMMARY

Midge Point is a settlement of approximately 500 people at the northern end of the Mackay Local Government Area. The Midge Point community has expressed concern that the Council managed and private residential lands are under threat from erosion of the foredune of the macro-tidal beach. Only spring tides, king tides and storm surge have the ability to reach and affect this sediment.

Significant changes to the southern end of the beach were reported by the community, but major concern was directed to the more recent changes in beach morphology adjacent to the residential section of the settlement. In this region the beach was reported to have changed from a gently sloping beach made up of relatively coarse grains (medium to coarse sands) to an almost flat beach of fine sands and silts with a steep upper component. .

Aerial photographic interpretation confirmed the noted shoreline changes to the south-western end of the beach, but while this may be of concern to the residents, the sediments in this location are highly mobile and intermittent periods of sediment deposition and erosion are not unexpected. Aerial photographic interpretation also confirmed this historic pattern of accretion and erosion through time.

Aerial photographic interpretation is too coarse to determine shoreline variability at the north-eastern end of the beach with any degree of certainty. Nevertheless, the variability in sand distribution across the intertidal zone is clearly apparent in the aerial photographs. A local photographer captured the alterations to the beach morphology reported by the locals, and this was also witnessed during the course of this investigation.

Geomorphological investigations failed to find an anthropogenic cause for the change in beach morphology at the north-eastern end of the beach and it is therefore necessary to consider alternatives.

Morphological interpretation indicates a tide dominated beach that fits between tidal sand flats and tidal mud flats. This is typical of a beach that receives sediments from two different sources dependent on prevailing conditions. It is also typical of a beach that is subject to periodic attack from high energy events.

Since 1910 an average of one cyclone every 3.5 years has come within 100km of Midge Point. Sediment removal during any high energy event is highly visible. Sediments removed from the shoreline and deposited offshore are slowly reworked back on to the beach, often in a manner that goes unnoticed by the human observer. But the periodicity of the cyclonic events quoted above is an average. Cyclones tend to happen in climatic clusters (e.g. during periods of El Niño Southern Oscillation activity). Natural beach attenuation is slow and recovery between events may be compromised. Artificial intervention may then become necessary.

Storm surge estimations associated with cyclonic activity are always a concern to coastal communities, but tidal range at Midge Point is approximately 6.0m during periods of Highest Astronomical Tide. High tides during this period will lap the top of the beach.

Storm surge on top of the Highest Astronomical Tide will be sufficient to transfer cyclone driven waters well into the Midge Point settlement.

The Mackay region is one of the few areas in Australia where sea level rise has been documented. While 1.2mm/yr may seem minute, over a number of years this rate can be significant. The noted changes to the beach morphology will not be entirely due to this increase, but the cumulative effect will increase the height of the Highest Astronomical Tide, and consequently the distance travelled into the settlement, and will also increase the height of the lower tides, possibly of greater impact on the front of the foredune.

It is possible that as a response to the steadily rising sea level the beach morphology is adapting into a much gentler profile, hence the creation of an erosion scarp along the coastline. Should this be the case, sediments removed from the beach will be transferred to a sediment store at the western end of the beach in front of the mouth of Yard Creek. The area in front of Yard Creek is undergoing a land-building process and some of the sediment sourced for this process will come from the beach in front of the residential area of Midge Point. Whether this is a long-term impact, or the rapid response to an increased period of high energy activity cannot be determined.

However, storm surge estimates for Midge Point (taking into consideration the recommended caution of an 0.8m sea level rise by the year 2100) will result in potential inundation of infrastructure currently associated with the Midge Point Community. The 1 in 50 year storm surge estimations place the water surface at approximately 4.37m AHD. At this level, the residential area of Midge Point will be inundated. If this 1 in 50 year storm surge event is accompanied by a relatively intense rainfall event (e.g. >1 in 10 year event) it is highly probable that access from (or to) Midge Point will be cut.

The extreme level of the 1:50 year storm surge (incorporating 0.8m sea level rise) lowers the economic viability of protecting the Midge Point township from inundation. During such an event, floodwaters will not only impede on the residential area from the south-east, but will also encircle the township and flood the area from the south-west (towards Yard Creek), the west (Yard Creek), from the north-east (small unnamed creek), and possibly from the north (low lying mangrove swamps). Further, if funds could be found to protect the township from all avenues open to storm surge ingress, the mitigation works would need to be constructed to a height where a basin-type structure would be created, and from which storm driven waters would not be able to escape, thus adding considerably to the flooding problems of the residents.

To reiterate, it is considered that any erosion mitigation works will not protect the local community from storm surge inundation, and indeed may dramatically exacerbate the problem.

In addition, the height of the foredune, the steepness of the upper beach, and the low population at risk from erosion ensure that it is both unviable and uneconomic to install the hard protection measures (e.g. an effective seawall) that is occasionally successful in erosion minimisation in some areas. Preliminary discussions indicate that the cost of hard engineering to the extent needed along the foreshore of Midge Point will be >$1.2 million but could spiral up to $5.5 million. Regardless of the cost, the medium to long-term success of the operation is limited by the shallowness of the tidal flats adjacent to the beach, and the ability of the storm driven waves to breach any structure, to cause the formation of eddys around the structure, and to erode and remove the loose, highly permeable material captured behind the sea wall or other hard engineering structure.

Subsequently it is recommended that a beach nourishment programme is undertaken.

7.2 RECOMMENDATIONS

7.2.1 GENERAL

This SEMP has detailed that the morphological changes along the forefront of Midge Point are natural, and that the current level of stress visible along the residential section of the beach is the reaction to a climatic cluster of high energy events. It is proposed that the majority of erosion at Midge Point is expressed as vertical profile changes, rather than lateral changes to the location of the foredune. Climatic clusters are now recognised as being cyclical within an unknown period, but thought to be in the vicinity of 20 to 30 years. While this does not mean that individual high energy events will not develop, but rather that the possibility of another cluster of events is reduced.

7.2.2 RECOMMENDATION 1: BEACH NOURISHMENT

This SEMP has indicated that protection of the foredune along the front of the beach is not possible in the long term. However, it has also indicated that the high energy events that cause erosion of the beach front are cyclical, and that beach nourishment on an as needed basis will significantly reduce beach recovery time, consequently decreasing the time the foredune will be exposed to wave action prior to recovery.

- It is recommended that:
  - A programme of beach nourishment should be implemented as quickly as possible.
  - It is unfeasible, and unrepresentative, to provide nourishment on an annual basis at Midge Point. The nourishment programme should be undertaken in response to intense events.
  - An initial nourishment of 7,200m^3 is recommended on the upper beach against the erosion scarp. This volume will replace the volume lost between 2009 and April 2011, also allowing for 50% of the sediment to be remobilised and washed off the nourishment zone.
  - The beach nourishment programme should be implemented rapidly after a high energy event to minimise the potential for sediment loss out of the system and/or sediment stabilisation and the formation of an independent ecosystem.

Before this can be instigated, it is recommended that the beach is re-surveyed for the entire length down to, and including Yard Creek. This will highlight areas where sediment can be sourced from the southern end of the beach for nourishment at the northern end.

A monitoring programme for the entire Midge Point beach should be set up. This monitoring programme should include / assess (at least every two years):

(i) Installation of coastal survey pegs and markers for future erosion estimation and/or sediment movement/replacement/retrieval,
(ii) Quantify changes to the beach profile;
(iii) Preferred areas of sediment drop,
(iv) Preferred area of sediment retrieval,
(v) Preferred method of sediment retrieval,
(vi) Development of Trigger Levels as (a) an indication that erosion may be imminent, and (b) that attention is needed.

Basic community training that will allow the residents to determine when a sand drop is required.

7.2.3 RECOMMENDATION 2: REVIEW

It is recommended that the SEMP should be reviewed on a regular basis (i.e. approximately every 10 years), dependent on the status of the climatic cycle, and/or the introduction of new knowledge.

7.2.4 RECOMMENDATION 3: EVACUATION PLAN

It is strongly recommended that an Evacuation Plan should be developed for Midge Point and regularly communicated to local residents.

The Evacuation Plan should be lodged in a prominent position and the community familiarised with the Plan and the requirements of the Plan on a regular basis.

An Evacuation Officer should be appointed and the identification of this person made known to all residents. Changes to the position of Evacuation Officer must be notified to the community immediately.

Within this Evacuation Plan it must be acknowledged that a "stay put" option will not be acceptable for safety reasons, both for the residents and for State Emergency Services.

7.2.5 RECOMMENDATION 4: LONG TERM PLANNING

Since the erosion problem at Midge Point is not anthropogenic, and the residential area lies on the wrong side of the proposed 1:50 year storm surge plus sea level rise prediction, it is recommended that the long-term strategy adopted by Council should be one of Planned Retreat.

In this strategy, development is slowed and infrastructure and residential allotments are gradually moved back from the coastline over the next 50 years.

Within this context it is strongly recommended that:

- The SEMP for Midge Point should include a Zoning Plan for future development.
- A topographic survey be undertaken before any new development is approved for Midge Point.
- Development should not take place to the south or east of the caravan park (i.e. future development should not include the removal of any vegetation between the caravan park and the beach).
- Future development should be restricted to areas of Midge Point above the estimated storm surge zone, or other zone nominated by the Mackay Regional Council.

8 REFERENCES

Bureau of Mineral Resources, Geology and Geophysics. Australia 1:250,000 Geological Series, Proserpine, Queensland (Sheet SF 55-4).

Department of Primary Industries (DPI) 2011. Protection and management of declared Fish Habitat Areas. http://www.dpi.qld.gov.au/28_9156.htm.

Calvert, G. 2011. An assessment of tree susceptibility and resistance to cyclones. A study based on Severe Tropical Cyclone Yasi. Published by Greening Australia.

Charlton, Ro. 2008. *Fundamentals of Fluvial Geomorphology*. Routelage, 2 Park Square, Milton Park, Abingdon, Oxon.

Coastal Wiki. 2011. Coastal Wiki [Online]. Available at: www.coastalwiki.org. Date accessed: 16/01/2012. Date last modified: not stated.

CRC for Coastal Zone, Estuary and Water Management. 2002. Proceedings of the Public Workshop "Beach Protection: Risk and Management".

EPA. 2004. *Mackay Coast Study*. Published by the Queensland Government Environmental Protection Agency.

Environment Agency (UK). 2010. Delivering benefits through evidence – Guidance for outline design of near shore detached breakwaters on sandy macro-tidal coasts. Part of the Flood and Coastal Erosion Risk Management Research and Development Programme.

Geoscience Australia (2008). Hillsborough Basin.

Great Barrier Reef Marine Park Authority (GBRMPA) 2003. *Report on the Great Barrier Reef Marine Park Zoning Plan 2003*. Commissioned by the Australian, Natural Heritage Trust in association with the Great Barrier Reef Marine Park Authority.

Grech, A. and Marsh, H. 2007. Prioritising areas for dugong conservation in a marine protected area using a spatially explicit population model. *Applied GIS*. 3(2): 1-14.

HAMMER WM and HAURI IR. 2007: Fine-scale surface currents in the Whitsunday Islands, Queensland, Australia: effect of tide and topography. *Australian Journal of Marine and Freshwater Research* 28(3) 333 - 359

HARDY T., MASON L., ASTORQUIA A. 2004: The Frequency of Surge Plus Tide During Tropical Cyclones for Selected Open Coast Locations Along the Queensland East Coast. In: *Queensland Climate Change and Community Vulnerability to Tropical Cyclones: Ocean Hazards Assessment. Stage 3.* CRC Reef Research Centre, James Cook University, Townsville, Australia.

Jackson, L.A. and Tomlinson, R.B. 1990. Nearshore nourishment: implementation, monitoring and model studies of 1.5mM3 at Kirra Beach. *Proceedings 22nd of the international conference on coastal engineering.*

Lee Long WJ, McKenzie LJ, Roelofs AJ, Makey LJ, Coles RG, Roder CA (1996) Baseline survey of Hinchinbrook Region seagrasses. October (spring) 1996. research Publication N. 51, Great Barrier Reef Marine Park Authority, Townsville

Limpus, C.J. 2008. A Biological Review of Australian Marine Turtles – 2. Green Turtle Chelonia mydas (Linnaeus). Published by the Environmental Protection Agency, Queensland.

Linham, M. Nicholls, R. 2010. Technologies for Climate Change Adaptation – Coastal Erosion and Flooding. Published by University of Southhampton.

Mackay Regional Council. 2010. *Midge Point Beach Plan*.

NQ Dry Tropics. Coastal Dry Tropics Landcare Group. 2010. *Coastal Plants of the Burdekin Dry Tropics*.

Queensland Climate Change Centre of Excellence. 2011. Queensland Coastal Processes and Climate Change. Published by the Department of Environment and Resource Management.

Rohweder, J., Rogala, J., Johnson, B., Anderson, D., Clark, S., Chamberlin, F. and Runyon, K. 2008. Application of Wind Fetch and Wave Models for Habitat Rehabilitation and Enhancement Projects [Online]. Available at: http://www.umesc.usgs.gov/management/dss/wind_fetch_wave_models.html. Published by the United States Geological Survey (USGS) Upper Midwest Environmental Sciences Centre.

Scottish Natural Heritage. 2000. *A guide to managing coastal erosion in beach/dune systems* [Online]. Available at: http://www.snh.org.uk/publications/on-line/heritagemanagement/erosion/index.shtml. Date Accessed: 25 January 2012. Date last modified: note stated.

Seagrass Watch 2011. http://www.seagrasswatch.org/whitsunday.html#MP2.

Short A.D. 2005: BEACHES OF THE QUEENSLAND COAST: Cooktown to Coolangatta. Sydney University Press, University of Sydney. 360pp.

Short A.D. (Undated) *Beach Geomorphics*. In: OzCoasts, Australian Online Coastal Information, Geoscience Australia, Australian Government. http://www.ozcoasts.gov.au/conceptual_mods/beaches/tdb.jsp

Thieler, R. Himmelstoss, E. Zichichi, J. Ergul, A. 2009. *The Digital Shoreline Analysis System (DSAS) version 4.0 – an ArcGIS Extension for Calculating Shoreline Change*. US Geological Survey Open File Report 2008-1278.

US Army Corps of Engineers (USACE). 2011. Coastal Engineering Manual [Online]. Available at: http://chl.erdc.usace.army.mil/chl.aspx?p=s&a=ARTICLES;101.

Vance, D.J., Haywood, M.D.E. and Staples, D.J. 1990. Use of a mangrove estuary as a nursery area by postlarval and juvenile banana prawns, *Penaeus merguiensis* de Man, in Northern Australia. *Estuarine, Coastal and Shelf Science*. 31(5): 689-701.

UK Clearing House Mechanism for Biodiversity (UKCHM). 2010. *Soft Engineering Techniques for high and low energy coasts*.

WBM Pty Ltd. 2006. *St. Helens Beach Shoreline Erosion Management Plan*. Undertaken for Mackay City Council.

APPENDIX 1 – ENVIRONMENTAL VALUES OF MIDGE POINT

MARINE VALUES

Coastal waters east of Midge Point Beach are scattered with numerous islands associated with the Great Barrier Reef. These islands include the Whitsunday Group to the north-east and the Repulse Islands and the Smith Islands to the east.

Marine and coastal ecosystems around Gould Island and Midge Island (approximately 4.5km and 5.5km south-south-east of Midge Point respectively), as well as the Midge Point Beach, are influenced by the currents associated with Repulse Bay to the north and Dempster Creek (and to a lesser extent Yard Creek) to the south.

The Great Barrier Reef Marine Park (GBRMP) encompasses the largest coral reef system in the world, covering an area of approximately 344,000km^2 and approximately 2,300km in length. This diverse natural/environmental resource is comprised of 2900 separate reefs, 600 continental islands and 300 coral cays. The area is estimated to be home to approximately 10,976 species of organisms. However, this figure is expected to increase with advancements in science and technology. Over 99% of this nationally protected area is also internationally protected, as of the 26th of October 1981, as a World Heritage Area.

The GBRMP is separated into seven distinct management zones of varying degrees of protection. Green and Pink Zones are the areas of greatest protection, with over 33% of the GBRMP covered by these two types of zones. Figure 1 shows the large Green Zone (Marine National Park Zone) associated with coastal waters approximately 2km off Midge Point Beach. This Green Zone (MNP-20-1127):

> "*…contains bioregion NA3. Repulse Bay is a significant foraging area for dugong and green turtle and the zone provides protection of movement corridors between foraging habitats. The zone is offshore to the nationally significant Proserpine-Goorganga Plain Wetland. The boundaries of the zone have been adjusted in response to submissions from trawl and line fishing sectors*" (GBRMPA 2003).

An NA3 bioregion under the Great Barrier Reef Marine Park Authority (GBRMPA) guidelines is a "High Nutrients Coastal Strip". This is described as:

> *"Terrigenous mud and high levels of nutrients from the adjoining land. Seagrass in sheltered sites only. Good turtle and dugong feeding habitat. Wet tropic influence for much of the coast"* (GBRMPA 2003).

Midge Point Beach and other beaches in Repulse Bay to the north of Midge Point are well known for their seagrass beds. Several studies have been conducted throughout the greater Whitsundays area on seagrasses and the dependant fauna. The Midge Point intertidal to foreshore seagrass meadows cover an area of approximately 30ha primarily comprising three species of seagrass; *Zostera capricorni*; *Halodule uninervis*; and *Halophila ovalis* (Seagrass Watch 2011). Seagrass Watch (2011) conducted seagrass surveys in the intertidal zone on Midge Point Beach from December 1999 til June 2009 and found that during this period the relative portions of seagrass species occurring at the site remained constant and the overall abundance followed a predicted seasonal trend. During sampling trips the presence of dugong feeding trails was also noted. While well known for dugongs the Midge Point area is not a mapped Dugong Protection Area by GBRMPA.

The seagrass beds within the Midge Point area are considered important nursery habitats for many reef and estuarine fish species of ecological and commercial importance in addition to providing a foraging area for dugongs. Seagrasses also help to stabilise fine sediment and assist in the maintenance of water quality throughout marine systems.

Seagrass beds at Midge Point are found below the low tide mark and are not likely to be severely impacted by mitigation measures proposed within this SEMP. However their presence has been noted and measures to minimise impact on these areas (i.e. from turbidity) have been included in this SEMP.

The main marine fauna species of significant conservation status occurring in the Midge Point Beach area and adjacent coastal waters include:

- The Beach stone-curlew (*Esacus neglectus*) – declared vulnerable in Queensland under the *Nature Conservation Act 1992*. This species occurs on beaches throughout northern Australia. However, is known to prefer beaches with estuaries nearby. Eight specimens have previously been recorded in the Midge Point area (Wildlife Online, date extracted March 2011).
- The Sooty oystercatcher (*Haematopus fuliginosus*) – declared near-threatened in Queensland (*Nature Conservation Act 1992*). This species is found in coastal areas around the whole of Australia and generally nests on off-shore islands. However, populations in northern Australia are considered sparse, especially in the Gulf of Carpentaria where it is considered rare.
- The Australian snubfin dolphin (*Orcaella heinsohni*) – declared near-threatened in Queensland (*Nature Conservation Act 1992*). Often misidentified as the Irrawaddy River Dolphin (*Orcaella brevirostris*), which has an overlapping range, the Australian snubfin dolphin was only identified as a separate species in 2005. Due to this relatively recent identification of the species its full extent of distribution and abundance is poorly understood. However, it is known to inhabit riverine, estuarine and coastal waters across northern Australia.
- The dugong (*Dugong dugon*) – declared vulnerable in Queensland (*Nature Conservation Act 1992*). This large, herbivorous, marine mammal inhabits the coastal and estuarine waters of northern Australia. While dugongs are known to frequent the Midge Point area they are not considered exceptionally abundant when compared to other areas throughout Queensland, such as Moreton Bay, Hervey Bay and the tip of Cape York Peninsula (Grech & Marsh 2007). Therefore the area is not considered especially significant for the dugong population and is not encompassed by a Dugong Protection Area.
- The green turtle (*Chelonia mydas*) – declared vulnerable in Queensland (*Nature Conservation Act 1992*) and vulnerable in Australia under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC). The species is not known to nest on Midge Point Beach but occur throughout the GBRMP, with large and numerous (12) rookeries located on islands in the southern GBRMP (Limpus 2008). Numbers of breeding females have been on a slow but steady increase since the stop of legal hunting for this species in the 1950s (Limpus 2008).

Other marine species with a high conservation significance, such as flatback and leatherhead turtles, may occur within the area. According to the Protected Matters Search Tool, there are approximately 30 threatened species that can be found within a 5km radius of Midge Point. Furthermore other marine species such as migratory whales, turtles and sharks, may momentarily inhabit the adjacent coastal waters but are not considered to rely on the local habitats for long periods of time throughout their life histories.

SEAGRASS BEDS

Coastal waters east of Midge Point Beach are scattered with numerous islands associated with the Great Barrier Reef. These islands include the Whitsunday Group to the north-east and the Repulse Islands and the Smith Islands to the east.

Marine and coastal ecosystems around Gould Island and Midge Island (approximately 4.5km and 5.5km south-south-east of Midge Point respectively), as well as the Midge Point

Beach, are influenced by the currents associated with Repulse Bay to the north as well as Dempster Creek (and to a lesser extent Yard Creek) to the south and south-west.

Midge Point Beach and other beaches in Repulse Bay to the north of Midge Point are known for their seagrass beds. Several studies have been conducted throughout the greater Whitsundays area on seagrasses and the dependant fauna. The Midge Point intertidal to foreshore seagrass meadows cover an area of approximately 30ha and are reported as relatively stable both in species composition, site occurrence and seasonality (Seagrass Watch (2011). This differs slightly to other Seagrass Surveys colonies (Lee Long *et al* 1996) where the seasonality has been noted, but the actual size and location of the intertidal seagrass beds has been recorded as being rather more dynamic. The surveys of Lee Long *et.al* suggested that intertidal beds were susceptible to a variety of environmental stress factors (e.g. temperature, wave action, salinity, turbidity), leading to the suggestion that subtidal seagrass beds are temporally more stable than intertidal seagrass beds, and probably provide a seagrass refuge during events that change or damage the less robust intertidal beds. If the intertidal seagrass beds at Midge Point are relatively stable, it would suggest that the impacts on the system are also relatively stable.

Seagrass Watch (2011) conducted seagrass surveys in the intertidal zone on Midge Point Beach from December 1999 til June 2009 and found that during this period the relative portions of seagrass species occurring at the site remained constant and the overall abundance followed a predicted seasonal trend.

Any shoreline erosion undertaken for the must ensure the sustainable maintenance of the seagrass beds.

ESTUARINE VALUES

The mouth of Yard Creek is located at the southern end of Midge Point Beach. This is a relatively small tributary compared to Dempster Creek, approximately 1.5km to the south, and is considerably smaller than the estuaries of the O'Connell and Proserpine Rivers, approximately 10 and 18km to the north-north-west and north respectively. Dempster Creek follows the Dempster Fault along the east/west translocation of the Conder Hills to the north and the Tonga Ranges to the south. Hence, the Dempster Creek estuary is, at least in part, controlled by the Fault complex created by the transform shifts of the Dempster Fault system. However, this small catchment is at odds with the size of the mouth (over 550m wide). The Dempster Creek estuary gains value above that normally associated with such a small creek system by

(e) the width of the estuary,

(f) the increased area of stored silts, muds and alluviums; and

(g) the flora and fauna maintained by this extensive system.

The area from the mouth of Dempster Creek out to Midge and Gould Islands and back across to the southern end of Midge Point Beach are covered by a Habitat Protection Zone within the GBRMP (Figure 1). This area is also overlapped by the larger Midge – Fish Habitat Area (FHA-001) which encompasses the whole of Dempster and Hervey Creeks out to Gould and Midge Islands and the foreshore/coastal waters south to Dewars Point (Figure 62). This covers an area of approximately 8,199ha and has been protected under this legislation since 1986.

FHAs are "*areas protected from the physical disturbances associated with coastal development and declared under Queensland's Fisheries Act 1994*" (DPI 2011). There are exceptions to the rule with approval of some works and/or activities to benefit the environment or deemed necessary infrastructure authorised dependent upon the management level of the FHA. The Midge – FHA is allocated a management level 'B'.

The main reason to manage this area is to conserve diverse recreational fishing grounds as well as significant marine turtle habitat.

This area was declared an FHA because of its habitat values. The area contains large, closed *Rhizophora* forests throughout the estuaries. Mangrove forests are well known as nursery areas for many ecologically, recreationally and commercially important fish and crustacean species, such as banana prawns (*Penaeus merguiensis*) (Vance *et al.* 1990). The fringing saltmarsh areas associated with these mangrove forests further add to the biodiversity value of the area. As previously stated, seagrass beds are located along the foreshore and in coastal waters. These are also found within estuary reaches, increasing their productivity. The final habitat value influencing the position of this FHA is the inshore reef and shoal areas. These remain a vital feeding/foraging area for larger pelagic predators.

The diverse habitat values for the area make it a significant resource for many marine fauna species. Commercial and recreational fisheries predicted to be benefitted by the Midge – FHA include:

- Barramundi (*Lates calcarifer*);
- Blue (threadfin) salmon (*Eleuteronema tetradactylum*);
- Bream (*Acanthopagrus australis*);
- Estuary cod (*Epinephelus malabaricus*);
- Various flathead species (such as *Platycephalus arenarius*);
- Grey mackerel (*Scomberomorus semifasciatus*);
- Grunter (*Pomadasys argenteus* or *Pomadasys kaakan*);
- Mangrove jack (*Lutjanus argentimaculatus*)
- Queenfish (*Scomberoides commersonnianus*);
- School mackerel (*Scomberomorus queenslandicus*);
- Various sweetlip species (such as *Diagramma pictum*);
- Various emperor species (such as *Lethrinus laticaudis*);
- Banana prawns (*Penaeus merguiensis*); and,
- Blue legged king prawns (*Melicertus latisulcatus*).

All of the above species will use the FHA for significantly importantly stages within their life histories. This may be as a nursery area for juveniles or, at the alternate end of the spectrum, as predatory grounds during adult stages.

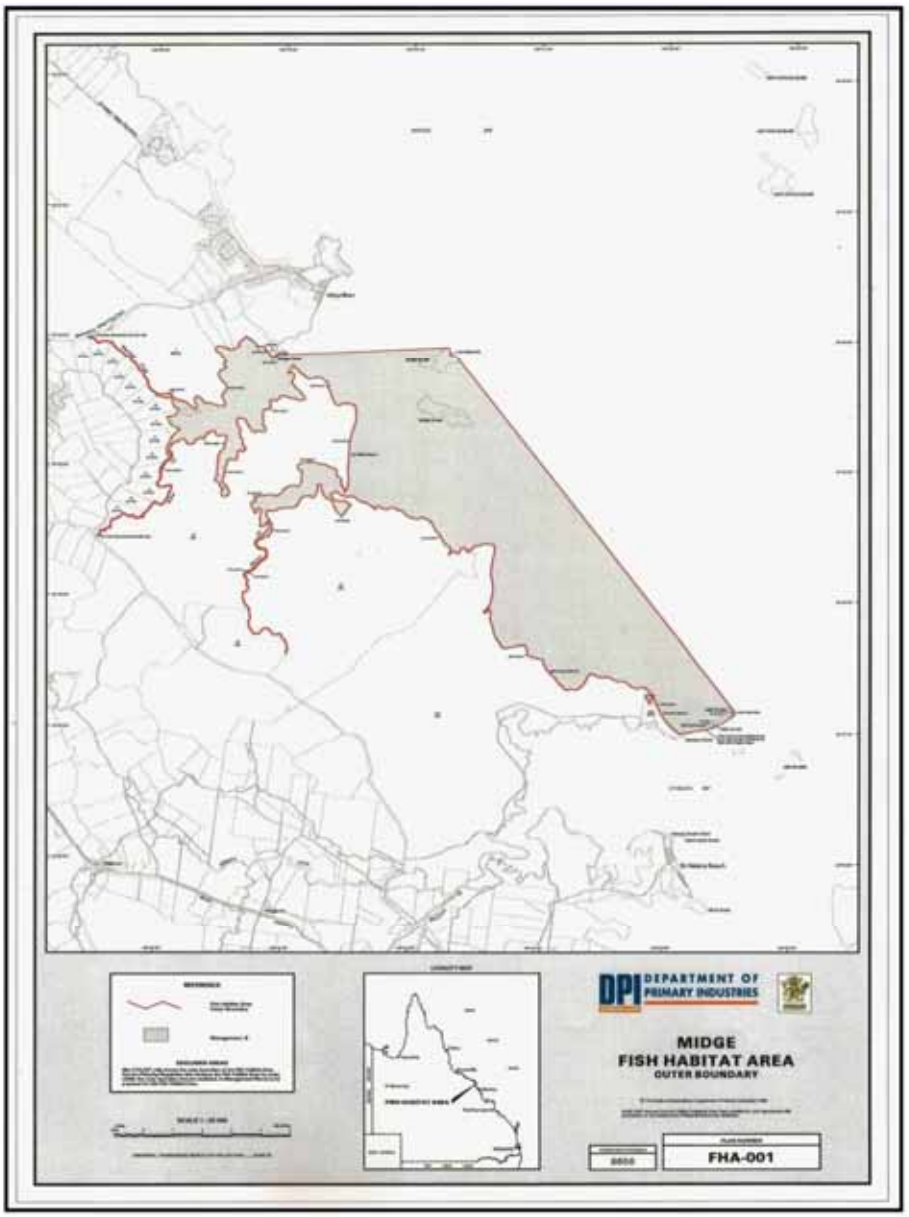


Figure 62: Fish Habitat Area (FHA) associated with Midge Point (Source: DPI 2011)

This area was declared an FHA because of its habitat values. The area contains large, closed *Rhizophora* forests throughout the estuaries. Mangrove forests are well known as nursery areas for many ecologically, recreationally and commercially important fish and crustacean species, such as banana prawns (*Penaeus merguiensis*) (Vance *et al.* 1990). The fringing saltmarsh areas associated with these mangrove forests further add to the

biodiversity value of the area. As previously stated, seagrass beds are located along the foreshore and in coastal waters. These are also found within estuary reaches, increasing their productivity. The final habitat value influencing the position of this FHA is the inshore reef and shoal areas. These remain a vital feeding/foraging area for larger pelagic predators.

The diverse habitat values for the area make it a significant resource for many marine fauna species. Commercial and recreational fisheries predicted to be benefitted by the Midge – FHA include:

- Barramundi (*Lates calcarifer*);
- Blue (threadfin) salmon (*Eleuteronema tetradactylum*);
- Bream (*Acanthopagrus australis*);
- Estuary cod (*Epinephelus malabaricus*);
- Various flathead species (such as *Platycephalus arenarius*);
- Grey mackerel (*Scomberomorus semifasciatus*);
- Grunter (*Pomadasys argenteus* or *Pomadasys kaakan*);
- Mangrove jack (*Lutjanus argentimaculatus*)
- Queenfish (*Scomberoides commersonnianus*);
- School mackerel (*Scomberomorus queenslandicus*);
- Various sweetlip species (such as *Diagramma pictum*);
- Various emperor species (such as *Lethrinus laticaudis*);
- Banana prawns (*Penaeus merguiensis*); and,
- Blue legged king prawns (*Melicertus latisulcatus*).

All of the above species will use the FHA for significantly importantly stages within their life histories. This may be as a nursery area for juveniles or, at the alternate end of the spectrum, as predatory grounds during adult stages.

VEGETATION

Vegetation of the area has colonised a series of prograding dunes and swales formed from sea level fluctuations over at least the last 7,000 years (refer Figure 8). The vegetation therefore consists predominantly of coastal vegetation with a sparse ground cover.

Regional ecosystems are vegetation communities in an area that are consistently associated with a particularly combination of geology, landform and soil. These Regional Ecosystems (RE's) are mapped over most of Queensland and are given a specific code relating to the region of Queensland, the landform (i.e. alluvium, sedimentary rocks etc.) and the vegetation community. RE's of relevance to Midge Point have been mapped below in Figure 63 and short descriptions of the regional ecosystems relevant to the coastline and erosion are outlined in Table 11.

Table 11: Regional ecosystems relevant to the foreshore at Midge Point

Regional Ecosystem ID	VMA Class	Short Description
8.2.6	Of Concern	*Corymbia tessellaris* + *Acacia leptocarpa* + *Banksia integrifolia* + *Melaleuca dealbata* + beach scrub species open forest on coastal parallel dunes
8.2.2	Of Concern	Microphyll vine forest on coastal dunes
8.1.1	Least Concern	Mangrove vegetation of marine clay plains and estuaries. Estuarine wetland
8.12.20	Least Concern	*Eucalyptus drepanophylla* and/or *E. platyphylla* +/- *Corymbia clarksonia* +/- *C. dallachiana* woodland on low gently undulating landscapes on Mesozoic to Proterozoic igneous rocks.

It should be noted that RE 8.2.6 is quoted as being 'naturally vulnerable to erosion' because of the sparse ground cover associated with the regional ecosystem.

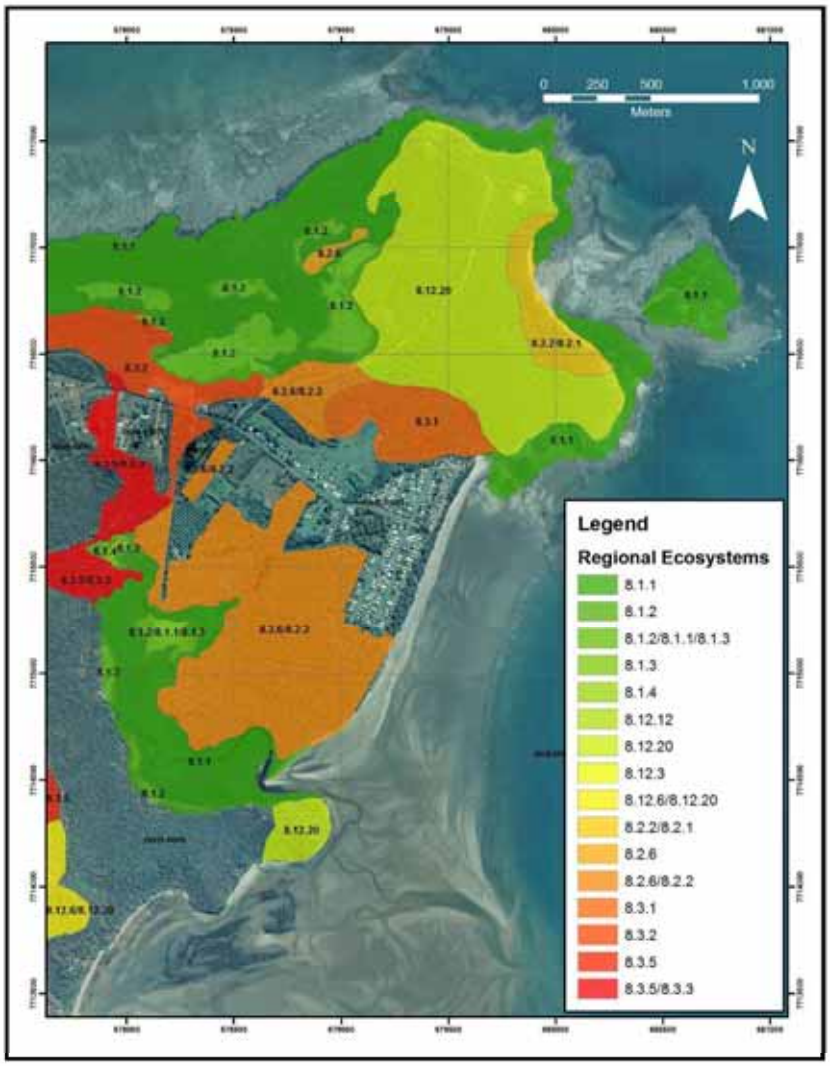


Figure 63: Regional Ecosystems near the Midge Point Beach

SOCIAL VALUES

The social values of an area are always difficult to adequately describe. To a large extent the social values are intangible, the "feeling" of a place, the attitude of the other residents, the "secret" fishing spots, or the shared discussion on how much the beach has eroded in the last six months. Regardless of how intangible these values are, they are real, and attempts at description tend to trivialise something of far greater enjoyment and importance than any piece of infrastructure.

To an outsider, the obvious social values are the communal use of the beach, the boat ramp, the freedom to enjoy a natural setting unimpeded by the demands and regulations of governing agencies, and the companionship of a small, like minded community where the kids have grown into adults and the adults into grandparents.

Also commonly overlooked are the values given by water views and the carefully maintained parkland forming the 'esplanade' between residential blocks on the north-western side of Nielsen Parade and the beach to the south-east of this road (Figure 4). Recent cyclones (such as Cyclone Ului in 2010) have destroyed and damaged vegetation within this esplanade area.

Figure 64: Council parkland separating residential allotments(right) from the beach (left).

APPENDIX 2 – CATCHMENT DRAINAGE

INTRODUCTION

To understand the sediment distribution patterns of Midge Point, and to identify potential changes to the distribution of the sediments, it is necessary to understand how the catchment delivers sediment to the marine system prior to redistribution to the beaches of Midge Point.

A number of catchments drain into Repulse Bay, each characterised by a different geological background that will impart different sediment characteristics, and consequently possess different distribution capabilities within the Bay. The catchments that have been identified as having the greatest impact on the movement of sediments along the Midge Point beach are Yard, Dempster and Hervey Creeks to the south, the O'Connell River to the north west, the Proserpine River to the north, and the numerous small creeks that predominantly drain along geological faults into the northern and eastern section of Repulse Bay. The importance of each of the catchments to the provision of sediments to Midge Point is discussed below.

The ecological and hydrological values of these catchments are discussed fully in Appendix 1. The geological framework that supports the distribution of the sediments is also recognised as significant and attention is given to this in Appendix 1. The system is also closely linked to the Great Barrier Reef Marine Park. The links with the GBRMP are recognised as highly significant and while they are noted in this Section, the ecological and hydrological supporting linkage between the marine and terrestrial values of the two systems is discussed in Appendix 1.

YARD CREEK

The relatively small Yard Creek catchment is located at the western end of the Midge Point Beach. The catchment draining this area is small, with the headwaters beginning approximately 4.5km inland from the beach within a series of isolated hills separating Midge Point from Laguna Quays. The lower half of Yard Creek cuts through a series of previously deposited alluviums, mud flats and salt pans. These features have formed in association with a prograding series of swales and beach ridges that have been successively interrupted by variations in sea level. The lower portion of Yard Creek is heavily flanked by mangroves.

Yard Creek, together with numerous other short streams between Midge Point and the mouth of the O'Connell River to the north and Dempster Creek to the south, drains through sedimentary sequences that make up the Upper Devonian to Lower Carboniferous Campwyn Beds of the Conder Hills. These sediments tend to be fine grained, and easily transported through the freshwater section of the creek. Flocculation into larger sediments may occur on entering the saline environment and deposition at this point is probable.

Settlement time of the finer sediments is often delayed on entering open waters and secondary tidal dispersion of the muddy sediments into the protected environment of the mangrove systems is probable.

DEMPSTER CREEK

Dempster Creek, approximately 2km to the south-south-west of the Midge Point settlement, follows the Dempster Fault that splits the Conder Hills from the Tonga Range,

both of which are part of the geological feature known as the Campwyn Beds (acid volcanics and inter-bedded sediments).

Approximately 17.5 km long, Dempster Creek drains a catchment of approximately 110km^2 of mixed farmland and bushland before emptying into the southern end of Repulse Bay through a 550m wide mouth. The lower reaches of the creek are dominated by mangroves with three mangrove covered sand islands within the estuary.

The area drained by Dempster Creek is geologically very similar to Yard Creek (refer Figure 6) with the exception of a short extension along the Dempster Fault into an area of high quality agricultural land between the Clarke Ranges and the Conder Hills/Tonga Ranges. Short tributaries of Dempster Creek also drain very small areas of granites at the intersection of the Dempster and Thoopara Faults. The majority of the Dempster Creek drainage into Repulse Bay is through a deltaic feature of previously deposited alluviums, mud flats and salt pans. The deltaic area is in its early stages of development. At very low tides it is clearly evident that the large sediment deposits at the mouth of Dempster Creek are in the early part of a land building process.

It is expected that during low energy flows through Dempster Creek fine sediments associated with the Campwyn Beds and the inter-bedded sediments and acid volcanics of the Carmila geological unit will settle rapidly within the quiet environment of the mangrove colonies, mud flats and salt pans. Remobilised material, or sediments held in suspension during higher energy events, will be carried off shore and remain in suspension for extended periods for future deposition within protected areas along the coastline.

HERVEY CREEK

Hervey Creek lies to the south of Dempster Creek around a headland and as such does not directly affect the beach at Midge Point. It is a smaller creek than Dempster with a catchment that lies almost north / south and stretches 10.5km up into the low hills to the south of Midge Point. The catchment itself is predominantly farmland with the low hills covered in bushland and lightly wooded.

O'CONNELL RIVER

The O'Connell River captures the Andromache River before entering Repulse Bay approximately 11km to the north of the Midge Point settlement. Drainage into these two river systems is almost entirely from the varying Plutonic rocks of the Upper Carboniferous, Lower Permian and Late Cretaceous Urannah Igneous Complex of the Clarke Ranges to the west of the O'Connell River. To the east of the O'Connell River, all creeks flow into Repulse Bay or Dempster Creek.

The majority of the O'Connell River flows through the inter-bedded sediments and acid volcanics of the Carmila geological unit. Agriculture in this area has developed to take advantage of the rich soils associated with the Palaeozoic / Lower Permian Carmila Beds. The O'Connell River enters Repulse Bay across wide stretches of previously deposited alluvials laid down during periods of higher sea level.

The O'Connell River estuary forms the southern boundary of the Goorganga Wetlands. Sediment load through the river system, and into Repulse Bay, is extensive. Available historical aerial photos indicate the majority of the sediment from the O'Connell River system is moved southwards along the coastline towards Midge Point.

Sediment transport and deposition within the O'Connell River and eventually into Repulse Bay, is discussed in Section 3.4.2.

PROSERPINE RIVER

The Proserpine River estuary forms the northern boundary of the Proserpine Plain / Goorganga Wetlands complex, a series of brackish and saline wetlands of National Significance. The headwaters of the Proserpine River originate in the acid to intermediate igneous rocks of the Cretaceous Hecate Granite complex. The river then flows across the Carmila Beds before traversing onto the Quaternary alluvial sediments of the coastal plain. These upper reaches are outside the western boundaries of the Hillsborough Basin system. To the east the Proserpine River crosses the extension of the O'Connell Fault.

Within the limits of the Hillsborough Basin the Proserpine River flows across Quaternary alluvials and follows the approximate west-north-west, east-south-east alignment of the Foxdale Fault adjacent to the Lower Carboniferous Edgecumbe Beds consisting of acid to intermediate volcanics with inter-bedded sediments. In the vicinity of the complex junctions of the Foxdale, Bona Vista, and Woodwark Faults (near Bonavista Palm Grove), the Proserpine River flows south-south-east across the Quaternary muds and saltpans of the coastal sedimentary complex along the margin of the acidic Proserpine Volcanics.

The southern catchment of the Proserpine River (tributaries of Thompson Creek) separates sharply from the O'Connell River by a small rise associated with the northern most extension of the Condor Hills.

Sediments from the upper part of the catchment will comprise quartzo-feldspatic sands which will either deposit on the alluvial plain for subsequent reworking, or be transferred into Repulse Bay. Similarly, sediments derived from the interbedded volcanics and sediments of the Carmila and Edgecumbe Units will be transported through the alluvial plain into the marine environment. Saltwater Creek drains the acidic rocks of the Lower Cretaceous, ryolitic and minor pyroclastics of the Proserpine Volcanics, directly into the estuary of the Proserpine River. Thus, the majority of the sediments being transported down the Proserpine River consist of the weathering products of acid to intermediate Plutonic and Volcanic rocks. That is, they will be quartz rich sediments with feldspathic components. These latter components degrade into a range of clay minerals including smectite, mixed layer smectite-illites, mixed layer smectite-kaolinite, and kaolinites. This mineralogical assemblage is consistent with the sediments found in Repulse Bay.

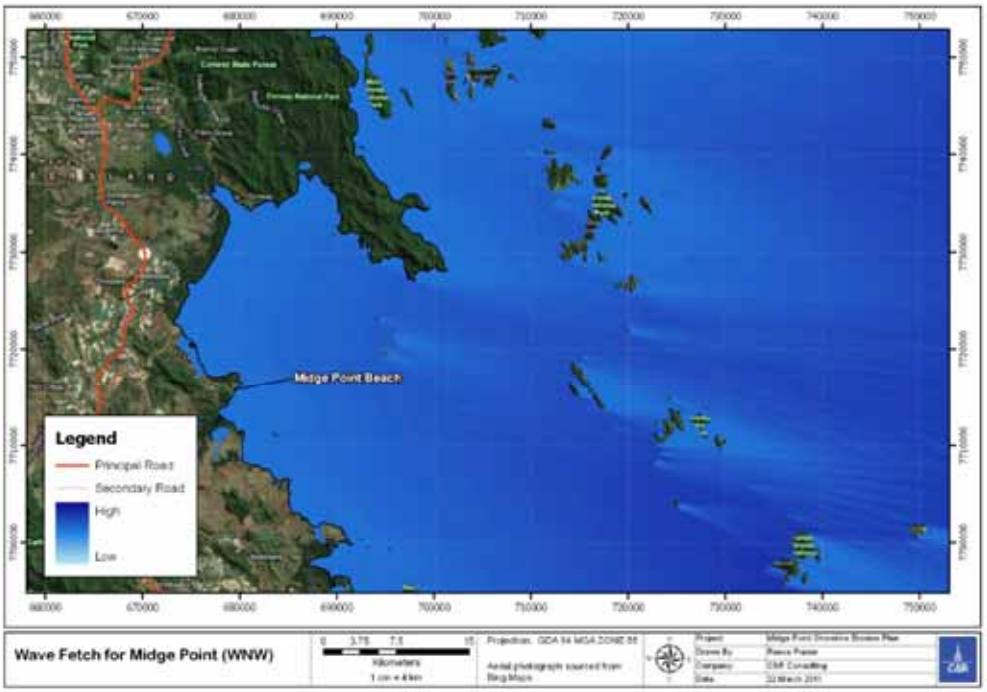
DRAINAGE INTO THE NORTHERN AND EASTERN SECTIONS OF REPULSE BAY

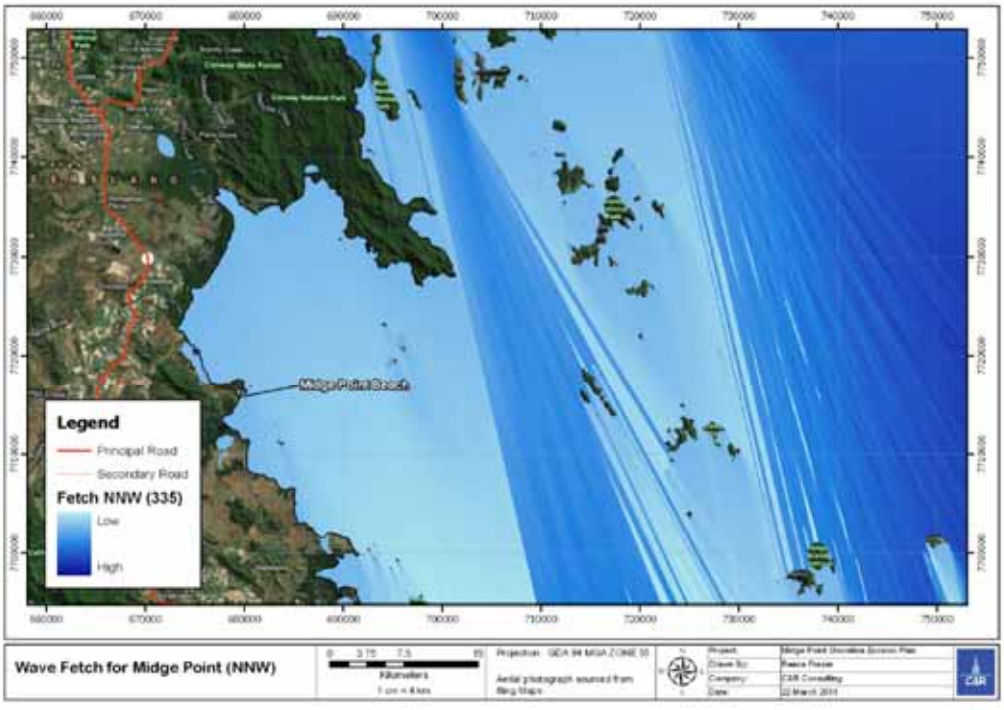
On the western side of the Conway Range, drainage of the upper reaches of the streams emptying into the northern end of Repulse Bay and into the estuary of the Proserpine River is almost entirely controlled by the numerous minor faults within the Proserpine Volcanics. The estuarine sections of these streams are incised through the quaternary alluvial sediments of infilled inlets. The Conway Range separates the Proserpine Volcanics from the slightly older, Lower Permian, acid to intermediate pyroclastics of the Airlie Volcanics. Drainage through the Lower Cretaceous Whitsunday Volcanics is minor. The lower estuaries of the creeks draining this sequence are also incised into the Quaternary alluvials of the infilled inlets.

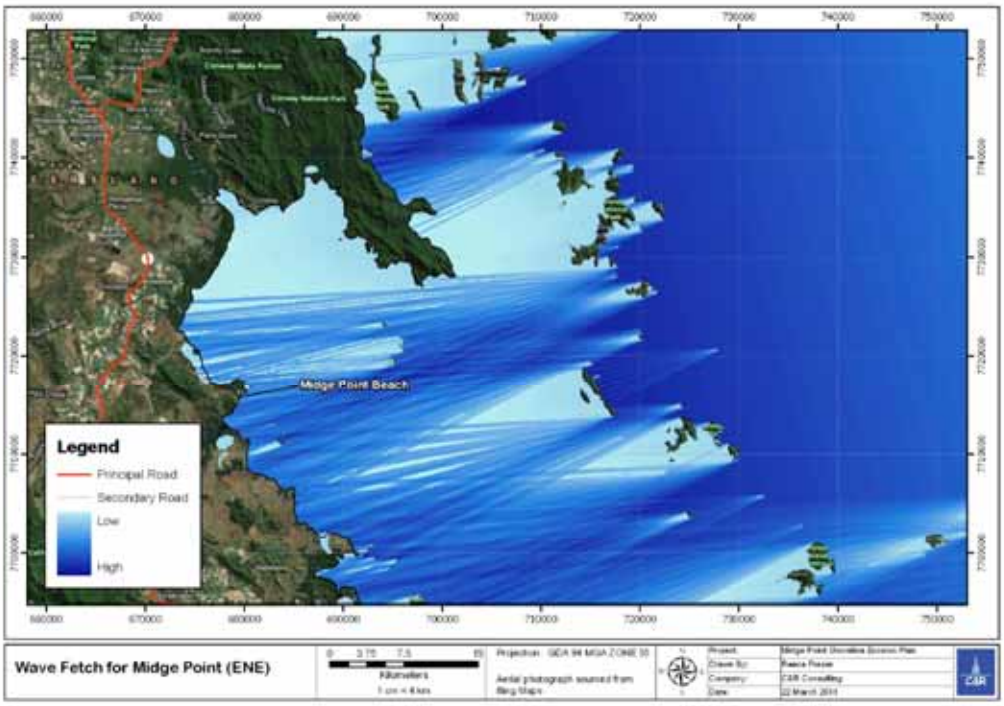
The Conway Fault separates the Conway Range from the Whitsunday Volcanics of Cape Conway. Drainage through the acid to intermediate pyroclastic flows and lavas will transfer

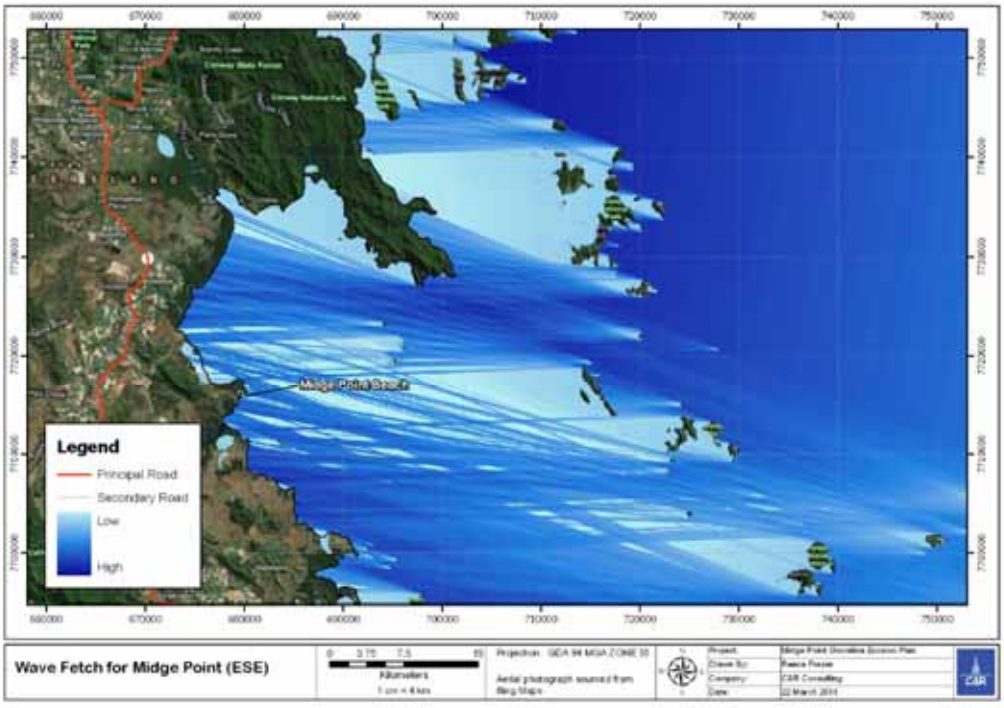
generally fine sediments to the eastern side of Repulse Bay. These fine sediments will be held in suspension during higher energy events, carried off shore, and may remain in suspension for extended periods for future deposition within protected areas along the coastline.

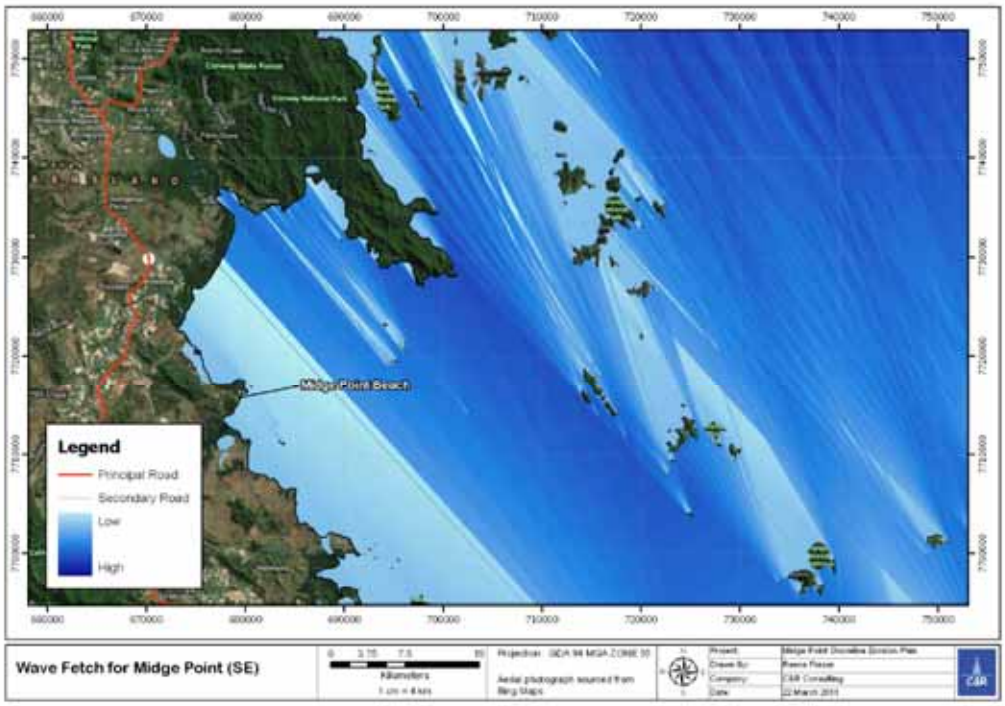
APPENDIX 3 – WAVE FETCH DIAGRAMS


Midge Point Beach
Legend
Principal Road
Secondary Road
High
Low
Wave Fetch for Midge Point (WNW)


Midge Point Beach
Legend
Principal Road
Secondary Road
Fetch NNW (335)
Low
High
Wave Fetch for Midge Point (NNW)

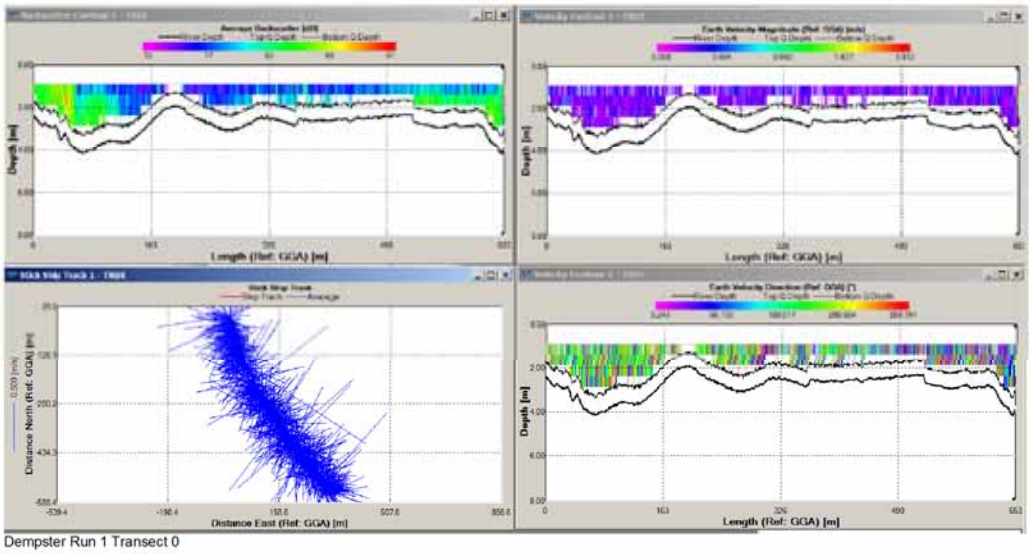

Midge Point Beach
Legend
Principal Road
Secondary Road
Low
High
Wave Fetch for Midge Point (ENE)


Midge Point Beach
Legend
Principal Road
Secondary Road
Low
High
Wave Fetch for Midge Point (ESE)


Midge Point Beach
Legend
Principal Road
Secondary Road
Low
High
Wave Fetch for Midge Point (SE)

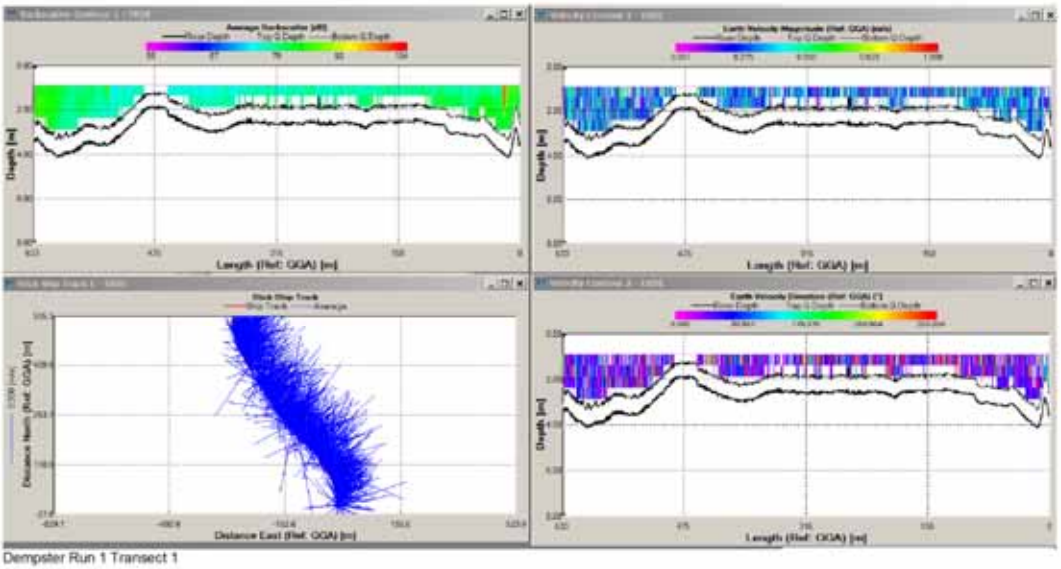
APPENDIX 4 - ADCP PROFILES

(Undertaken by Hydrobiology Pty Ltd)



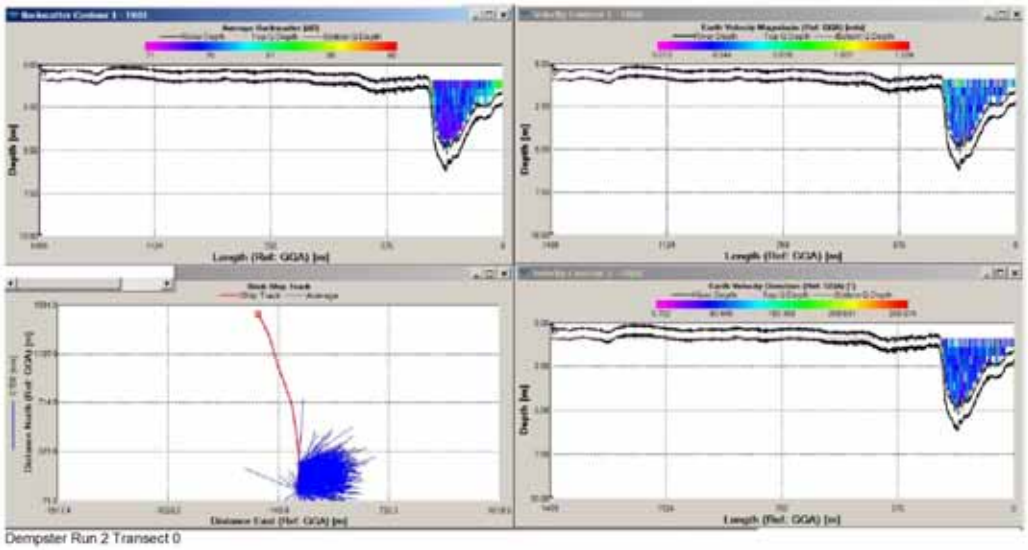
Dempster Run 1 Transect 0

149



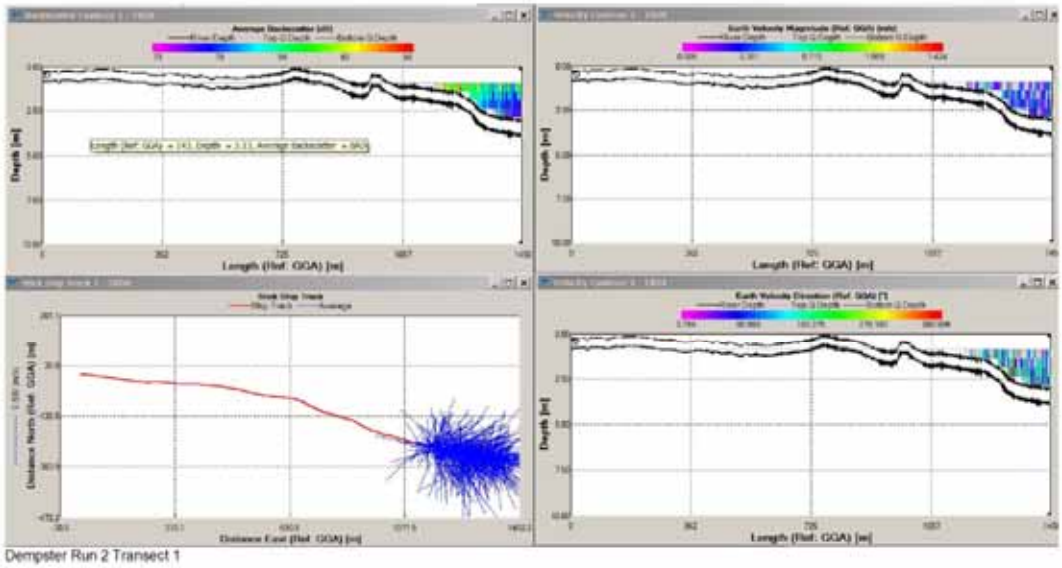
Dempster Run 1 Transect 1

150



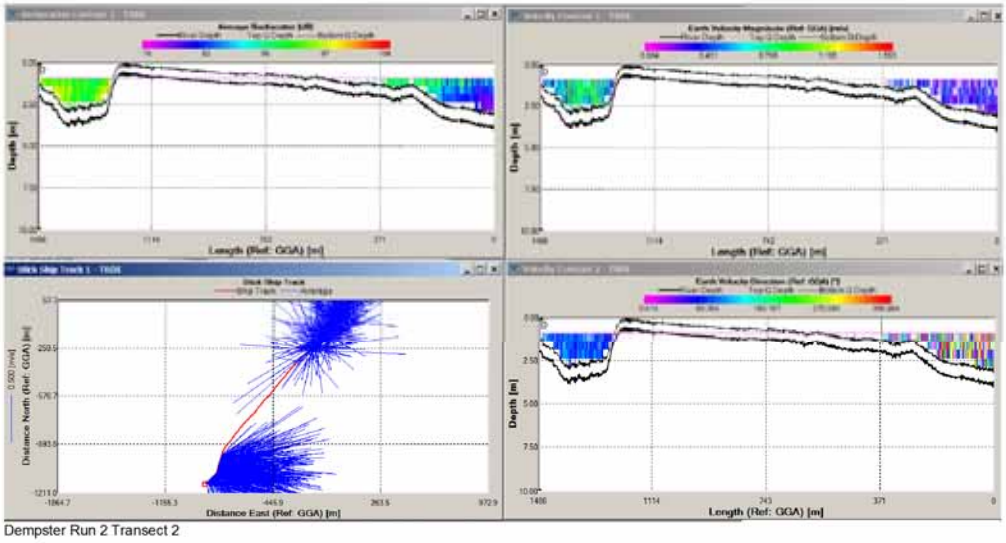
Dempster Run 2 Transect 0

151



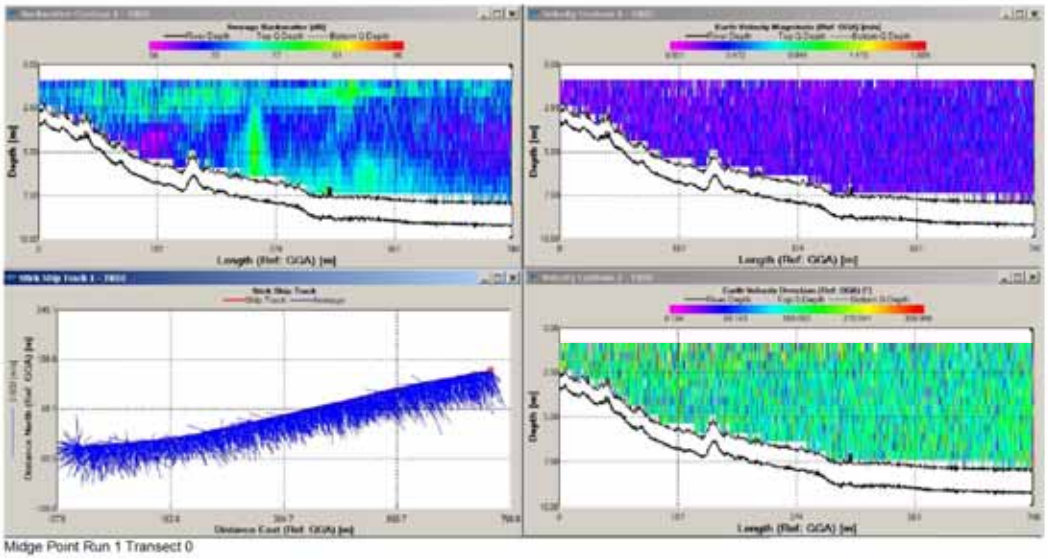
Dempster Run 2 Transect 1

152



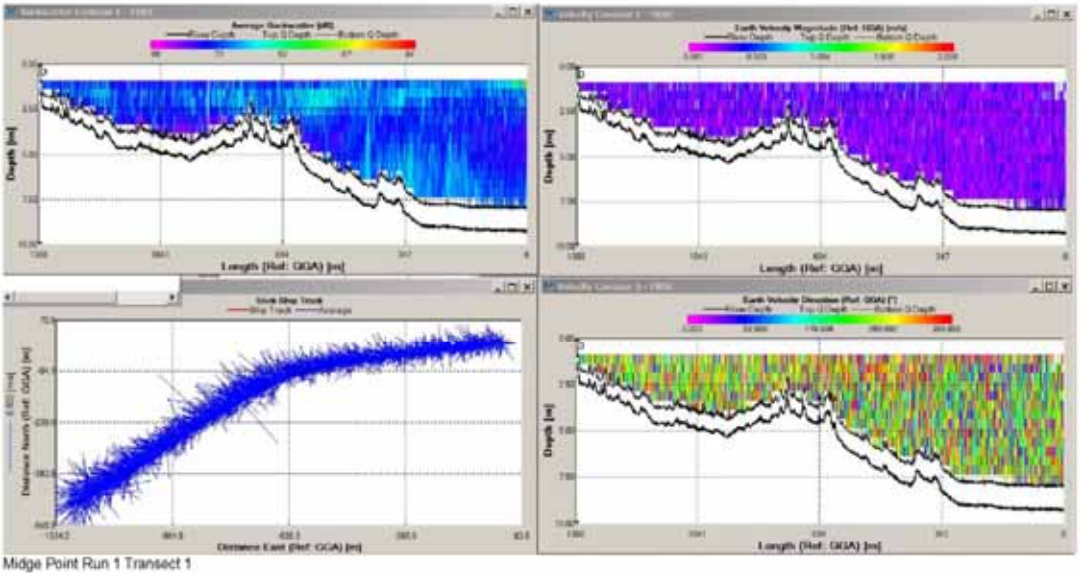
Dempster Run 2 Transect 2

153



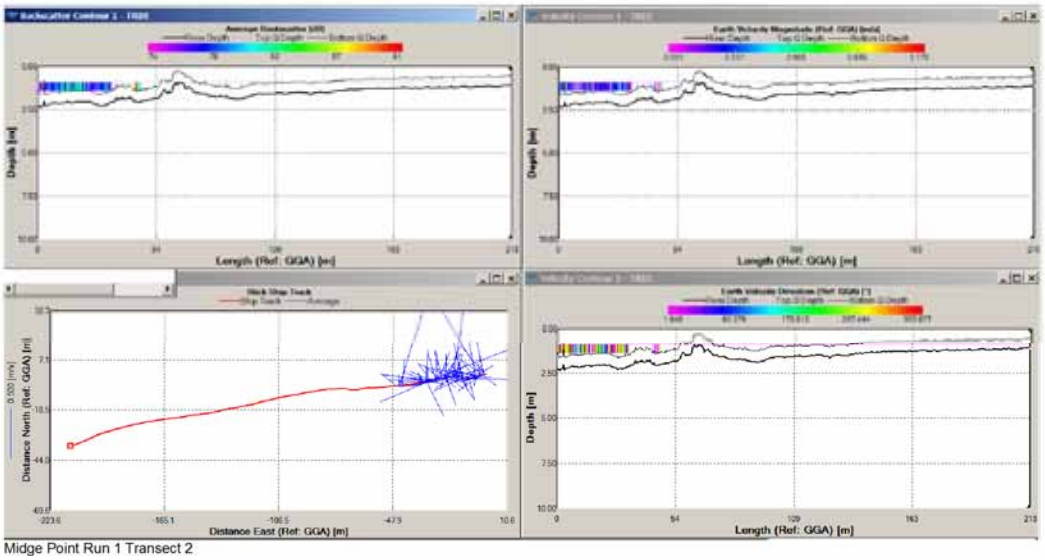
Midge Point Run 1 Transect 0

154



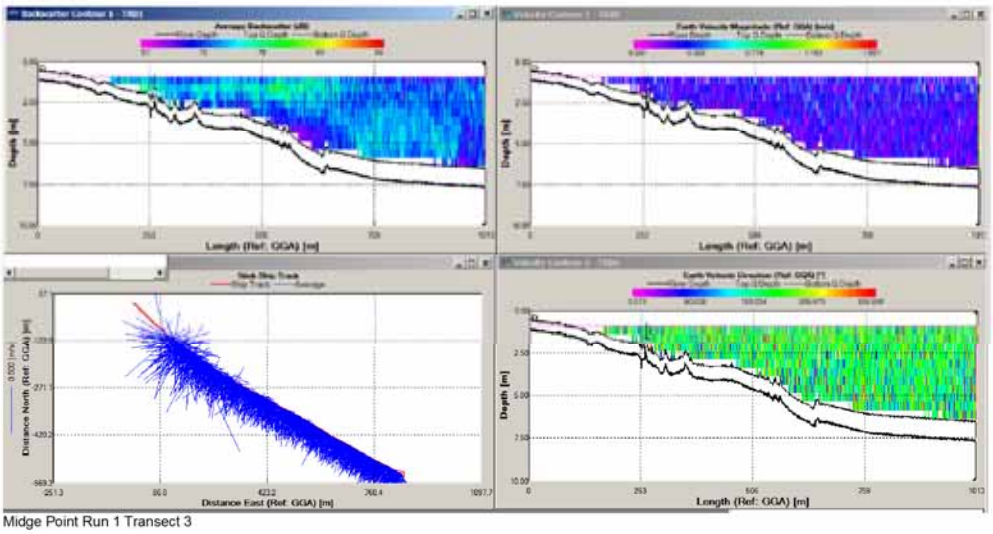
Midge Point Run 1 Transect 1

155



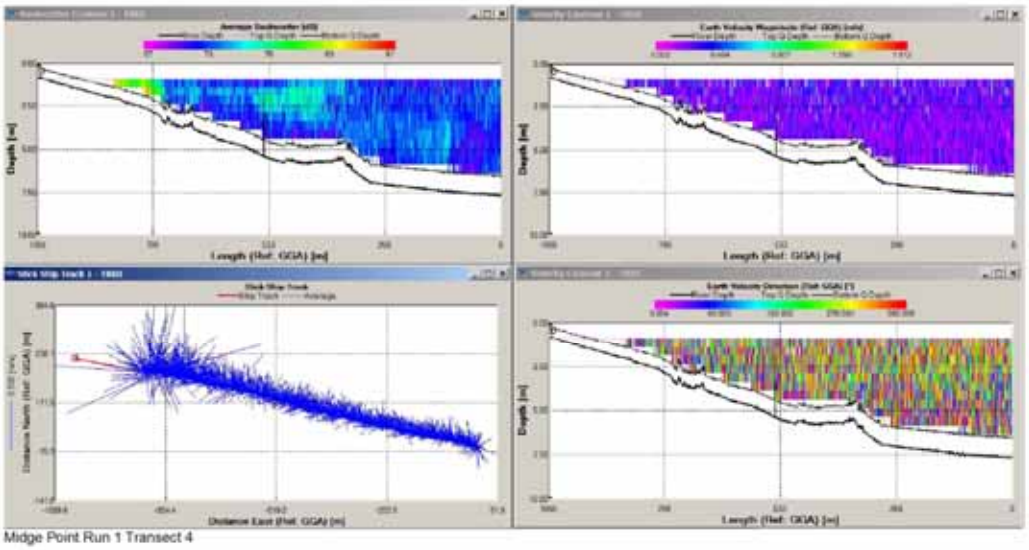
Midge Point Run 1 Transect 2

156



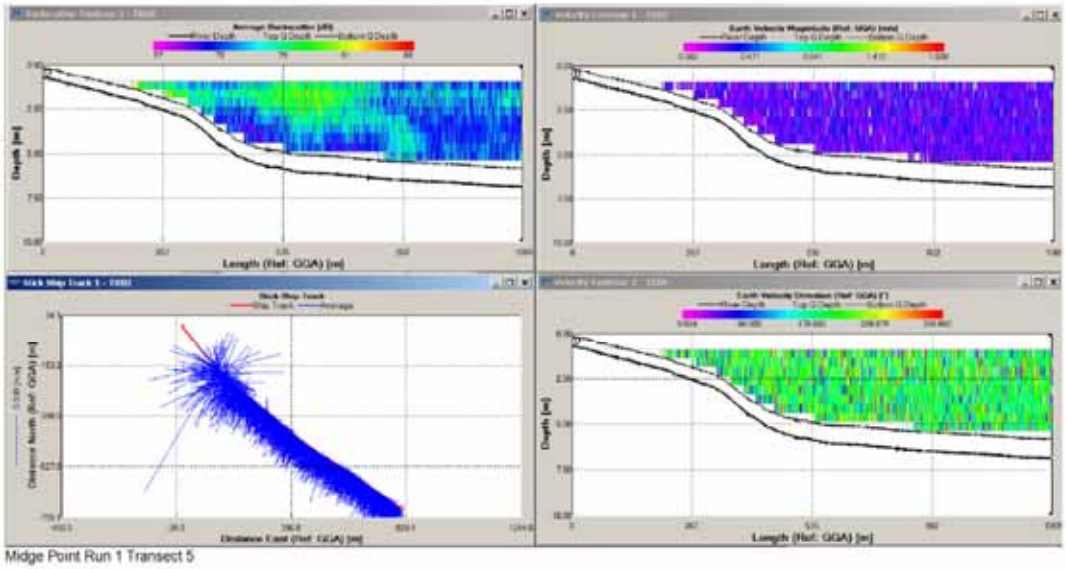
Midge Point Run 1 Transect 3

157



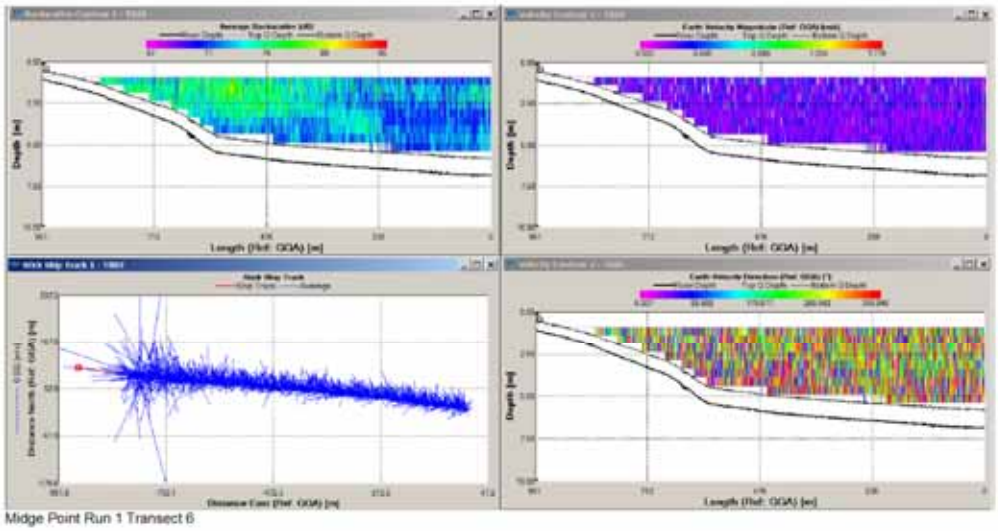
Midge Point Run 1 Transect 4

158



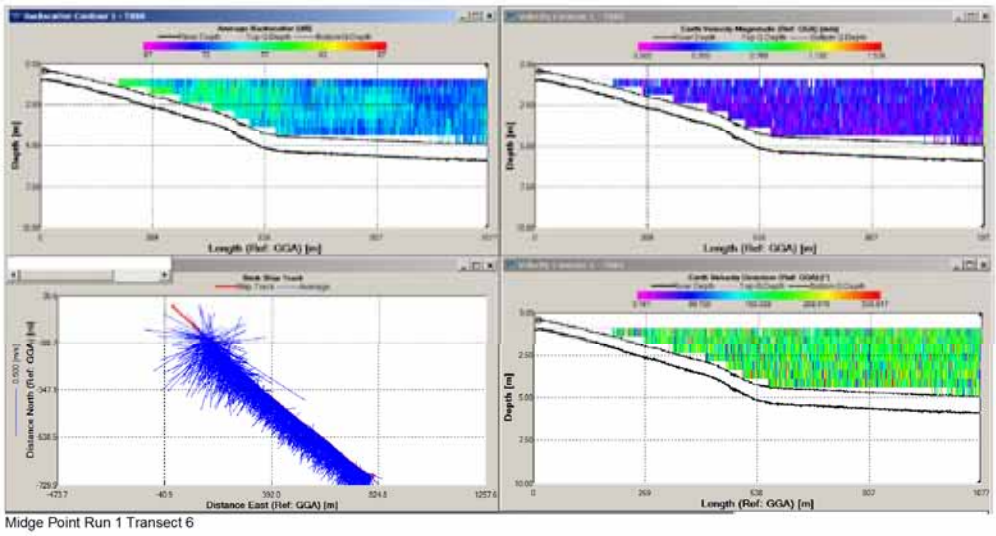
Midge Point Run 1 Transect 5

159



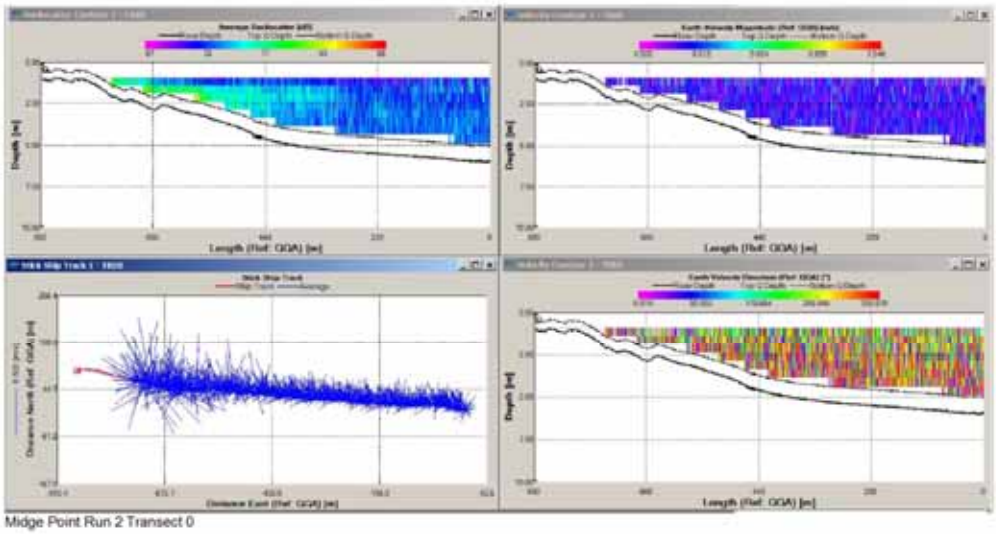
Midge Point Run 1 Transect 6

160



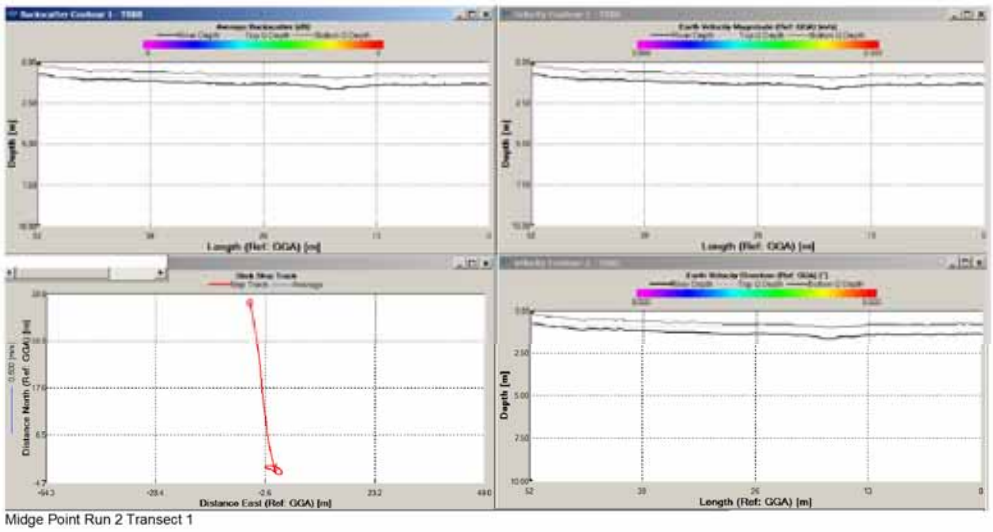
Midge Point Run 1 Transect 6

161



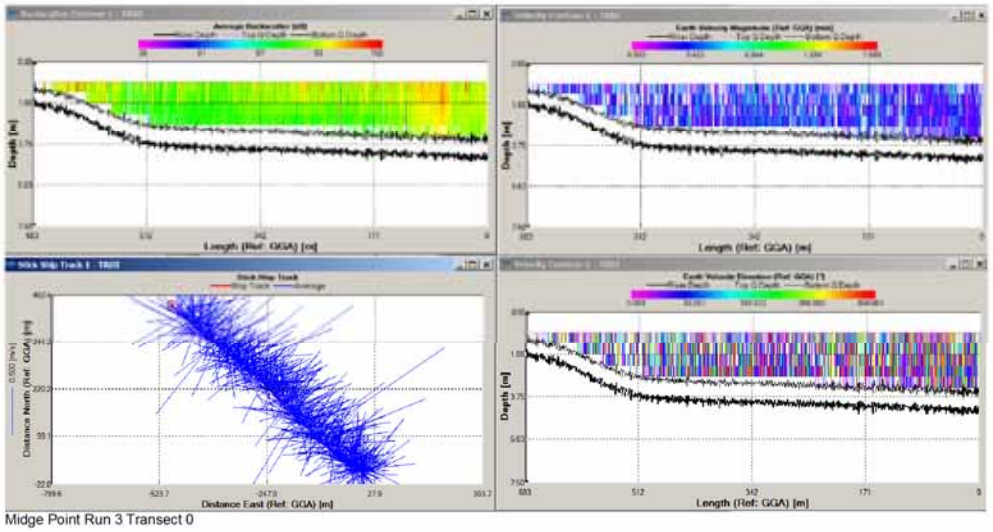
Midge Point Run 2 Transect 0

162



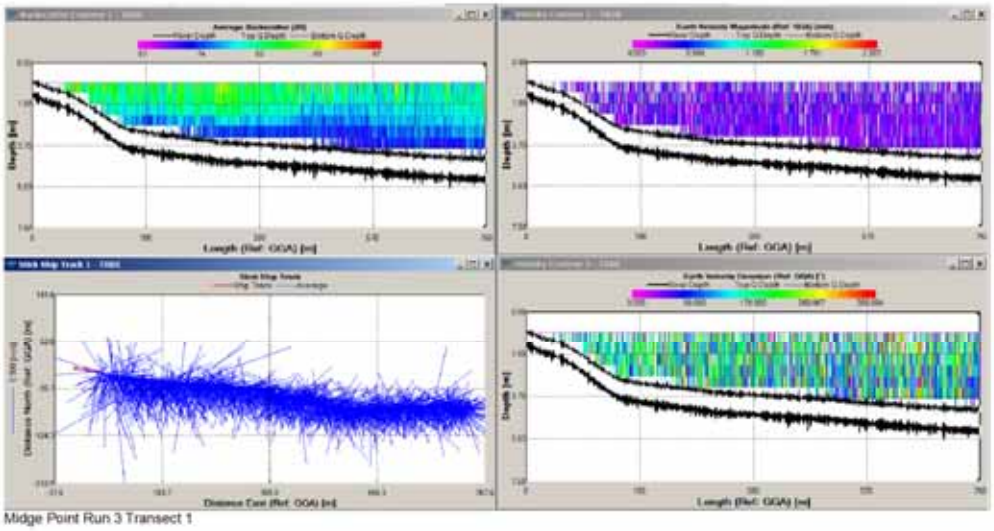
Midge Point Run 2 Transect 1

163



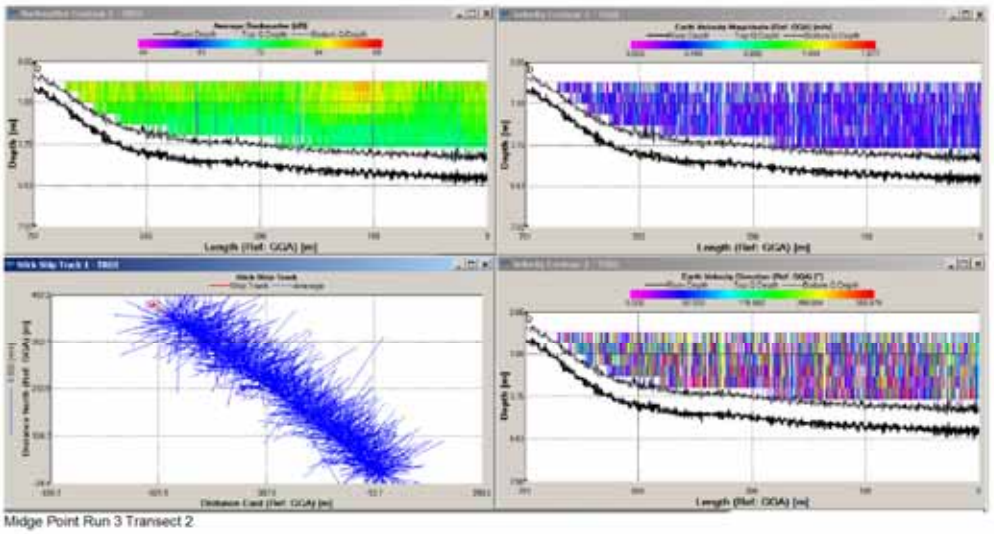
Midge Point Run 3 Transect 0

164



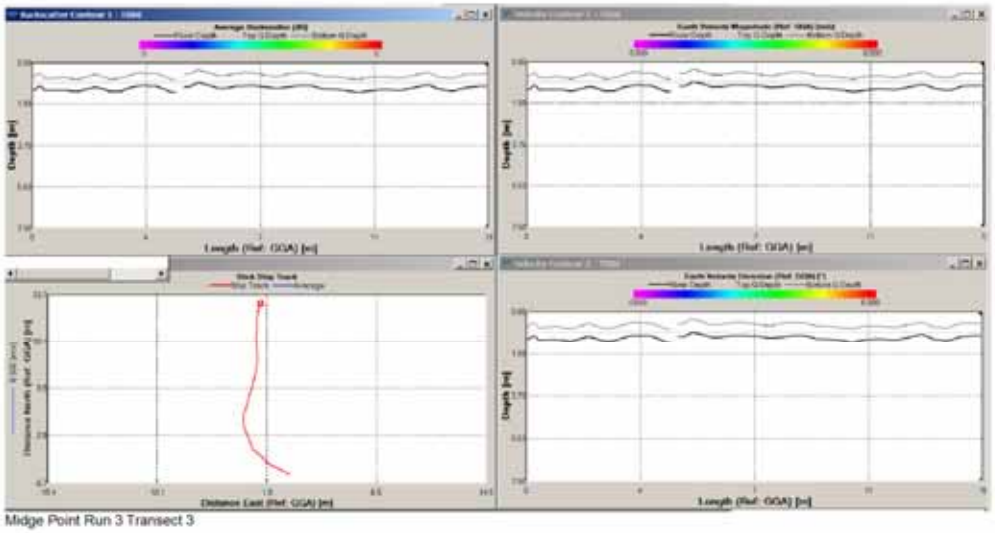
Midge Point Run 3 Transect 1

165



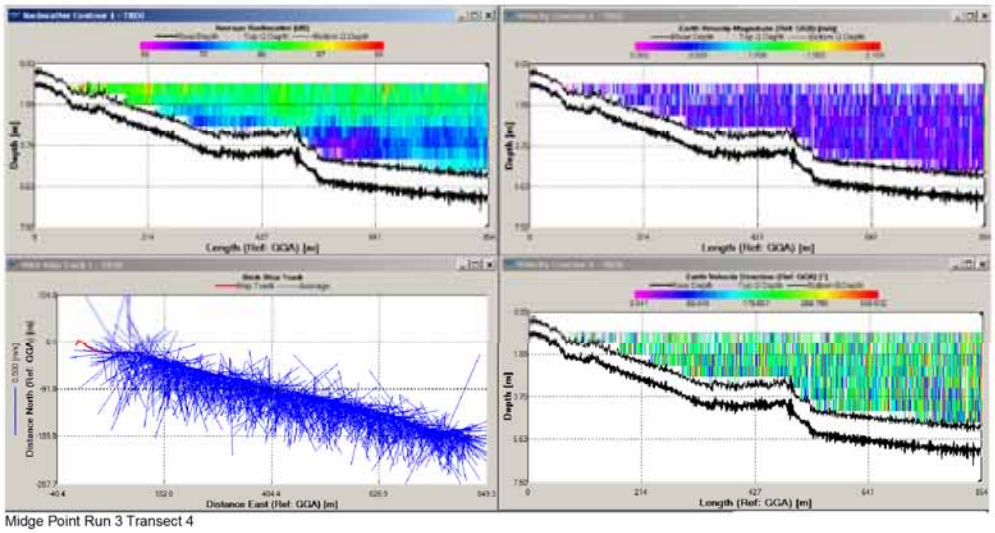
Midge Point Run 3 Transect 2

166



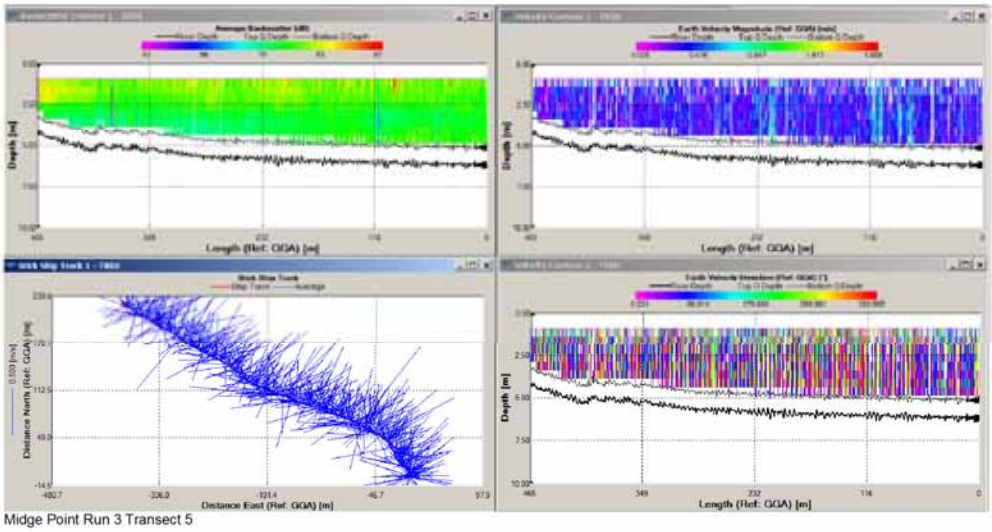
Midge Point Run 3 Transect 3

167



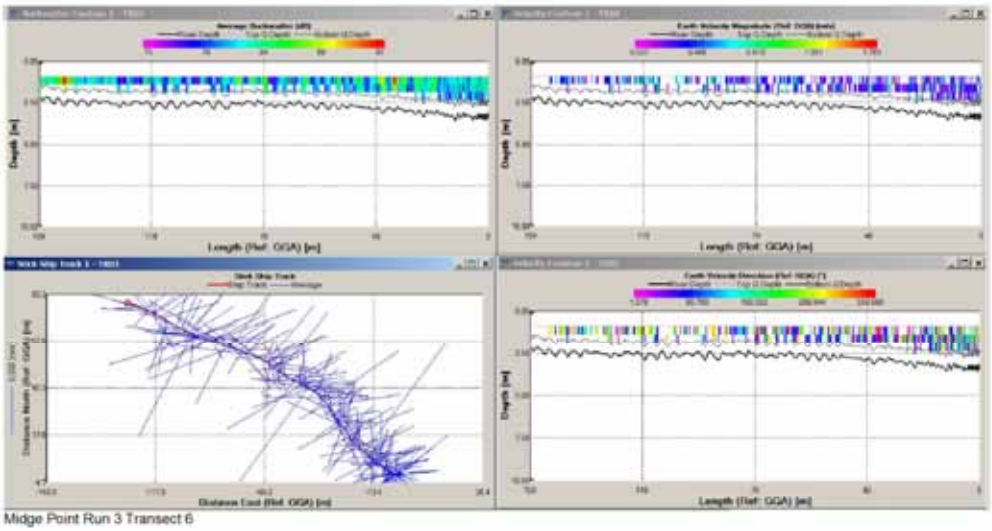
Midge Point Run 3 Transect 4

168



Midge Point Run 3 Transect 5

169



Midge Point Run 3 Transect 6

170

APPENDIX 5 - TIDE LEVELS AND STORM SURGE MAP

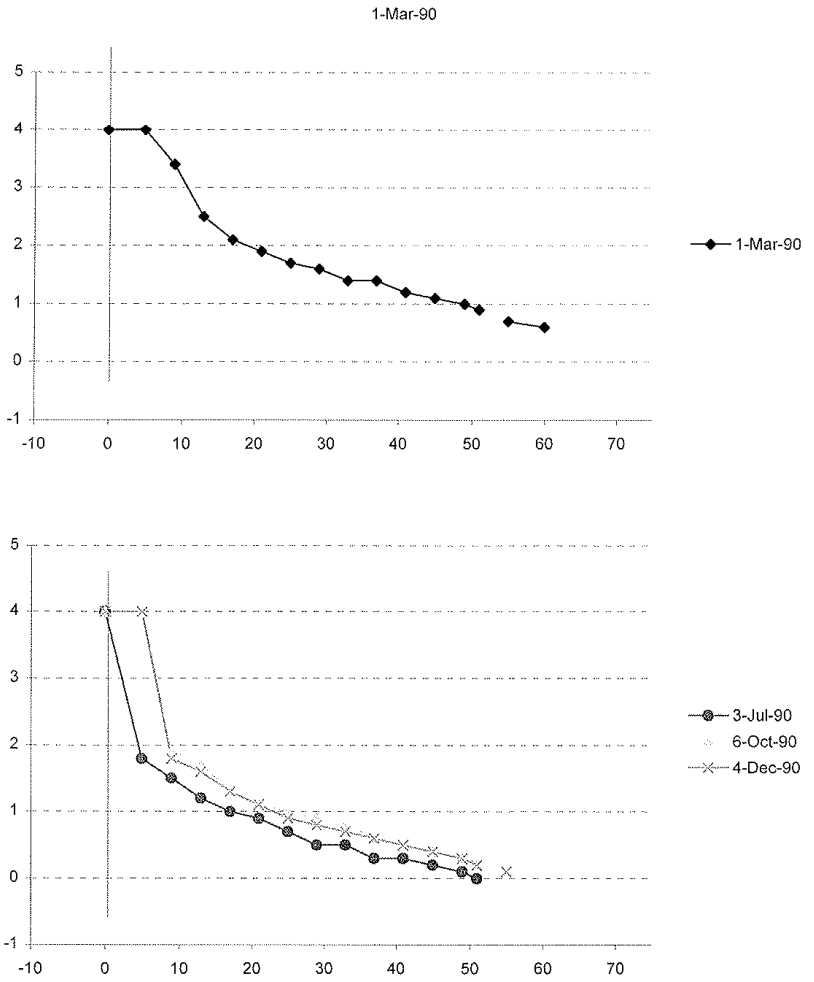
Legend
Lowest Astronomical Tide
Mean Sea Level
Highest Astronomical Tide
1:50 Storm Surge + 0.8m Sea Level Rise
Tide and Storm Surge Levels
0 250 500 1,000
Meters

APPENDIX 6 – C.O.P.E. BEACH PROFILES

C.O.P.E.

Beach Profiles

C.O.P.E. (Coastal Observation Programme Engineering



Distances and Levels are measured in metres.

Level datum is Assumed

Coastal Observation Programme Engineering

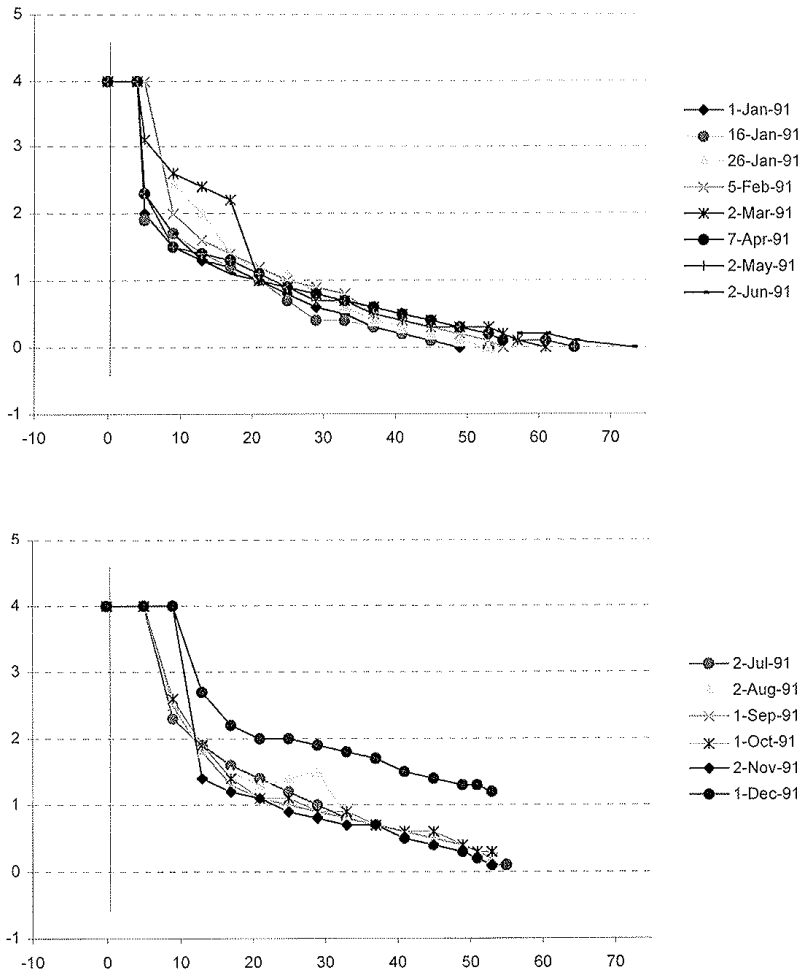
	Midge Point (2007)	**Figure:1**

MIDGEPT.XLS

C.O.P.E.

Beach Profiles

C.O.P.E. (Coastal Observation Programme Engineering



Distances and Levels are measured in metres.

Level datum is Assumed

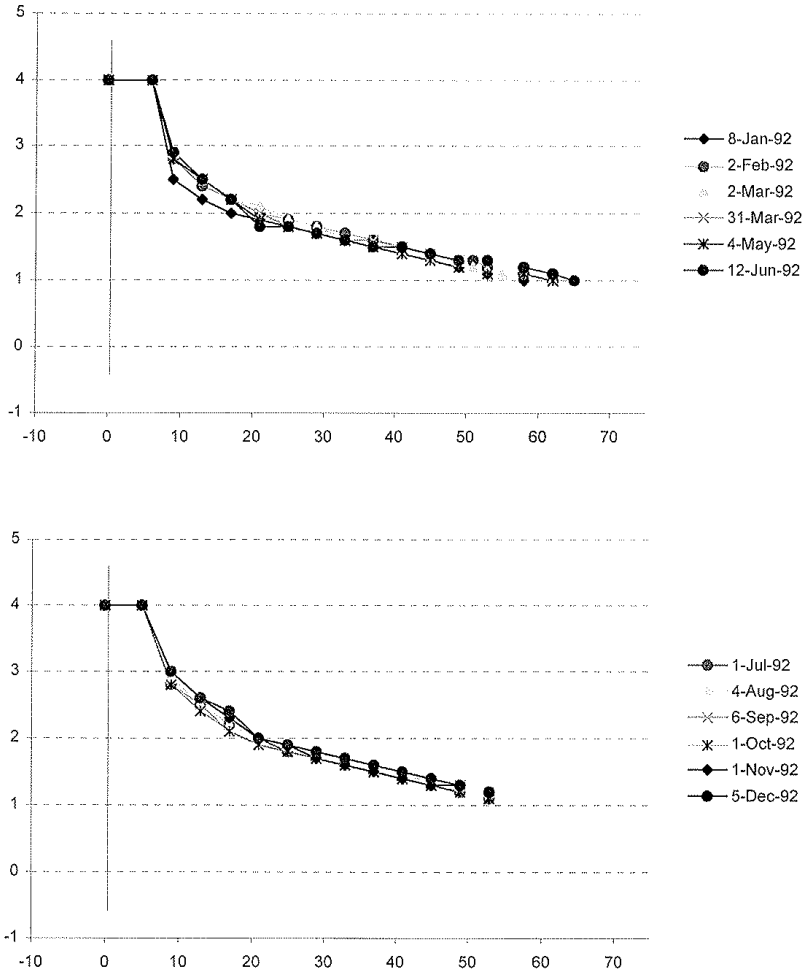
Coastal Observation Programme Engineering		
	Midge Point (2007)	**Figure:1**

MIDGEPT.XLS

C.O.P.E.

Beach Profiles

C.O.P.E. (Coastal Observation Programme Engineering



Distances and Levels are measured in metres.

Level datum is Assumed

Coastal Observation Programme Engineering

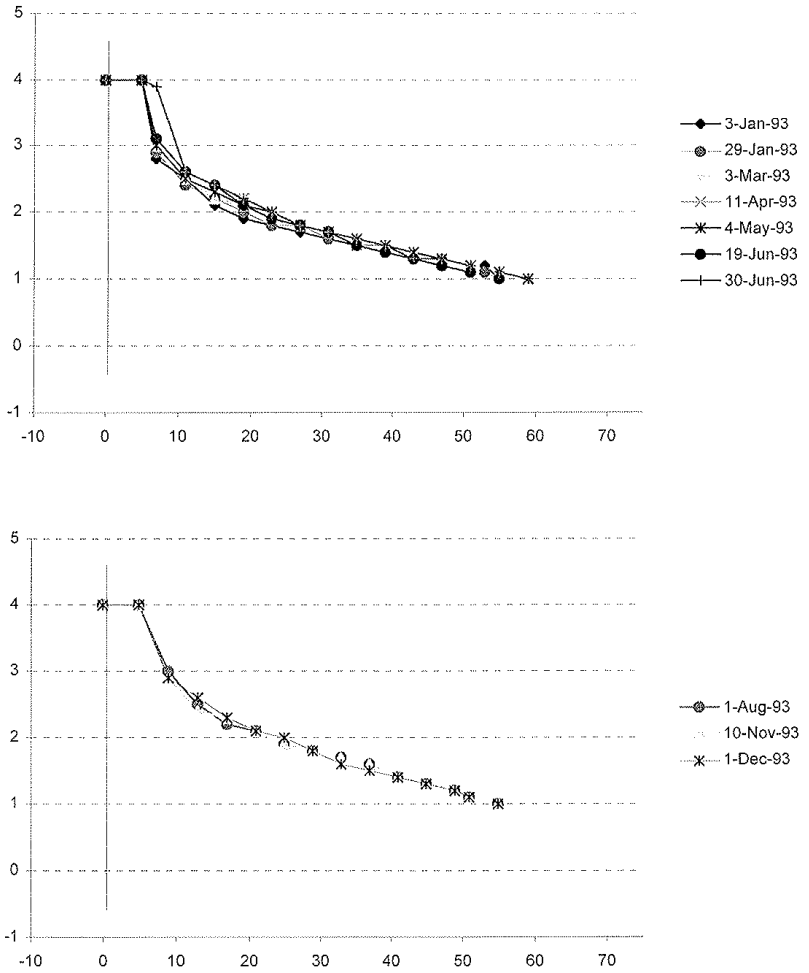
	Midge Point (2007)	**Figure:1**

MIDGEPT.XLS

C.O.P.E.

Beach Profiles

C.O.P.E. (Coastal Observation Programme Engineering



Distances and Levels are measured in metres.

Level datum is Assumed

Coastal Observation Programme Engineering

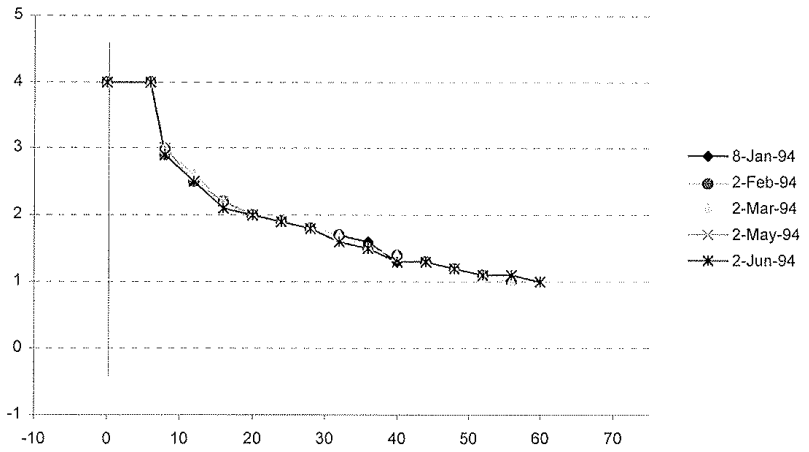
	Midge Point (2007)	**Figure:1**

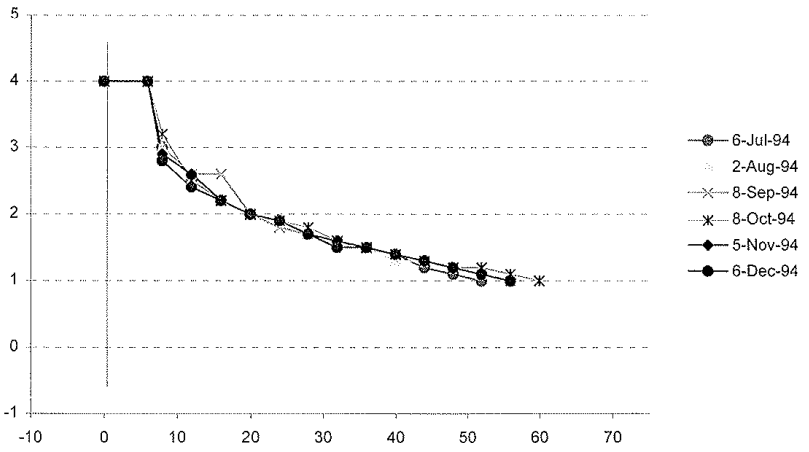
MIDGEPT.XLS

C.O.P.E.

Beach Profiles

C.O.P.E. (Coastal Observation Programme Engineering





Distances and Levels are measured in metres.

Level datum is Assumed

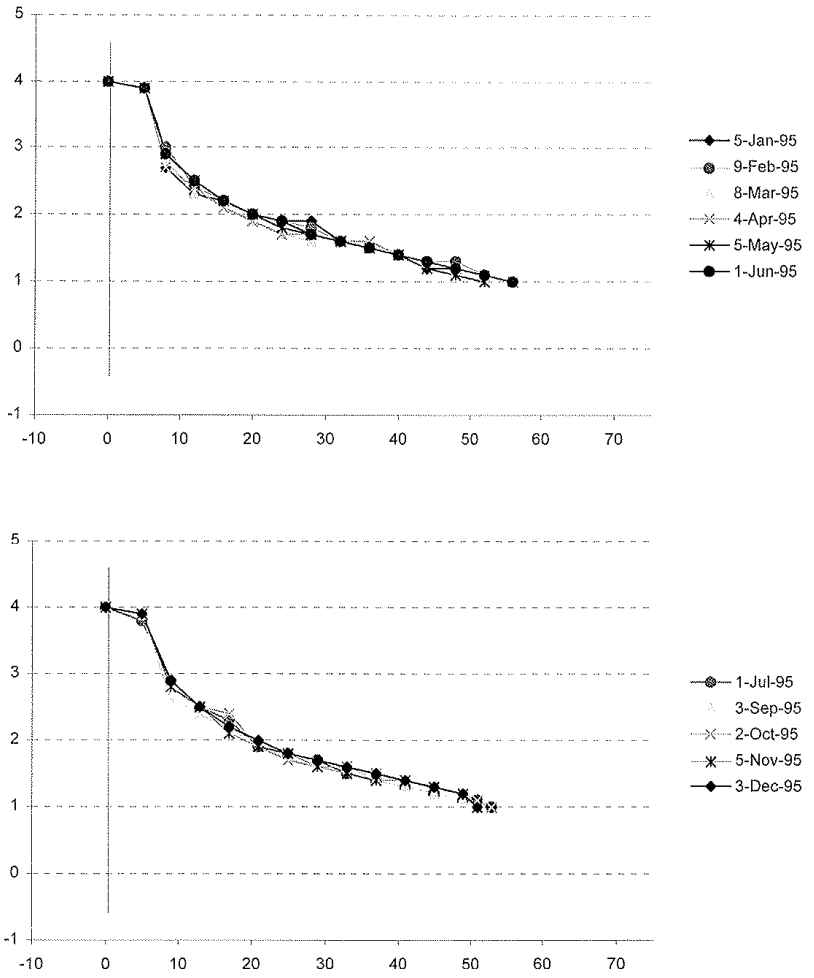
Coastal Observation Programme Engineering		
	Midge Point (2007)	**Figure:1**

MIDGEPT.XLS

C.O.P.E.

Beach Profiles

C.O.P.E. (Coastal Observation Programme Engineering



Distances and Levels are measured in metres.

Level datum is Assumed

Coastal Observation Programme Engineering

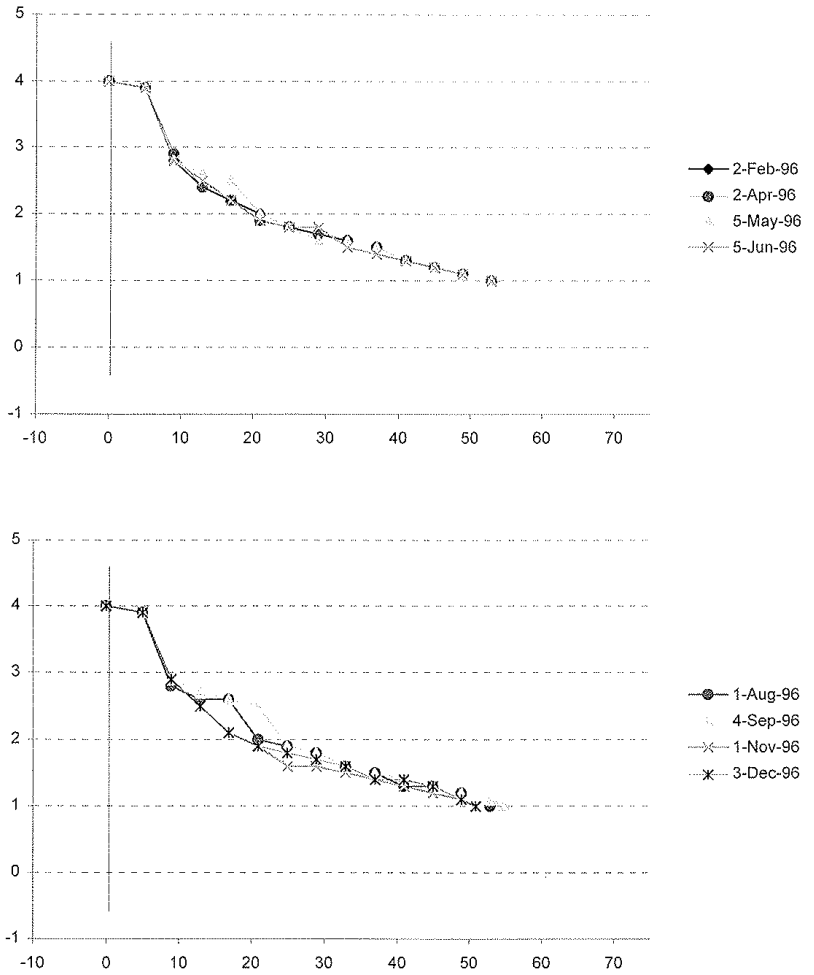
	Midge Point (2007)	**Figure:1**

MIDGEPT.XLS

C.O.P.E.

Beach Profiles

C.O.P.E. (Coastal Observation Programme Engineering



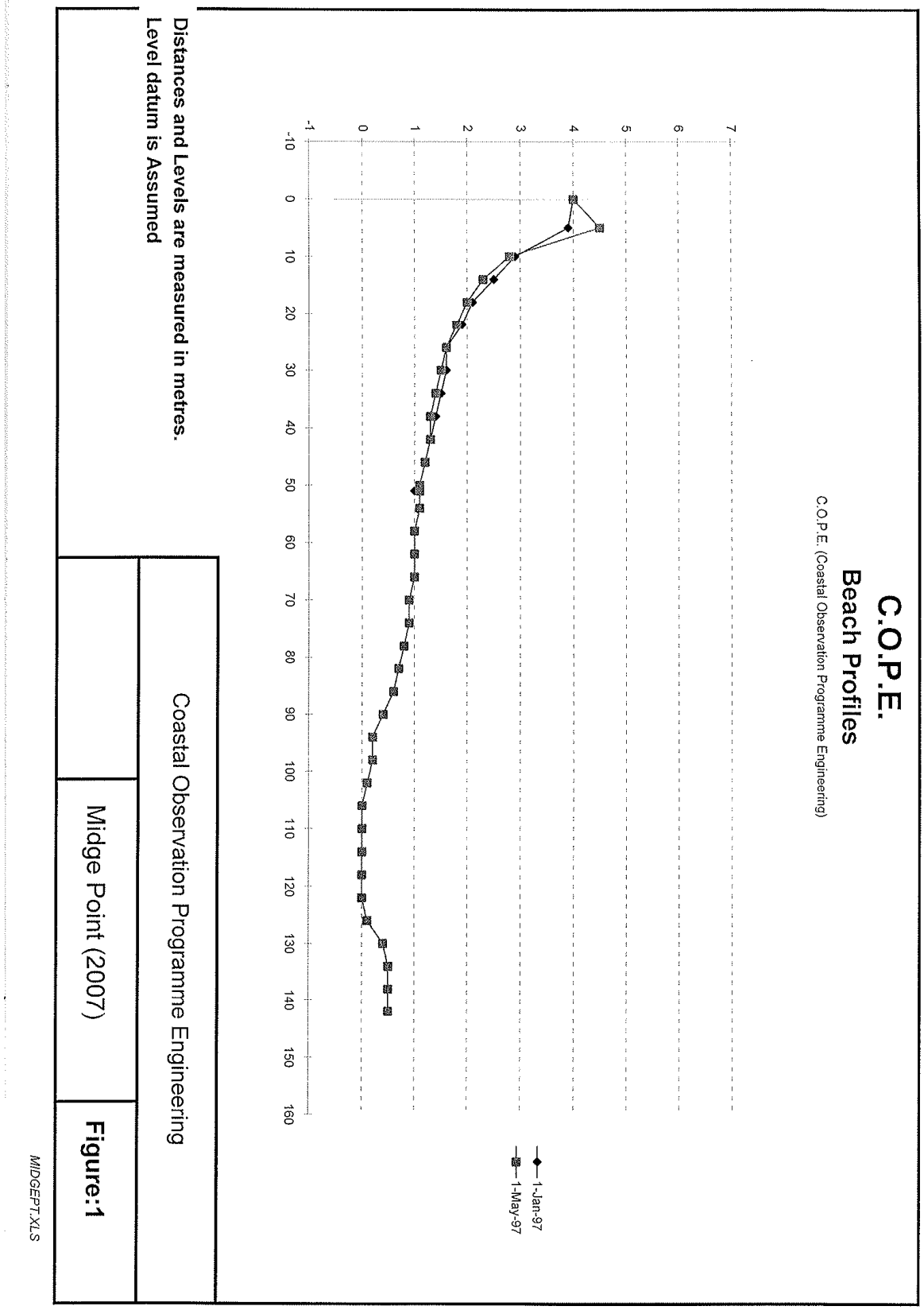
Distances and Levels are measured in metres.

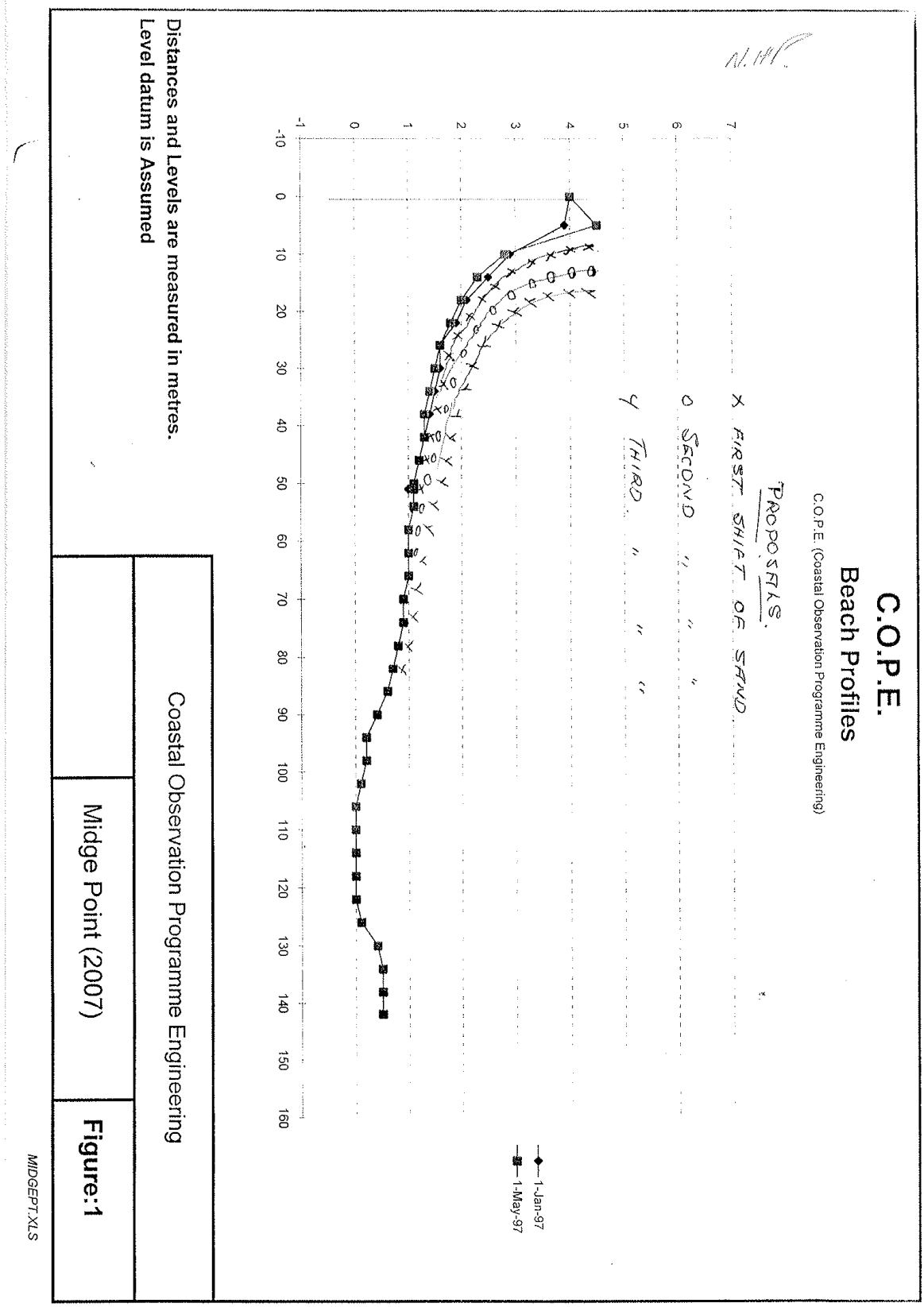
Level datum is Assumed

Coastal Observation Programme Engineering

	Midge Point (2007)	**Figure:1**

MIDGEPT.XLS


C.O.P.E.
Beach Profiles
C.O.P.E. (Coastal Observation Programme Engineering)
1-Jan-97
1-May-97
Distances and Levels are measured in metres.
Level datum is Assumed
Coastal Observation Programme Engineering
Midge Point (2007)
Figure:1
MIDGEPT.XLS


C.O.P.E.
Beach Profiles
C.O.P.E. (Coastal Observation Programme Engineering)
PROPOSALS.
X FIRST SHIFT OF SAND.
O SECOND " " "
Y THIRD " " "
1-Jan-97
1-May-97
Distances and Levels are measured in metres.
Level datum is Assumed
Coastal Observation Programme Engineering
Midge Point (2007)
Figure:1
MIDGEPT.XLS

APPENDIX 7 - LEGISLATION APPLICABLE TO SHORELINE PROTECTION MEASURES

Legislation most applicable to the preparation and operation of the Shoreline Erosion Management Plan is the *Sustainable Planning Act 2009* (SPA) and *Coastal Management and Protection Act 1995* (CMPA). The CMPA sets the administrative landscape i.e. coastal management districts, erosion zone and definition of tidal works.

The Queensland Coastal Plan has been prepared under the Coastal Protection and Management Act 1995 and came in effect from 3 February 2012. It replaces the State Coastal Management Plan (2001) and associated regional coastal management plans and it is made up of two parts:

- State Policy for Coastal Management and
- State Planning Policy 3/11: Coastal Protection.

The State Policy applies to decisions and activities in coastal areas not assessable under SPA. The State Planning Policy 3/11 (SPP 3/11) applies to coastal waters and landward to cover all coastal islands and the mainland either 5 km from the cost or where it reaches 10m AHD. It is a statutory instrument under the Sustainable Planning Act 2009 (SPA). The SPP 3/11applies to the assessment of developments or activities which trigger the application of SPA including building work, operational work, reconfiguration of a lot and material change of use as specified in Schedule 3 of the Sustainable Planning Regulation 2009. The Regulation were prepared under statutory authority of SPA

Any mitigation strategies that involving engineering solutions will probably be considered tidal works under the meaning of the CMPA and, therefore, are assessable development under SPA. As such they will need approval under both pieces of legislative and will need to be compliant with the object of the acts and associated regulations. SPA administers the operational guidelines for any operational works in Shoreline Erosion Management Plan (SEMP) and the authorities required carrying out the works. CMPA directs aspects of the development approval (of the operational works) including its compliance with state coastal planning initiatives and policy direction such as managing coastal hazards.

Other legislation which directly applies to the SEMP (depending on the level of intervention adopted in the plan) include the following:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC). As the sea grass area in front of Midge Point attracts marine species listed under the EPBC, it is prudent to refer the proposals for the 'hard engineering' strategies (if adopted) to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities. The department can then ascertain with certainty if referral of the proposed strategy is required.
- *Fisheries Act 1994*. If marine plants are to be destroyed as an outcome of the SEMP, development approval will be required under the IDAS provisions of SPA with DEEDI as the assessment manger. However, provision is made in 8(c) for the destruction (if minor) to be considered self-assessable (see Part 2 Self Assessable Development);
- State Planning Policy 2/20 - Planning and Managing Development Involving Acid Sulphate Soils. Midge Point is below 5m AHD and has been mapped on the Acid Sulphate Soils overlay for the Mackay Council. Harder engineering options in the SEMP (if adopted) will require excavation of filling of more than 500m3 of material. Preliminary soils testing will have to be undertaken as set out in the guidelines for the SPP 2/20. If ASS are detected, the policy will have to be adhered to as regards treatment and management of the ASS during the operational works phase.

Other legislation that does apply but has restricted impact includes:

- *Great Barrier Marine Park Act 1975*. Although Midge Point is located within the Great Barrier Reef Marine Park it is zoned General Use and as such (it's designation within the Marine Park) should have no effect on the operation of the SEMP;

- *Natural Resources and other Legislation Amendment Bills 2010.* This bill will only be triggered if an area within the SEMP is reconfigured or resurveyed; and
- Mackay Town Planning Scheme. The SEMP is consistent with DEOs in the plan and the site is mapped on the Acid Sulphate Soil overlay.

Legislation	Jurisdiction	Application to the Midge Point Shoreline Erosion Management Plan (SEMP)
Queensland Legislation		
Coastal Protection and Management Act 1995 (CPMA)	1.The Object of the Act is as follows: (a) provide for the protection, conservation, rehabilitation and management of the coastal zone, including its resources and biological diversity; and (b) have regard to the goal, core objectives and guiding principles of the National Strategy for Ecologically Sustainable Development in the use of the coastal zone; and (c) ensure decisions about land use and development safeguard life and property from the threat of coastal hazards; and (d) encourage the enhancement of knowledge of coastal resources and the effect of human activities on the coastal zone.	1.The CPMA governs the structure and implementation of the Shoreline Erosion Management Plan. The current SEMP must and does comply with the object of the act.
	2. The CPMA defines the coastal zone and authorises the preparation of a Coastal Plan which states policies for coastal management.	2. The study area is within the coastal zone.
	3. The act declares coastal management districts and erosion prone areas in the coastal zone.	3. The SEMP lies within the Whitsunday Hinterland & Mackay Coastal Management District zone and within the erosion zone.
	4. Section 104B of the CMPA Applications for operational work involving removal of quarry material states that if a person has development approval for operational works in a tidal area and the operational works involves removal of quarry material (sand) despite section 264(1) of SPA the application need not be supported by evidence of resource entitlement. The applicant does not need to apply for a quarry allocation.	4. The final SEMP may involve excavation of sand from one location and filling in another location. Section 104 of the CMPA allows this to be included along with the operational (tidal) works component and therefore not requiring additional approvals.

177

Legislation	Jurisdiction	Application to the Midge Point Shoreline Erosion Management Plan (SEMP)
	5. Schedule Dictionary of the CMPA defines tidal works that might possibly apply to the SEMP as follows as 1 Tidal works means work (the relevant work) in, on or above land under tidal water, or land that will or may be under tidal water because of development on or near the land, and work that is an integral part of the relevant work, wherever located. 2 Tidal works includes the construction or demolition of a basin, boat ramp, breakwater, bridge, dam, dock, dockyard, embankment, groyne, jetty, pipeline, pontoon, power line, seawall, slip, small craft facility, training wall or wharf and works in tidal water necessarily associated with the construction or demolition. 4 Tidal works does not include— (a) removing quarry material that has that has accumulated within the boundaries of, or in an area adjoining, a previously approved tidal work to allow the work to be used for the function for which it was approved; or removing quarry material from land under tidal water, if the removal is for no other purpose than the sale of the material or use of the material to reclaim land.	5. The mitigation strategies are tidal works under the meaning of the CMPA and as such area assessable development under SPA. As such they will need approval under both pieces of legislative and will need to be compliant with the object of the acts and associated regulations.
The Queensland Coastal Plan	1. The Queensland Coastal Plan has been prepared under the Coastal Protection and Management Act 1995 and came in effect from 3 February 2012. It replaces the State Coastal Management Plan (2001) and associated regional coastal management plans and It is made up of two parts: (a) a State Policy for Coastal Management and	1. Both the State Policy and the State Planning Policy apply to the SEMP for Midge Point. The State Policy guides and directs the sustainable management of the coastal zone including management regimes for state coastal lands. The State Planning Policy applies to any activities in the SEMP that are assessable under the Sustainable Planning Act 2009 (SPA).

178

Legislation	Jurisdiction	Application to the Midge Point Shoreline Erosion Management Plan (SEMP)
	(b) State Planning Policy 3/11: Coastal Protection.	
	2. The Coastal Plan establishes the conditions under which a local authority is advised to prepare a Shoreline Erosion Management Plan (SEMP). A SEMP is a non-statutory planning document to proactively plan for erosion management.	2. The plan guides the content and strategies of Midge Point SEMP.
State Policy for Coastal Management	1. The State Policy for Coastal Management applies to decisions and activities not assessable under the SPA.	1. The policy guides the content of the SEMP and the implementation of any strategies that are not assessable development under the Sustainable Planning Act (SPA).
	2. It applies to coastal land and its resources within the coastal zone (includes tidal waters, erosion prone areas, land at risk from storm tide inundation or permanent inundation (coastal hazard areas), coastal roads and esplanades, reserves & USL, HES and other parcel of land adjacent to the foreshore. Coastal Hazard Areas and areas of HES can be found in Annex1 of the SPP.	2. The State Policy applies to the Midge Point SEMP as Midge Point is within the coastal zone and the SEMP is concentrated within tidal waters on State or public land. The practical application of the Policy on the SEMP is direction in constructing management options for the state lands adjoining the beach and its guiding principles when considering a SEMP.
	3. The policy applies to land at risk from storm tide inundation below 1.5m HAT in SE Queensland and 2m HAT everywhere else.	3. Midge Point is at risk of tidal inundation.
	5. DERM's preferred method for public lands (reserves, USL, esplanades, etc.) is the preparation and implementation of a SEMP.	5. Residential lots within the vicinity of Midge Point are surrounded by State Lands including esplanades, reserves, etc. The policy guides how public access and other infrastructure are managed in the area. The preparation of the SEMP for Midge Point is compliant with the State Policy.
State Planning Policy 3/11: Coastal Protection (SPP 3/11)	1.SPP 3/11 applies to coastal waters and landward to cover all coastal islands and the mainland either 5 km from the cost or where it reaches 10m AHD	1. Midge Point lies within the jurisdiction of the SPP.

179

Legislation	Jurisdiction	Application to the Midge Point Shoreline Erosion Management Plan (SEMP)
	2. SPP 3/11 is a statutory instrument under the Sustainable Planning Act 2009 (SPA).	2. The SPP 3/11 applies to the SEMP as the mitigation strategies for the SEMP are classified as tidal works and as such are assessable activities under SPA.
	3. The SPP applies to the assessment of developments or activities which trigger the application of SPA including building work, operational work, reconfiguration of a lot and material change of use as specified in Schedule 3 of the Sustainable Planning Regulation 2009.	3. The mitigation strategies involving deposition of sand within the tidal zone or construction of breakwaters, sea walls etc. is classified as tidal works (under the meaning of the CMPA) within a coastal management district; and tidal works is deemed to be Operational Work under the meaning of SPA which is listed as Assessable Development in Schedule 3 of the Sustainable Planning Regulation 2009.
	4. The guidelines of SPP 3/11 (pages. 84-88) sets out the steps for the preparation of a Shoreline Erosion Management Plan (SEMP) including the authorities required to implement the SEMP and the guidelines for preparing a compliant SEMP.	4. The SEMP is compliant with the guidelines because it explores a number of erosion control strategies which present both soft and hard engineering solutions. The SEMP aims to achieve maximum erosion control with minimal disturbance to the shoreline.
	5. Section 2.4 of the SPP 3/11 Coastal protection work. States the following:	5. Section 2.4of the SPP 3/11 will require that any future coastal protection work at Midge Point on adjacent areas (requiring approval under SPA) must be consistent with the SEMP.
	Development that is coastal protection work complies with this policy only if:	The SPP 3/11 states that soft engineering options are preferred over hard which are consistent with the proposed Midge Point SEMP.
	(a) the development is consistent with a shoreline erosion management plan; or	There are a number of existing residences on the foreshore of Midge Point under threat. The feasibility or other wise of abandonment or relocation is considered under the "DO Nothing option of the SEMP".

180

Legislation	Jurisdiction	Application to the Midge Point Shoreline Erosion Management Plan (SEMP)
	(b) the development protects coastal-dependent development, development within a maritime development area, or redevelopment referred to in policy 2.3.4; or (c) there is a demonstrated need to protect existing permanent structures from an imminent threat of coastal erosion; and abandonment or relocation of the structures is not feasible.	
	6. Section 2.4.2 Coastal protection work that involves beach nourishment to control coastal erosion is preferred over erosion control structures, wherever feasible.	6. This SPP 3/11 directs the adaption of more sustainable and less intrusive coastal protection work for tidal works that need approval under SPA and as such the SEMP is consistent with the SPP.
Sustainable Planning Act 2009	Ch1 Preliminary Part 3 Interpretation includes operational works under the meaning of SPA as: (h) undertaking – (i) tidal works; or (ii) work in a coastal management district	The proposed mitigation strategies in the SEMP are proscribed operational works under the meaning of SPA and need approval under the IDAS provisions of SPA
Sustainable Planning Regulation 2009	The Sustainable Planning Regulation 2009 was prepared under SPA. Schedule 3 Part 1 Assessable Development Table 4 Item 5.- Operation work is defined as: • extracting gravel, rock, sand or soil from the place where it occurs naturally; or • excavating or filling that materially affects premises or their use; or • undertaking— (i) tidal works; or (ii) work in a coastal management district; or	Operational Works under the meaning of SPA includes tidal works, excavating and filling and work in a coastal management district. The provisions of the legislation directly apply to the Midge Point SEMP. The more intrusive erosion mitigation strategies identified in the SEMP are assessable development and will require development approval under SPA. THE CMPA provides the meaning of tidal works. Under Part 1 (Assessable Development), if marine plants are to be destroyed as an outcome of the SEMP. Development approval will be required under the IDAS provisions of SPA with DEEDI as the

181

Legislation	Jurisdiction	Application to the Midge Point Shoreline Erosion Management Plan (SEMP)
	• constructing or raising waterway barrier works; or • performing work in a declared fish habitat area; or • removing, destroying or damaging a marine plant.	assessment manger. However, provision is made in 8(c) for the destruction (if minor) to be considered self-assessable (see Part 2 Self Assessable Development).
	Schedule 3 Part 1Assessable Development Table 4 Operational Works Item 8 For assessing operational work against the Fisheries Act, operational work that is the removal, destruction or damage of a marine plant, other than operational work that is— (c) self-assessable development under Part 2;	
	Under Schedule 3 Part 2 Self Assessable Development Table 4 Operational Works Item 8 for removal, destruction or damage of marine plants. For assessing operational work against the Fisheries Act, operational work (other than work on premises to which structure plan arrangements apply) that is the removal, destruction or damage of a marine plant if the removal, destruction or damage— (a) is of dead marine wood on unallocated State land, other than in a wild river area, for trade or commerce; or (b) is reasonably necessary for the maintenance of existing structures, including, for example, the following structures, if the structures were constructed in compliance with all the requirements, under any Act, relating to a structure of that type— (i) boat ramps, boardwalks, drains, fences, jetties, roads, safety signs, swimming enclosures and weirs; (ii) is reasonably necessary for the construction or placement of structures, if— (iii) the extent of the removal, destruction or damage is	The Part 2 (Self Assessable Development) permits minor destruction of marine plants that may come about due to the SEMP to be considered as self-assessable if the destruction is of a minor nature and if the destruction is caused by an activity already authorised under another act.

182

Legislation	Jurisdiction	Application to the Midge Point Shoreline Erosion Management Plan (SEMP)
	minor; and (iv) the structures were constructed in compliance with all the requirements, under any Act, relating to a structure of that type.	
Operational Policy (CPMA) Operational work on State coastal land	Excavation required for erosion control works (hard works) including: revetments, groynes, and sea walls constructed of rock, concrete, gabions, or of bags containing sand; or	The policy will have application to the SEMP as some of the mitigation strategies are located above the mean water spring tide level on state land.
	Works for erosion control or management that involve the augmentation of or relocation of natural coastal sediments (soft works), including sand nourishment; beach scraping; and dune reprofiling.	
	Such "soft" erosion control works are preferred methods for managing erosion on the coast. However, the various methods have limitations, particularly with respect to the duration of benefit.	
	Some of the above works may also be tidal works where they occur below mean high water springs tidal level and are more appropriately dealt with as this type of operational work.	
Operational Policy – CPMA – removing or interfering with coastal dunes in an erosion prone area on land other State Coastal Land	The land to which this policy and assessable development refers must be above the level of mean high water spring tide, within a coastal management district and within an area to which an erosion prone area plan as defined by the Coastal Protection and Management Act 19954 (Coastal Act).	This policy applies to Midge Point settlement. The SEMP targets the foredune immediately in front of the residential area for rehabilitation. Erosion mitigation strategies range from operational works to revegetation. The preservation of sand stabilisation and dune building processes is critical for the dunes immediately adjacent to the foreshore, commonly described as the foredune or frontal dune zone.

183

Legislation	Jurisdiction	Application to the Midge Point Shoreline Erosion Management Plan (SEMP)
	Subject to the planning scheme, the Department of Environment and Resource Management (DERM)) acts as the assessment manager or a concurrence agency for the development application, and assesses proposals against the CMPA and policies contained in the State Coastal Plan and the relevant regional coastal plan.	The SEMP is compliant with the policy. It recognizes that a number of strategies are required to stabilize the foredune – no one strategy will do. This zone commonly supports pioneer dune vegetation, including sand spinifex grass (Spinifex sericeus) and marine couch Sporobolus virginicus, mixed dunal herbland containing goat's foot convolvulus (Ipomoea pes caprae), and often communities containing woody dune colonising plants, including horsetail she-oak (Casuarina equisetifolia var. incana), swamp oak (Casuarina glauca), ball nut (Calophyllum inophyllum), Burdekin plum (Pleiogynium timorensis), and species of Acacia, Eucalyptus, Melaleuca, Banksia and Terminalia. Damage to the vegetation on this zone can lead to wind erosion as well as tidal and wave erosion.
State Planning Policy 2/20 - Planning and Managing Development Involving Acid Sulphate Soils	The policy applies to all land, soil and sediment at or below 5 metres Australian Height Datum (AHD) where the natural ground level is less than 20 metres AHD where the activity involves: - excavating or otherwise removing 100 m3 or more of soil or sediment; or - filling of land involving 500 m3 or more of material with an average depth of 0.5 of a metre or greater.	Midge Point is below 5m AHD and has been mapped on the Acid Sulphate Soils overlay for the Mackay Council. A number of the harder engineering options in the SEMP will require excavation of filling of more than 100m3 of material. Preliminary soils testing will have to be undertaken as set out in the guidelines for the SPP 2/20. If ASS are detected, the policy will have to be adhered to as regards treatment and management of the ASS during the operational works phase.
Mackay City Planning Scheme	Local Planning Schemes are statutory planning instruments under the SPA. Each local authority is required to have a planning scheme compliant with the SPA. Desired Environmental Outcomes (DEO) are based on ecological sustainability established under SPA and are the basis for the measures of the planning scheme. The Planning scheme for the City of Mackay includes:	The SEMP directly addresses this DEO. There are a number of residential properties at risk of storm tide inundations at Midge Point due to excessive erosion.

184

Legislation	Jurisdiction	Application to the Midge Point Shoreline Erosion Management Plan (SEMP)
	(iv) Community safety and buildings, structures and other physical infrastructure are not jeopardised by unacceptable risks due to natural hazards such as bushfire, excessive erosion and land slippage, disturbance of acid sulfate soils, or inundation by flood waters. Midge Point residential area and beach area has been identified in the Acid Sulphate Soils Overlay of the planning scheme as being at risk of housing Acid Sulphate Soils (ASS).	
	Midge Point was not included in the Coastal Management and Biodiversity Overlay of the planning scheme.	Applications for tidal works approvals will need to address the risk posed by ASS and comply with the SPP 2/20.
Natural Resources and other Legislation Amendment Bills 2010	The legislation applies to cadastral boundaries in particular coastal, tidal and watercourse boundaries (referred to as ambulatory boundaries) that also have a role under the Land Titles Act and the Land Act 1994 in demarcating property rights. Any new approval for the reconfiguration of a lot or any action that requires a new survey plan for a property triggers this bill. The new cadastral boundaries are to be feature based (i.e. top of bank, toe of the foredune.) Therefore the size of the lots will be significantly reduced in some cases.	If the SEMP recommends closing the road reserve (at the north-eastern end of the Midge Point settlement) and incorporating it into the reserve to reduce vehicular access to the beach, a new survey plan will have to be drawn up. The new survey plan may result in the cadastral boundary shifting further inland. The implication for the SEMP is if this redrawing of cadastral boundaries may result in a strip of public lands too narrow to undertake a rehabilitation program e.g. revegetation.
Fisheries Act 1994	Schedule 3 Part 1 Assessable Development Table 4 Item 5.- Operation work is defined as: • extracting gravel, rock, sand or soil from the place where it occurs naturally; or	Operational Works under the meaning of SPA includes tidal works, excavating and filling and work in a coastal management district. The provisions of the legislation directly apply to the Midge Point SEMP. Erosion mitigation strategies identified in the SEMP are assessable development and will require development approval under SPA.
	• excavating or filling that materially affects premises or their use; or	THE CMPA provides the meaning of tidal works.

185

Legislation	Jurisdiction	Application to the Midge Point Shoreline Erosion Management Plan (SEMP)
	• undertaking— - (i) tidal works; or - (ii) work in a coastal management district; or • constructing or raising waterway barrier works; or • performing work in a declared fish habitat area; or • removing, destroying or damaging a marine plant.	If marine plants are to be destroyed as an outcome of the SEMP, development approval will be required under the IDAS provisions of SPA with DEEDI as the assessment manger. However, provision is made in 8(c) for the destruction (if minor) to be considered self-assessable (see Part 2 Self Assessable Development).
	Schedule 3 Part 1Assessable Development Table 4 Operational Works Item 8 For assessing operational work against the Fisheries Act, operational work that is the removal, destruction or damage of a marine plant, other than operational work that is— (c) self-assessable development under part 2;	
	Under Schedule 3 Part 2 Self Assessable Development Table 4 Operational Works for removal, destruction or damage of marine plants - For assessing operational work against the Fisheries Act, operational work (other than work on premises to which structure plan arrangements apply) that is the removal, destruction or damage of a marine plant if the removal, destruction or damage—	The Part 2 (Self Assessable Development) permits minor destruction of marine plants that may come about due to the SEMP to be considered as self-assessable if the destruction is of a minor nature and if the destruction is caused by an activity already authorised under another act and/or authority.
	(a) is of dead marine wood on unallocated State land, other than in a wild river area, for trade or commerce; or	

186

Legislation	Jurisdiction	Application to the Midge Point Shoreline Erosion Management Plan (SEMP)
	(b) is reasonably necessary for the maintenance of existing structures, including, for example, the following structures, if the structures were constructed in compliance with all the requirements, under any Act, relating to a structure of that type— (i) boat ramps, boardwalks, drains, fences, jetties, roads, safety signs, swimming enclosures and weirs; (ii) is reasonably necessary for the construction or placement of structures, if— (iii) the extent of the removal, destruction or damage is minor; and (iv) the structures were constructed in compliance with all the requirements, under any Act, relating to a structure of that type.	
Commonwealth Acts		
Environment Protection and Biodiversity Conservation Act 1999 (EPBCA)	Section 18 of the act Actions with significant impact on listed threatened species or endangered community prohibited without approval states: (1) A person must not take an action that:(a) has or will have a significant impact on a listed threatened species; or(b) is likely to have a significant impact on a listed threatened species. Under section 68 of the EPBCA a person proposing to take an action, or a government body aware of the proposal, may refer the proposal to the Minister so he or she can decide: (a) whether his or her approval is needed to take the action; and	As the sea grass area in front of Midge Point attracts marine species listed under the EPBCA (e.g. Chelonia mydas), it is prudent to refer the proposals for the 'hard engineering' strategies (if adopted) to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities. The department can then ascertain with certainty if referral of the proposed strategy is required under the EPBC. Activities involving excavation and filling, construction of groins, sea walls etc. would generate disturbance to the sea bed and induce turbidity. Sedimentation and turbidity impact deleteriously on sea grass beds and hence on dependent species of turtles and other species of marine life scheduled

187

Legislation	Jurisdiction	Application to the Midge Point Shoreline Erosion Management Plan (SEMP)
	(b) how to assess the impacts of the action to be able to make an informed decision whether or not to approve the action.	under the EBBCA. The onus of this act is on the proponent of the SEMP to identify the threat from the proposed activity and to refer the proposal to the department.
Great Barrier Marine Park Act 1975	The main object of this act is to provide for the long term protection and conservation of the environment, biodiversity and heritage values of the Great Barrier Reef Region. Subsidiary legislation - the Great Barrier Reef Marine Park Zoning Plan 2003 - is the primary planning instrument for the conservation and management of the Marine Park. Midge Point lies within the Mackay/Capricorn Management Area and is zoned General Use.	Although Midge Point is located within the Great Barrier Reef Marine Park it is zoned General Use and as such (it's designation within the Marine Park) should have no effect on the operation of the SEMP. The objective of the Zoning Plan for the General Use Zone is to provide for the conservation of areas of the Marine Park, while providing opportunities for reasonable use. The SEMP would be considered It is important to note A Habitat Protection Zone is located just south of study area for the SEMP and a highly protected zone – a Marine National Park zone - is located just east of the study area and probably reflects the high value of the sea grasses to marine mammals, turtles, crocodiles and other coastal fauna. The SEMP applies to an area in close proximity to these areas zoned as high value in the GBPMP. Any operational works from the SEMP generating turbidity should set in place turbidity control devices such as silt curtains and should only be conducted during calm weather.

188

APPENDIX 8 – POSSIBLE FUNDING SOURCES

ENVIRONMENT INFRASTRUCTURE PROGRAM

This program provides up to 25% of the capital cost for environmental infrastructure. However funding opportunities are based on a priority ranking of all applications. It is expected that the ranking for erosion protection works at Midge Point would be relatively low.

NATURAL RESOURCE MANAGEMENT GROUPS

There may be fees available from the Mackay-Whitsunday NRM group to assist with capital costs for installation of erosion protection options at Midge Point. However this would need to be aligned with the current management priorities of the group.

NATURAL DISASTER MITIGATION PROGRAMME

Funding is available through this programme for infrastructure to protect public infrastructure from damage. The programme provides funding to local councils with funds sourced from both Federal and State governments. The fund is a pre-emptive and applications for reimbursement of existing works will not be accepted.

CARING FOR COUNTRY

The Caring for Country programme is administered by the Federal Government and combines several older programmes such as the National Heritage Trust (NHT), National Action Plan for Salinity (NAP), the National Landcare Program (NLP), the Environmental Stewardship Program and the Working on Country Indigenous and Environmental program. The Caring for Country has a national priority for 'coastal environments and critical habitats'. However goals of the 'Coastal Environments and Critical Aquatic Habitat' are:

- Protecting Ramsar Wetlands
- Protecting critical aquatic ecosystems
- Improving coastal hotspots
- Increasing coastal community engagement

These priorities for investment do not align with the goals of the SEMP or the location of Midge Point and therefore it is considered that the probability of a successful application is relatively low.

REGIONAL ARTS DEVELOPMENT FUND (RADF) ADVISORY COMMITTEE

Monday 4 March 2012

Minutes

ATTENDANCE: Chair Cr Chris Bonanno, Arts Development Officer (ADO) Fiona Bishop-Vuibeqa, ADO Lara Payne, Ronald Ailwood, Leonie Wood, Tammy Stone, Tracey Heathwood, Brigitte Zimmermann, Namarca Corowa, Pamela Hutley, Billie-Jo Obst.

APOLOGIES: Deputy Chair Cr Theresa Morgan, Carol Forbes, Graeme Connors.

The meeting commenced at 5.35pm.

1. **MINUTES OF PREVIOUS MEETING**

   Approved
   Moved Ron Ailwood, Seconded Billie-Jo Obst

2. **MATTERS ARISING**

   NIL

3. **AGENDA ITEMS**

   Welcome Namarca Corowa to the RADF Committee
   Cr Chris Bonanno welcomed Namarca Corowa to the committee.

   News from the ADOs and Farewell to Fiona Bishop-Vuibeqa
   Fiona said thank you to the committee for all their time and effort and farewell until she returns from maternity leave in about 12 months. Lara Payne is also soon to go on maternity leave but will be here for the next meeting.

   Arts Qld Update
   Nominations for the 2013 Regional Arts & Culture Awards are now open, and committee members are encouraged to nominate any artists or projects that they think are worthy.

   It was recently announced that Ian Walker was appointed to the Queensland Government Cabinet as Minister for Science, IT, Innovation and the Arts after the Queensland Premier Campbell Newman accepted the resignation of the previous Minister Ros Bates.

LGAQ Update
The LGAQ Senior Advisor, Arts and Culture, Charlie Cush, has resigned from his position to take on the role of General Manager of Circa. Georgina Siddall will be acting in the position in a temporary capacity while the recruitment process is carried out.

Council RADF bid

- The 2013/2014 RADF bid is due in March 2013.
- In light of the coming changeover of ADO staff it has been proposed that no major Council Led Initiative be included in the bid. The Guided walks with art project proposal will still be completed as a suggested option for the new officers coming on board to pursue within the boundaries of Council allocated project funding within the ADO position. However, we will not be bidding for extra funding from Arts Queensland for this to ensure the new worker/s are given the flexibility to introduce new or extended proposals to the position.
- Local Area Considerations/Priorities:
  - As 2013 marks the 150th anniversary of the arrival of the first Islanders brought from the Pacific Islands (predominantly the Solomon Islands and Vanuatu) as indentured labourers, applications that acknowledge this were made a priority in the local RADF Guidelines for the 2012/2013 funding year. This will continue to be a priority in the 2013/2014 funding year.
  - In recognition of this a commitment was made to have at least one member of the RADF committee who can identify as an Australian South Sea Islander, and this has been reflected in a review of the RADF Committee's Terms of Reference Document (attached) and the commencement of a tenth committee member. There are a number of project proposals in the pipeline and we are hoping these will result in future RADF applications.
  - It is suggested that a priority for Council in the 2013/2014 year could involve extra follow up support for the mackay creatives website project as it is handed over to the community in 2013. This could be by way of a small follow up seminar or forum in late 2013 to see how things are going and to offer some marketing assistance to keep the ball rolling.
- Lara Payne has started planning for the 2013 Showcase Event. The date and venue have been confirmed and invitations are being distributed. This year's event will be held at Coffee Divine at Pinnacle from 2:30pm on Sunday 10th March. This event may be postponed due to the weather. The final decision will be made tomorrow. **Update - The event has been postponed until 21st April 2013.

RADF Committee Training suggestions
Proposed for Committee members to attend the Arts Queensland Articulate Conference in Rockhampton, 21-23 August 2013, committee members who are interested are to contact the ADOs via email so registration can be arranged using this year's training budget.

Further discussion around the use of surplus committee training budget raised the question: Is there the potential to direct some of the surplus RADF Committee Training funding toward community workshops that assist not only the RADF Committee but also the broader community with the local development of Cultural Tourism product:

- Discussion around how we could develop and further promote local artwork as viable cultural tourism products and thus down the track increase applications to the Interest Free Arts Loan category;
- Suggested perhaps the ADOs can produce a media release around the cultural tourism category to encourage applications for that particular category in the next & future RADF Rounds; and support the community to access this by providing some educational opportunities around developing & marketing themselves and their art from a more commercial perspective;
- Educational opportunities could involve: Art & Industry: workshops for artists in the promotion, marketing and commercial production of their work; and some form of networking to match with or education on how to find designers & other industry providers to share concepts and current technology to enable mutual development of their ideas;
- Suggested also to hold discussions with the local Tourism bodies;
- It was also clarified that this process would be different from previous work done through ABAF as feedback from local artists has been that the goals set by this process seemed too far away and thus intimidating and unobtainable. Therefore we need to work on a smaller scale, step by step to increase awareness and skills around basic concepts first before trying to run activities that encourage network opportunities to partner with business.
- Although this is beyond the capacity for ADO Fiona Bishop-Vuibeqa, who commences maternity leave in three weeks, ADO Lara Payne may have the opportunity to deliver it, or the new ADO filling Fiona's position could take it on and apply as a Council Coordinated Project through the Building Community Cultural Capacity Category after surplus training funds have been redirected to the community bucket for Round Four.

RADF Projects update

The ADOs and various committee members outlined the outcomes provided in the following recently acquitted RADF applications: Noel Giles, Crossroad Arts, Katrina Cornwell, U3A Musical Chimes Group, Bush to Beach

RADF Council Led Initiative: Mackay Creatives Website Refresher Workshop & Community Consultations facilitated by Human Ventures

- We have received a draft report from Human Ventures detailing the feedback received with recommendations to consider. The ADOs will be reviewing the document over the coming weeks before giving Human Ventures the go ahead to commence building the Mackay Creatives Network Landing Page.

Acquitted Grants

Edward Rigby
Jason Chetcuti – in process, awaiting corrections
Kucom Theatre Inc
Mackay District Cake Decorators Inc – in process, awaiting corrections
Margaret Burgess
Noel Giles
Quota International Of Mackay's Rural North Inc.
Valley District Youth Council

Crossroad Arts
Debbie Connors
Katrina Cornwell
U3A Musical Chimes Group
Bush to Beach

Over Due Acquittals
Lyn Logan – Midge Point Arts & Crafts Group – This outcome report has now been received and is awaiting processing
Mel Selleck
Tracey-Lee Newport – Grant money to be written off and applicant to be banned from applying to future RADF rounds.
Trent Kinnersley

Approved acquittal extensions
Cheryl Mitchell

ADO has full copies of all outcome reports and these are available for the committee to view at any time.

Assessment of Applications
6 applications received to a total value of $29, 011. There is $54,337.54 available for this round comprised of $31, 033 as allocated for Round Three, $20,295.54 surplus from Round Two, and $3009 returned to the RADF Program from a previous grant recipient.

4. **APPLICATIONS**

Total Amount requested: $29,010.40
Amount available for Round Three: $54, 337.54
Committee recommendation: That 6 of the applications be supported to the total value of $26,710.40. Applicants are encouraged to contact the Arts Development Officers for specific feedback on their applications.

Name: Riot Stage
Category: Regional Partnerships
Amount Requested: $9,000
Project Name: The Chorus
Project Description: The grant will be used towards the cost of the creation, rehearsal and presentation of The Chorus: a new devised theatre piece created with the young people of Mackay.
Conflict of interest: Nil
Recommendation: The application is to be supported in full.
Comments: The committee found it very positive that fundraising is also being sought via Pozzible. Absent Committee members' feedback was included in discussion.

Name: Judith Grieve
Category: Concept Development
Amount Requested: $3,495
Project Name: Creative Arts Therapy- Movement Program Series: The Body Reveals
Project Description: The grant will be used towards the cost of content development,

facilitation, supervision and promotion of this Movement Therapy project, and the 3 workshops.
Conflict of interest: Nil
Recommendation: Application to be supported in full. The applicant is encouraged to contact Artspace Mackay (49619737) to assist her with promotion of the program.
Comments: Absent Committee members' feedback was included in discussion.

Name: Martin Odger
Category: **Developing** Regional Skills
Amount Requested: $960
Project Name: none
Project Description: The grant will be used towards the cost of participation (travel and accommodation) in a writer's residency for JUTE Theatre's regional arts development program- Enter Stage Write.
Conflict of interest: Nil
Recommendation: The application is to be supported in full with the following conditions: the applicant provides the quotes, related to travel and accommodation, and a letter of registration or letter of confirmation from Jute regarding the activities he will be attending.
Comments: Absent committee members' feedback was included in discussion.

Name: Lenna-Maree Moxey
Category: Cultural Tourism
Amount Requested: $6,127.50
Project Name: Website launch and Marketing Project
Project Description: The grant will be used towards the cost of a wage to produce a website launch, some costs involved in producing the website and overall, marketing myself in Mackay.
Conflict of interest: Nil
Recommendation: The application is to be supported in full. It has been suggested that the applicant consider joining the mackay creatives network (http://mackaycreatives.com.au/). The applicant is encouraged to contact the Arts Development Officers who can pass on details of artists who may be able to assist with this process.
Comments: Absent committee members' feedback was included in discussions. The question arose regarding whether a website would be considered a capital item. This is to be followed up with Arts Queensland by the Arts Development Officers.

Name: Phoebe Clarke
Category: Developing Regional Skills
Amount Requested: $1,927.90
Project Name: Neoterics
Project Description: The grant will be used towards the cost of travel to KSAS in Footscray, Victoria where Miss Clarke will be undertaking a two week residency and successfully staging an exhibition The Neoterics featuring new artworks by herself and a collaboration with the Melbourne artist Ilya Milstein.
Conflict of interest: Nil
Recommendation: The application is to be supported in full. The applicant is encouraged to contact Artspace Mackay (49619737) as they may be interested in supporting her to find opportunities to showcase her work and to conduct workshops or residencies locally in the Mackay Region.

Comments: Absent committee members' feedback was included in discussions.

Name: Margaret Burgess
Category: Building Community Cultural Capacity
Amount Requested: $7,500
Project Name: Building Connections
Project Description: The grant will be used towards the cost of project management, professional wages, transport and accommodation, required to host Building Connections which consist of two professional development workshops for artists, one educational seminar for the public, and an exhibition of recent work by Sydney Artists.
Conflict of interest: Brigitte Zimmerman stated she had supplied a letter of support but would receive no financial gain from this project. It is considered that there is no conflict of interest.
Recommendation: The application is to be partially supported to the value of **$5,200** to cover the costs of professional fees, travel, accommodation and per diems for John Phillips, and Project Coordination Fees for Margaret Burgess.
Comments: Absent committee members' feedback was included in discussions. The committee found that because the workshop component from Julian Edwards had been funded previously and the workshop material being presented seemed similar to the previous one it is ineligible for further funding from this program. The other components of the project are considered different to what has been done before and so can be funded through the RADF program. The applicant is strongly encouraged to contact the ADOs for further feedback about the marketing components of this project and the potential to bring other speakers who can provide alternative perspectives on marketing and other topics relevant to local artists.

5. **GENERAL BUSINESS**

- Cr Chris Bonanno spoke about having recently met with Adrian Connors of NE Food regarding a new food festival in Mackay proposed for September in the CBD. This would involve local restaurants, and would include a component of food art.
    - Discussion followed based around the definition of "food art" and also why this event would not be partnered with the current Wine and Food Day event that is held during the Mackay Region Festival of Arts. Many of the issues stem from strict licensing laws around outdoor venues away from established restaurant kitchens. It is also a strategy to improve the profile of the CBD.
- The ADOs sought feedback from the committee about a potential applicant wanting to access funding via a Quick Response option.
    - Historically the RADF Program has not offered the Quick Response Option due to a range of reasons, although they are technically possible.
    - Generally applicants whose events/projects fall outside of funding rounds are usually directed to other funding programs such as the Regional Quick Response Grants (Artslink Queensland) and advised also to access the Easy Grants Newsletter to source other funding options that may be available to them.

DATE OF NEXT MEETING

Monday 3 June 2013, 5.15pm for a 5.30 start
First Floor Reception Room, Mackay Regional Council Administration Building.

The meeting closed at 8.15pm.