



# DATA & INFORMATION GAP ANALYSIS For Coastal Hazard & Risk Management

Gingin Dandaragan Coast  
(Hill Primary Coastal Compartment)

*September 2013*

This document was prepared for the Northern Agricultural Catchments Council, the Shires of Gingin and the Shire of Dandaragan by Coastal Focus.

*This document is for coastal practitioners such as local and state government agency staff particularly town planners and coastal engineers, councillors, natural resource managers and consultants who are seeking guidance about coastal hazards. Written in plain English, this report is a source of information for the broader community who wish to build an understanding of how coastal processes shape the coast and how coastal hazards are likely to affect the Hill Primary Coastal Compartment in the foreseeable future. Coastal Focus.*

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Approved for final release by:

**Chiara Danese**



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### Disclaimer

Coastal Focus has prepared this report for the use of NACC and the Shires of Dandaragan and Gingin in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. The methodology adopted and sources of information used by Coastal Focus are outlined in this report.

**Cover:** Top image courtesy of Ashley Robb, smaller images courtesy of Paul Robb, from left Lancelin, Hill River, Seabird and Thirsty Point (Cervantes).

# EXTENDED SUMMARY

## INTRODUCTION

Sections of the Hill Primary Compartment located across the Shires of Dandaragan and Gingin are particularly vulnerable to the impacts of coastal erosion and inundation due to the local topography, sensitivity to coastal processes and increasing development and recreational pressures on coastal ecosystems (Eliot et al. 2011). Coastal hazards are already causing temporary or permanent loss of natural and built assets, and the services that these assets provide. Change in coastal processes due to climate variability is likely to expose new areas to the impacts of erosion and/or inundation, and/or lead to more severe impacts, such as chronic erosion, in already vulnerable areas. In order to predict how private and public assets will be further impacted by coastal hazards it is necessary to understand how coastal processes operate at the sediment cell level. Understanding coastal processes requires reliable and accurate data sets that are not always available in regional areas.

## PURPOSE

The purpose of this Data and Information Gap Analysis (Report) is to summarise existing coastal data sets for the Hill Primary Compartment and their usefulness for assessing and mapping coastal hazards at a scale that is useful for local planning and decision-making.

This Report, commissioned by the Shire of Dandaragan, the Shire of Gingin and the Northern Agricultural Catchments Council, represents the first step towards preparing and adapting to the impacts of coastal hazards in the Gingin Dandaragan region. The second step is to use the information gathered from this report to inform a **Project Partner Workshop** (to be held in July 2013) and prepare the **Workshop Summary Report** (September 2013).

## SCOPE

This Report looks at existing data sets that describe the coastal processes operating between the Moore River and North Head (Figure 1). This stretch of coast was identified as the Hill Primary Compartment by Eliot et al. (2011) due to similar coastal landform features that occur along this stretch of coast. The Hill Primary Compartment is subdivided into four secondary compartments, 10 tertiary compartments and 28 primary sediment cells.

This Report identifies the best coastal data currently available to describe:

- meteorological drivers (winds, storms, rainfall and weather cycles)
- ocean drivers (water levels, tides, resonant phenomena)
- geological and geomorphic features
- sediment transport.

The objectives of this Report are to:

1. Provide a summary of the main physical coastal processes that are altering morphology (erosion and/or recession) or are causing coastal inundation within the Hill Primary Compartment.

2. Identify existing coastal data sets, their availability, location and characteristics.
3. Identify the data sets required for understanding coastal processes and for mapping coastal hazards.
4. Identify data gaps and shortcomings in the existing information that would limit its application in assessing and mapping coastal hazards.
5. Suggest appropriate monitoring mechanisms for the collection of new data sets for areas at greatest risk from coastal hazards including locations, frequency, responsible parties and indicative costs.
6. Identify research or investigatory work required to fill information gaps (e.g. analysis of data sets) in order of priority and over a five-year timeframe.

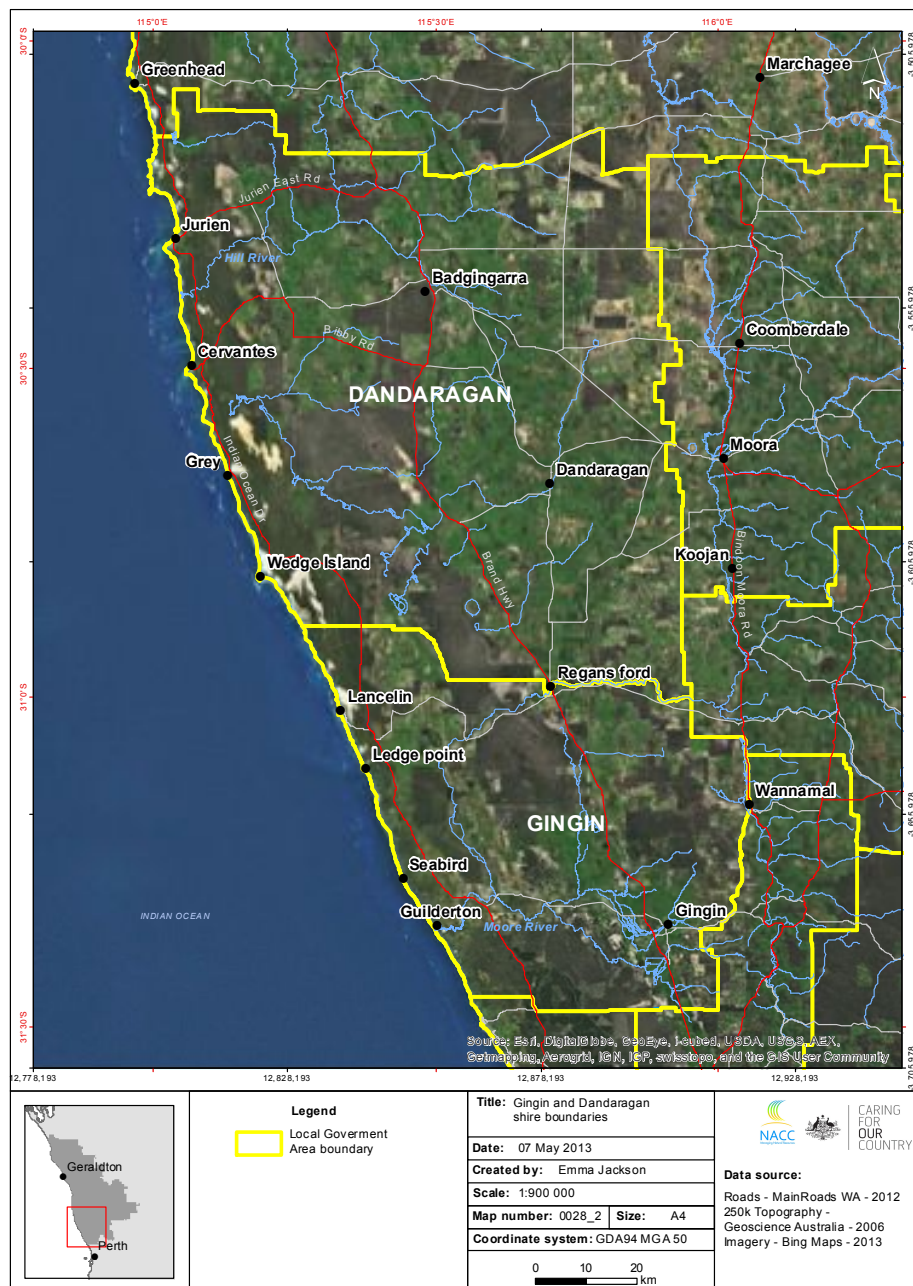


Figure 1 (Summary): Gingin Dandaragan coast, Study Area/

## **METHODS**

Research for this report involved the following steps:

- i. A desktop analysis of available coastal data sets, which included researching technical reports, scientific papers, studies undertaken for proposed coastal development and liaising with data custodians.
- ii. A review of available data and information to assess data location, accuracy and relevance for coastal hazard assessment and mapping.

The majority of coastal data and information about the data (metadata) were provided by data custodians such as the Department of Planning, the Department of Transport and the Department of Water and publicly available. Some reports were not made available to the consultant due to confidentiality restrictions.

## **DATA REQUIREMENTS FOR COASTAL HAZARDS ASSESSMENT**

Interactions in coastal processes are complex. Understanding how those interactions contribute to coastal change is difficult to predict with certainty. The time span for data records in regional areas can be too short to identify trends, or the quality of information is poor due to changes in instrumentation technology or location. These deficiencies can compromise the accuracy of numeric simulation models, projections and ultimately the quality of hazard assessment and mapping. Data collection programs can be put in place to remedy deficiencies in the spatial and temporal extent of data. Nevertheless, in the absence of high quality data, broad scale hazard assessments can provide a 'first cut' to planners and managers as to how the shoreline will change in the next 100 years and the location and extent of areas prone to coastal inundation. Broad scale assessments have limited value in areas where more robust information is needed about risks to private and public assets, such as areas experiencing significant development pressures.

Third pass assessments at the tertiary sediment cell level are likely to be required at locations where the uncertainty of future impacts on existing or future coastal assets needs to be reduced for planning and management purposes. Third pass assessments require site-specific, high quality data in order to provide sufficient detail for land-use planning mechanisms such as setback lines, coastal recession lines and zones subject to coastal inundation.

The key data requirements for finer scale assessments, such as second pass and third pass erosion and inundation hazard assessments, are listed in Table 1.

Good elevation and high resolution bathymetric data is required for more detailed inundation maps especially if complex modelling exercise is to be undertaken. Modelling is required to estimate shoreline changes (erosion, accretion) caused by long-term climatic processes (for the chosen climate change scenarios), storm surges, coastal inundation scenarios and sediment transport.

Table 1 (Summary): Key data requirements for second and third pass erosion and inundation hazard assessment and mapping.

DATA	SECOND PASS	THIRD PASS
<b>EROSION HAZARD MAPPING</b>		
<b>Meteorological drivers (rainfall, winds, storms, weather patterns)</b>	Long term records and analysis	Long term records and analysis
<b>Topography</b>	High resolution contours Topographic maps, LiDAR DTM & DEM Description of geomorphological, geological and geotechnical features at the regional scale.	At least 0.25m contours Topographic maps, LiDAR DTM & DEM Description of geomorphological, geological and geotechnical features at the tertiary scale.
<b>Bathymetry</b>	Bathymetric charts not more than 10 years old derived from singlebeam or multibeam hydrographic surveys or nautical charts. Older bathymetric charts can be validated with ground truth measurements (new bathymetries might not be required for certain sites).	Recent and high resolution bathymetric charts derived from bathymetric LiDAR or Multibeam hydrographic surveys
<b>Geology, geomorphology and sediment transport</b>	Description of geomorphological and geological features at the regional scale. Model for regional sediment transport.	Description of geomorphological and geological features at the tertiary scale. Determination of potential change of unstable landforms at the tertiary scale. Sediment/bedrock relationships and add geotechnical data. Mechanisms for beach/dune interactions. Analysis of current and future (long-term) sediment transport and sediment budget rates: <ul style="list-style-type: none"> <li>i. Alongshore distribution of sediment</li> <li>ii. Cross shore distribution of sediment</li> <li>iii. Influence of in-situ rock and artificial coastal management</li> </ul>

DATA	SECOND PASS	THIRD PASS
		structures Role of nearshore currents in sediment transport and budgets.
<b>Shoreline movement plots and beach profiles</b>	Shoreline change and future beach behaviour to sea level rise at the regional scale.  Up to date shoreline movement plots	Shoreline change and future beach behaviour to sea level rise at the tertiary scale.  On-going beach surveys at hot spots.  Up to date shoreline movement plots
<b>Storm surge and water level</b>	Historic analysis of storm surge heights associated with extreme weather events (*) to determine Annual Recurrence Interval (ARI).	Historic analysis of storm surge heights associated with extreme weather events (*) to determine Annual Recurrence Interval (ARI).
<b>Waves</b>	Projected storm wave heights (wind related) - for specified ARI. Wave climate response to SLR. To be accurate wave data sets should cover a period longer than 40 years.	Projected storm wave heights (wind related) - for specified ARI. Wave climate response to SLR. To be accurate wave data sets should cover a period longer than 40 years.
<b>SLR scenarios</b>	Projected sea levels for the specified climate change scenarios.	Projected sea levels for the specified climate change scenarios.
<b>Benthic habitats</b>	Spatial distribution of sediments and seagrass communities to estimate sediment budgets and transport.	Spatial distribution of sediments and seagrass communities to estimate sediment budgets and transport.
<b>INUNDATION HAZARD MAPPING</b>		
<b>Meteorological drivers (rainfall, winds, storms, weather patterns)</b>	Long term records and analysis	Long term records and analysis
<b>Topography</b>	Existing topographic contours.	At least 0.25m contours, LiDAR DTM/DEM.  Description of geomorphological, geological and geotechnical features at the tertiary scale.  As the storm surge reaches shallow water and the complex nearshore environment, increasingly finer scale

DATA	SECOND PASS	THIRD PASS
		bathymetric and elevation data is required.
<b>Bathymetry</b>	Possibly not older than 10 years. Acceptable if derived from single-beam hydrographic surveys and/or nautical charts.	Recent and high-resolution bathymetric charts derived from bathymetric LiDAR or Multibeam hydrographic surveys.  As the storm surge reaches shallow water and the complex nearshore environment, increasingly finer scale bathymetric and elevation data is required.
<b>Storm surge and water level</b>	Historic analysis of storm surge heights associated with extreme weather events (*) to determine Annual Recurrence Interval (ARI).	Historic analysis of storm surge heights associated with extreme weather events (*) to determine Annual Recurrence Interval (ARI).
<b>Waves</b>	Projected storm wave heights (wind related) - for specified ARI.	Projected storm wave heights (wind related) - for specified ARI
<b>Hydrology</b>	River flooding hazard maps if available (for estuarine areas).	River flooding hazard maps if available (for estuarine areas).
<b>SLR scenarios</b>	Projected sea levels for the specified climate change scenarios.	Projected sea levels for the specified climate change scenarios.

## GAP ANALYSIS: KEY FINDINGS

Overall there is a lack of historical information and detailed analysis of metocean drivers and processes for the Hill Primary Compartment and future data collection will be required to fill the identified gaps.

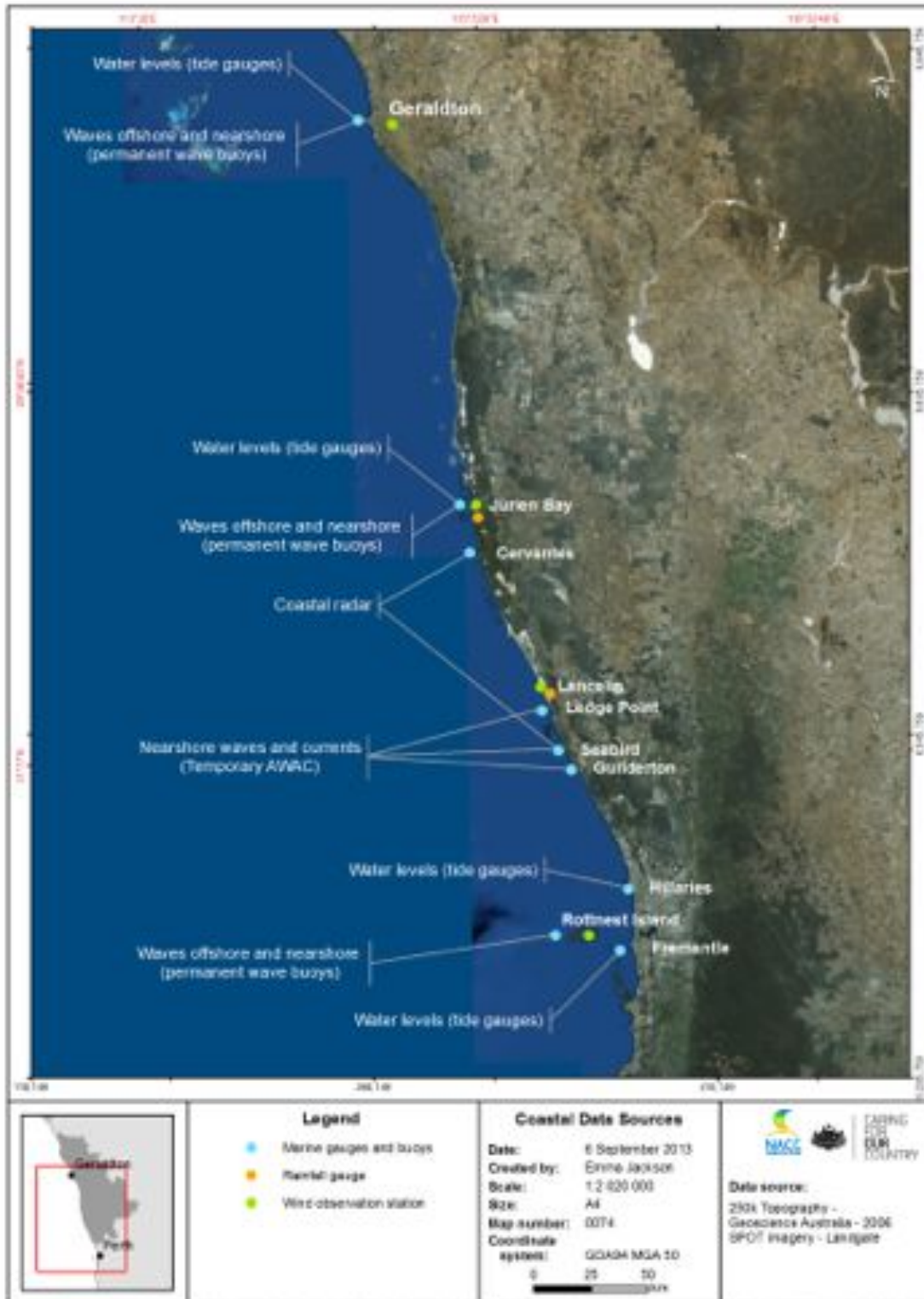
Table 2 and Figure 2 describe the existing data sets (location and timeframe) and identify their key shortcomings for coastal hazard and risk assessment.

Table 2 (Summary): Existing data sets for the Hill Primary Compartment and relevant for coastal hazard and risk assessment.

PHYSICAL DATA	AVAILABILITY	DATA QUALITY & GAPS
<b>Winds</b>	40 years +	Interpretation of wind records need to take into consideration how winds are/have been affected by geography, topography and change in instrumentation as well as differences in records between observation stations.
<b>Rainfall</b>	40 years +	Good quality
<b>Storm surge and water level</b>	18 years of regional records, 40 + from Fremantle and Geraldton.	<p>Geraldton and Fremantle records are reliable from 1965 (since establishment of AHD) while the Jurien Bay records are too short.</p> <p>The long-term historic sea level data records can provide information about possible change in storminess over the Hill Primary Compartment, extreme weather events and trends in sea level variations.</p> <p>Regional variability in oceanographic and meteorological phenomena such as astronomical tides, changes in atmospheric pressure, winds, river discharges, ocean circulation and changes in water density must be considered when analysing and applying long-term data sets from stations located outside the study area.</p>
<b>Waves</b>	<p>Sporadic in nature from 1971 to 1994.</p> <p>Records from Rottnest (from 1994 located at -48m) and Jurien Bay (from 1997 located at -</p>	<p>Longer and accurate records are required to provide a description of the wave climate for the Hill Compartment and better understanding of the impact of off-shore coastal structures on wave climate.</p> <p>Further investigation of coastal processes</p>

PHYSICAL DATA	AVAILABILITY	DATA QUALITY & GAPS
	42m) provide the closest representation of the region's wave climate.	for the region will require a better understanding of variability, trends and extremes of both offshore and nearshore wave climate and improve the interaction between waves, local topography and geomorphology. This could be achieved by installing new wave buoys offshore and onshore at certain locations.
<b>Currents</b>	Studies on currents have been undertaken in Jurien Bay (2008) and surface current stations are installed at Seabird and Cervantes. AWAC installed temporarily in 1989, 2003, 2002 and 2006 at various sites provide information on nearshore and offshore currents.	More information is required on nearshore currents for the study area especially current behaviour in proximity of islands and reefs.
<b>Bathymetry</b>	40 years of nautical charts and hydrographic surveys at various location and timeframes.	Bathymetric data that is older than 10 years need to be repeated for better accuracy (Guilderton, Seabird, Ledge Point, Jurien Bay). Older bathymetric charts can be validated with ground truth measurements (new bathymetries might not be required for certain sites).  Bathymetric LiDAR for the entire region or Multibeam hydrographic surveys to be collected at hot spots (erosion areas near developed areas or future development).
<b>Beach levels &amp; profiles</b>	Beach levels have been undertaken for various years at various locations from 1970 to present day. Beach profile analyses were undertaken at Seabird (2002 and 2004), Thirsty Point and Jurien Bay.	Beach profiles should be collected for areas subject to erosion in proximity of coastal development and repeated every 5 years.
<b>Shoreline Movement Plots</b>	Exist for all coastal towns up to 2002.	Need to be up to date to 2013.
<b>Topography</b>	LiDAR was collected in 2013 by NACC and DoW	High Resolution data. To be repeated in 10 to 15 years.

PHYSICAL DATA	AVAILABILITY	DATA QUALITY & GAPS
<b>Geology and Geomorphology</b>	Geological maps available since the 1940s'. Various reports, studies also available for the study area.	An assessment of elevation and coverage of underlying rock (exposed and submerged) is required. A study of the perched beach system at the local scale is also recommended.
<b>Sediment Transport &amp; Budgets</b>	To date not much information on local sediment transport regimes and budgets exist. The only information available comes from studies undertaken as part of site specific projects such as coastal protections, setbacks, dredging.	The sediment cell classification needs to be updated with more accurate topography and bathymetric data to identify tertiary sediment cell boundaries.  Regional and local scale sediment budget analysis and sediment transport modelling is required for detailed coastal hazard risk assessments.
<b>Sediment samples</b>	Sediment analysis was undertaken at Seabird and Lancelin (2009).	Sediment thickness, availability and transport needs to be better understood.
<b>Benthic habitat</b>	Mainly around Jurien Bay.	Extend the mapping to priority areas as part of coastal hazard assessments.
<b>Hydrology</b>	Information on river discharge is available for the Hill River (1968 to present day) and the Moore River (1965 to present day). Hydrologic study was undertaken for the Moore River in 1991 and 2000.	Hydrological and flood studies should be conducted to improve the understanding of influence of rivers play on sediment transport and potential implications of riverine floods on coastal areas.
<b>Groundwater</b>	Regional study undertaken in 1994. Broader vulnerability assessment for Australia undertaken in 2012.	Improve understanding of local vulnerability of coastal aquifers.



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Figure 2 (Summary): Coastal Data Sources for the Hill Primary Coastal Compartment. Map: Emma Jackson (NACC).

## RECOMMENDATIONS

The following recommendations are drawn from the findings of the Gap Analysis and informed by research and lessons learned from coastal hazard risk assessments undertaken in other regions.

**Recommendation 1:** That existing data sets are improved in order to develop second pass erosion and inundation hazard maps for the Hill Primary Compartment. The maps will identify areas that are likely to be more vulnerable to coastal erosion and/or inundation at different timeframes and climate change scenarios. Second pass assessments are generally undertaken for the entire coastal compartment (or sub compartments) as a ‘first cut’ to provide planners and managers with a basic level of information regarding potential impacts of hazards on natural and built coastal assets. In many cases these ‘first or second pass’ assessments identifies areas that require additional investigations. It is important to note that alone, broad scale assessments have limited value in areas where more robust information is needed regarding future risks to private and public assets, such as areas experiencing significant development pressures. However, these broad scale assessments help to prioritise and frame finer scale assessments at the local level by identifying compartments and sediment cells that are likely to be more vulnerable to coastal change over time. For this purpose the following project tasks are recommended:

- I. **Coastal Sediment Cells Study** to identify sections of the coast that exhibit similar processes and morphology as the framework for estimating sediment budgets and local scale assessment of hazard and risk. Improved bathymetric data is a key requirement.
- II. **Bathymetry Mapping Program** to identify priority locations for new bathymetric surveys for improved data on nearshore structures, behaviour and responses, sediment transport and sediment distribution on the seafloor and sediment cell classification. A LiDAR bathymetric survey for the entire compartment would provide a wider context for available bathymetric information and facilitate a more complete assessment of natural resources, including sediment availability and distribution, although a costly option. A cheaper option would be to collect Multibeam Hydrographic Surveys at priority areas. Older bathymetric charts can be validated with ground truth measurements (new bathymetries might not be required for certain sites).
- III. **Regional Sediment Transport Model** specific to the Hill Primary Compartment to estimate sediment sources, sinks and key transport pathways and determine rates of coastal change.
- IV. **Analysis of Historic Water Levels and Storm Surges Data** associated with historic extreme weather events and determine ARI events for the Hill Primary Compartment.
- V. **Shoreline Change and Movement Plots Analysis** to assess historical shoreline change for the Hill Primary Compartment and help predict future coastal change.
- VI. **Coastal Assets and Values Study** to gather information on coastal assets, uses and values that are potentially at threat from future coastal hazards and to identify areas of high vulnerability and high value.

**Recommendation 2:** That existing data sets are improved in order to undertake a ‘third pass’ erosion and inundation hazard assessment and mapping at priority areas. The priority

areas will be identified from the Coastal Sediment Cells Study (I) and the Coastal Assets and Values Study (IV) projects. Site specific hazard and risk assessment will require the following projects:

- VII. **Bathymetry Mapping Program** to generate high-resolution bathymetric charts at the tertiary sediment cell level at identified priority areas. This will improve data on nearshore structures, behaviour and responses, sediment transport and sediment distribution on the seafloor and sediment cell classification at identified priority areas.
- VIII. **Additional Wave Buoys** for areas that require installation of temporary wave buoys for improved site-specific wave and current data.
- IX. **Sediment Transport and Budgets Analysis** to estimate sediment sources, sinks and key transport pathways to determine the rate of coastal change at the tertiary level (key priority areas) and assess potential migration or retreat of unstable landforms.
- X. **Geotech Investigations** to assess the elevation and coverage of underlying rock at priority sites.
- XI. **Shoreline Movement Plots and Beach Profiles** to be extended to the whole compartment or at key priority areas for assessment of shoreline change and sediment budget calculation.

**Recommendation 3:** That on-going data collection programs are continued. Specifically, the following programs be maintained:

- XII. **Beach monitoring program** (profiles, historic photos and community photo-monitoring) for assessment of shoreline change and sediment budget calculation and potential impact of engineered structures at identified priority areas.
- XIII. **Sediment Sampling Program** for improved understanding of sediment transport pathways, sinks and supplies.

Table 8 (page 56 of this report) lists the recommendations for future data requirements for undertaking a hazard risk assessment and mapping at a scale useful for planning and management decision making.