ALKIMOS COASTAL NODE
LOCAL STRUCTURE PLAN

Appendix 5
Coastal Hazard Risk Management and Adaptation Plan

Alkimos Coastal Node Local Structure Plan

Coastal Hazard Risk Management & Adaptation Plan

Prepared for LandCorp

By Essential Environmental

December 2014

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SUMMARY

This report has been prepared to present the outcomes of a Coastal Hazard Risk Management & Adaptation Planning process undertaken to support and inform the development of the *Alkimos Coastal Node Local Structure Plan (ACNLSP)*.

A number of stakeholders have been consulted through the Coastal Hazard Risk Management & Adaptation Planning process and in the development of this report. In keeping with the expressed objectives for the ACNLSP area the comments and advice of stakeholders has been considered through the Coastal Hazard Risk Management & Adaptation Planning process and are presented in this final report. The outcomes of this process have been embedded within the *ACNLSP*.

The key objectives of this plan were developed through consultation with various stakeholders with reference to broader planning objectives and consideration of possible development outcomes. These objectives have been agreed as follows:

- Provide and protect a quality regional beach destination.
- Provide and protect quality tourism accommodation.
- Provide and protect a thriving coastal community.
- Maintain functions of the coastal dunes.
- Manage public safety and protect public infrastructure.

Critical to this development area and the Coastal Hazard Risk Management & Adaptation Planning process which informs its structure planning is its designation as a “regional beach destination”. The *Alkimos Eglinton District Structure Plan* (City of Wanneroo, 2010) identifies the establishment of a coastal village at Alkimos and the adjacent foreshore as an area of concentrated recreational activity within the context of maintaining the natural state of the foreshore in other parts of the district structure planning area. Infrastructure and large numbers of people will need to be located within the study area (the area affected by coastal processes) in order to facilitate the area to function as a "Regional Beach" and vibrant "Coastal Village". The description of the Alkimos coastal village contained within the district structure plan provides useful context as to the agreed vision for the urban development:

> *"Physically and visually linked to the Alkimos Secondary Activity Centre the Alkimos Coastal Village (Local Activity Centre) is located at the southern end of the Alkimos Regional Beach, and provides an important coastal focal point for the community. It will be a place of “vitality” engendering the coastal lifestyle, being an essential element in delivering the vision for the project.*
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> *This node has a strategic location centred on an excellent regional swimming beach with panoramic views northward up the coastline.*
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> *It is intended that “Alkimos by the Sea” will be an intensive lifestyle and recreation node with:*
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> - *Pedestrian promenades;*
> - *Extensive landscaped areas;*
> - *Grassed terraces;*
> - *Boardwalks;*
> - *Shelters;*
> - *A Main Street; and*
> - *Other Beach Facilities.*

Importantly it will provide for a diverse range of housing types including medium and higher densities. The vibrancy of this node will derive from intensifying density housing around the proposed lifestyle elements including cafes and restaurants that focus on and are integrated with beach side facilities.

Whilst addressing the need for good environmental outcomes, coastal development should be integrated with, and provide for strong connectivity with adjacent land uses. At the local structure planning and detailed design stages, the opportunity to integrate tourism, beachside facilities and activity nodes with the coastal foreshore should be explored and pursued. This process will provide an opportunity for a review of coastal setbacks, which would require appropriate environmental and planning assessment and approvals.

The possibility of a new marina adjacent to the Alkimos Coastal Village as recommended in the recently released Department for Planning and Infrastructure, Draft Perth Recreational Boating Facilities Study will add a new dynamic dimension to this activity centre and will provide a further catalyst to enabling a wider range of tourist, community, recreation and aquatic activities and uses to be incorporated.

The opportunity to incorporate this marina into the development and integrating it with the Alkimos Coastal Village is still at a very premature stage, however the implications of this facility being developed need to be explored at the local structure planning stage along with the early identification of protocols and process needed to achieve necessary environmental and planning approvals. "

A second key informing document to the development of this plan was produced by the Environmental Protection Authority (EPA) during assessment of the District Structure Plan and associated rezoning of the land in the MRS (Amendment 1029/33). This document provides further useful context that assists in establishing vision for the area and critical functions of the foreshore reserve.

The principle change made by Amendment 1029/33 that directly affected the ACNLSP area was the rationalisation and reductions to coastal foreshore reservations (Area 7). The land comprising the study area within the ACNLSP area was the subject of Area 7a. The purpose of the change at Area 7A was described in the EPA report as follows:

"The coastal foreshore reservation is proposed to be reduced in the western part of Lot 102 to accommodate a coastal node".

The WAPC noted in their response to submissions that the proposed reduction in width in Area 7a was supported *"because of the overall sustainability benefits that will arise from a well designed coastal village, providing amenity to the Alkimos regional beach..."*

The EPA made an assessment of environmental values at the site and concluded that the change in the Area 7a could be supported on the basis that:

"values within Area 7a, while significant and desirable to retain if possible, are protected elsewhere on the site."

The status of the ACNLSP area as a regional beach together with the determination of the EPA that environmental values of the site are protected elsewhere means that the Coastal Hazard Risk Management & Adaptation Plan can appropriately consider a foreshore reserve that provides for the values and services that are required for a regional beach destination without an additional area provision for protection and preservation of environmental values. The

values and services required to be accommodated within the ACNLSP foreshore reserve are therefore defined as:

1. Recreation and safety – Provided through development of a surf lifesaving club and associated facilities as well as other public recreation facilities such as landscaped areas, shelters, seating, tables, barbeques and a playground.
2. Public access to the beach – A high level of access is required to support outcomes of the District Structure Plan which sought to protect environmental values of the foreshore reserve in other areas of the coast by focussing recreational activity at this location.

These values and services can be adequately provided for within the area considered to be at risk from coastal processes within the 100 year planning timeframe. However, it is recognised that high value infrastructure (surf lifesaving club and associated facilities) will need to be accommodated within the ACNLSP area beyond the planning timeframe. Therefore, these items have been accommodated outside of the area considered to be at risk from coastal processes and the foreshore reserve has been widened at key locations to accommodate them.

Key outcomes from the Coastal Hazard Coastal Hazard Risk Management & Adaptation Planning process which have been incorporated into the *ACNLSP* include:

- Establishment of a foreshore reserve which will ensure that the area can continue to provide the values, functions and uses required if coastal hazards are realised over the planning timeframe.
- Permanent locations for infrastructure critical to the functioning of the regional beach (car parking and surf lifesaving club house) have been identified within or adjacent to the foreshore reserve.

Additionally, future actions which will need to be undertaken include:

- Preparation of a foreshore management plan to formally establish and identify the future management requirements of the full extent of the foreshore reserve.
- Design of permanent infrastructure (eg: roads) and private property set back beyond the landward extent of possible erosion at the 100yr planning horizon as identified by the coastal processes assessment.
- Design of temporary infrastructure (eg: landscape assets) set back beyond the landward extent of possible erosion at the planning horizon appropriate to the design life of the asset as identified by the coastal processes assessment.
- Relocation of temporary infrastructure (eg: landscape assets) to alternative locations when required.
- Monitoring and maintenance of natural and built assets.
- Review of the coastal processes assessment and foreshore management plan will be required periodically to refine relocation requirements for temporary assets and to update asset management actions. The first of these staged reviews should be undertaken in approximately 10 years' time.
- Community consultation and communication of actions undertaken to manage public safety within the foreshore including relocation of assets where required

CONTENTS

1 INTRODUCTION 1
1.1 Purpose 1
1.2 Scope 1
1.3 Stakeholder involvement in preparation of this plan 2

2 CONTEXT 4
2.1 Stakeholder roles and responsibilities 4
2.2 Objectives 4
2.3 Study area 6
2.4 Planning context and controls 6
2.5 Functions of the foreshore reserve 10
2.6 Natural and community assets 12
2.7 Risk evaluation criteria 15

3 HAZARD IDENTIFICATION 20
3.1 Coastal processes assessment 20
3.2 Potential impacts 22
3.3 Vulnerability 22
3.4 Coastal hazards 24

4 RISK ANALYSIS AND EVALUATION 25
4.1 Existing controls 25
4.2 Likelihood 25
4.3 Consequence 26
4.4 Evaluation 27

5 MANAGEMENT AND ADAPTATION PLAN 32
5.1 Categories of action 32
5.2 Evaluation of options 33
5.3 Recommended Management and Adaptation Plan 37

6 IMPLEMENTATION, MONITORING AND REVIEW 39
6.1 Proposed actions 39
6.2 Resource requirements and timing 40

7 References 46

Figures

Figure 1: Coastal Processes Assessment (MP Rogers 2013) 21
Figure 2: IPCC AR4 sea level rise predictions 26
Figure 3: Development scenario by existing controls 28
Figure 4: Land use planning response 42

Tables

Table 1: Possible asset inventory 13
Table 2: Likelihood of exceedance 16
Table 3: Scale of likelihood 17
Table 4: Scale of consequence 18
Table 5: Risk evaluation matrix 19
Table 6: Risk assessment 29
Table 7: Evaluation of proposed adaptation strategy 34
Table 8: Implementation plan 43

1 INTRODUCTION

1.1 Purpose

The purpose of this coastal hazard risk management and adaptation plan is to provide guidance regarding the ongoing management of coastal hazard risk. Such a plan is required to inform land use planning outcomes and future management of assets in the area of the coast which is potentially impacted by coastal hazards.

In particular this coastal hazard risk management and adaptation plan has informed the preparation of the *Alkimos Coastal Node Local Structure Plan* (ACNLSP). The ACNLSP considers that a number of existing and proposed assets within the area which may be affected by coastal processes. These include existing natural assets (the beach and dunes), and 'community' assets such as car parks, lookouts, shelters, footpaths, and a surf club. This plan provides recommendations for risk management and adaption to ensure that there is an appropriate response to the coastal hazards which might impact on these assets or present other hazards to the community.

1.2 Scope

State Planning Policy No. 2.6: State Coastal Planning Policy (WAPC 2013) (SPP 2.6) provides guidance on the process for planning and development in coastal areas. In regards to management of coastal hazards, the policy requires development proposals to be considered in the context of coastal hazard risk management and adaption planning undertaken by the responsible authority or proponent of the development.

Establishment of a regional beach within the study area and development of the adjacent coastal village has been previously approved by the WAPC (by approval to the Alkimos Eglinton District Structure Plan) and endorsed by the EPA (by approval of MRS Amendment 1029/33). In submissions to the EPA regarding MRS Amendment 1029/33, the WAPC noted support for reduced coastal setbacks within the study area to support the coastal village and provide facilities associated with the Alkimos regional beach (EPA 2005). In order to establish the required amenity associated with a regional beach, infrastructure, services and people will need to be located within an area which is subject to current and possible future coastal hazards.

In response to the desired planning outcomes and coastal planning policy requirements, this coastal hazard risk management and adaptation plan discusses the viability and management of infrastructure and/or development within the area potentially impacted by physical coastal processes. Objectives for the study area are derived from approved and draft town planning instruments and from relevant state government policy, described further in Section 2. The objectives derived for the site are considered along with the technical outputs from the *Alkimos Coastal Processes Assessment* (MP Rodgers 2013) to inform an assessment of coastal hazard risk and develop a proposed suite of management and adaptation planning measures.

1.2.1 Process used to develop the plan

The SPP 2.6 Guidelines (WAPC 2013b) and Draft CHRMAP Guidelines (WAPC 2013c), referred to hereafter in this document as "the guidelines", outline the recommended process for preparing a CHRMAP and suggest that the following elements are required:

1. Establishment of the context.
2. Coastal hazard risk identification.
3. Coastal hazard risk analysis.
4. Coastal hazard risk evaluation.
5. Coastal hazard risk adaption planning.
6. Monitor and review
7. Communicate and consult

The key outcome of this process is management and adaptation measures which have been developed with an understanding of hazard risk. The process is drawn from standard approaches to risk management, as per AS/NZS ISO 31000 (Standards Australia, 2009), through stakeholder consultation and specific identification of risk evaluation criteria (definitions of likelihood, consequence and risk tolerance) and use of that criteria to inform decision making processes.

The use of a risk assessment framework to inform coastal planning provides a flexible approach allowing impacts to coastline development, recreational uses, and ecological and other coastal values to be managed appropriately. The approach is particularly relevant given the uncertainty surrounding the local effects of climate change and lack of data for erosion rates, historical shoreline change and sediment transport. In this context a risk assessment framework can help to define overall levels of risk, as outcomes may be assessed and appropriate adaptive management responses determined to address those risks even when there is little available data.

This plan has been structured around the key elements of the recommended process described in the guidelines.

1.2.2 Planning timeframe

The planning timeframe for this coastal hazard risk management and adaptation plan is 100 years to meet the requirements of *SPP 2.6* (WAPC 2013) (as defined in Schedule One), which takes into consideration long timeframes associated with coastal hazards, particularly sea level rise associated with climate change.

Intermediate planning timeframes have also been considered where relevant to particular time-dependant activities and adaptation options. This allows the consideration of suitable locations for assets in areas that are not expected to be subject to coastal hazards over the design life of the asset.

1.3 Stakeholder involvement in preparation of this plan

The following stakeholders have an active interest in the outcomes of the plan and as such were consulted and/or involved the development of the plan:

- **City of Wanneroo;**

The City of Wanneroo has significant interest in the outcomes of the plan due to its responsibility as the ultimate public asset owner and manager of the study area.

- **Department of Planning;**
  The Department of Planning is responsible for ensuring that proper planning is undertaken for subdivision and development, and in doing so, plans for the impacts of a proposed landuse on the surrounding area, such as a foreshore reserve. In this context the Department of Planning was consulted as the advisory agency to the approving authority for the future rezoning of land which is the subject of the ACNLSP.
- **LandCorp;**
  LandCorp is a landowner with an interest in the ACNLSP and is acting as the project manager for the development of the structure plan on behalf of other landowners, and
- **Water Corporation;**
  The Water Corporation is a landowner with an interest in the ACNLSP and the Water Corporation is also an operator of significant infrastructure within the study area.

Due to the inclusion of a future surf lifesaving club associated with the Alkimos regional beach, Surf Life Saving WA is also a relevant stakeholder. Surf Life Saving WA has been consulted as part of the preparation of the local structure plan and relevant information has been considered as part of this assessment.

As the ACNLSP area has yet to be developed and is relatively isolated from surrounding subdivisions there is no established community. No community consultation has therefore been undertaken. The broader community will be consulted as part of the development of the structure plan and foreshore management plan through the public advertising process. The planned process of monitoring and ongoing review of coastal hazard will include the future community of the ACNLSP area once it has been established.

A risk workshop was undertaken to assist in identification of objectives, hazards and possible adaptation strategies for key assets. The workshop was attended by representatives from the City of Wanneroo, LandCorp and the Department of Planning. The key aims of this workshop were to ensure stakeholders have an active interest in the development of the plan and were able to guide preliminary outcomes and recommendations.

2 CONTEXT

The first task in the CHRMAP process is to determine the context of the assessment. In particular, responsibilities of stakeholders including their respective roles in decision making, the objectives of the process/plan, and to establish risk evaluation criteria to be used for assessment of hazards and adaptation options.

2.1 Stakeholder roles and responsibilities

As indicated in section 1.3, the stakeholders that have been identified as having some involvement in the future management of the foreshore reserve within the ACNLSP area are:

- City of Wanneroo;
- Department of Planning;
- Water Corporation; and
- Surf Life Saving WA.

All stakeholders should be involved in the future management of the study area depending on their level of responsibility with respect to asset ownership and management.

As the local government, the City of Wanneroo represents the interest of the future community of the ACNLSP area and will be responsible for both the future management and decision making relating to the adaption of the study area and its assets to long term coastal processes.

The Department of Planning will consider the planning implications of the proposed future development including the management of long term coastal hazard risk, consistent with SPP 2.6 (as well as other relevant strategic and statutory planning guidance).

The Water Corporation will remain responsible for the management of its existing wastewater outfall infrastructure into the future.

While Surf Life Saving WA will be responsible for the future management of the proposed surf lifesaving club and associated infrastructure within the study area, these assets will be constructed by the developer and/or local government and owned by the local government. Surf Life Saving WA's requirements for a suitable surf lifesaving club will influence the location and layout of club infrastructure, however it will be a publicly-owned asset leased by Surf Life Saving WA.

2.2 Objectives

The first step in assessing risks of any type is to define the objectives which are being considered and which might be impacted by the hazards and influenced by interventions to those hazards. By setting objectives we establish the context in which to identify the need for specific actions.

Specific objectives for the study area are informed by a broader consideration of coastal management objectives at the district scale. Key district planning outcomes have been agreed through adoption of the *Alkimos Eglinton District Structure Plan* (City of Wanneroo, 2010), which identifies the establishment of the a coastal village at Alkimos (in addition to others at Alkimos North and Eglinton) as an area of concentrated recreational activity, within

the context of maintaining the natural state of the foreshore in other parts of the district structure planning area.

Local scale planning outcomes will follow in line with this broad objective for an intensive recreational node and coastal village within and/or adjacent to the study area.

Objectives to be considered in this assessment need to respond to local scale outcomes of the established planning objectives and broadly relate to protection of environmental and community assets, facilitating ongoing uses of the coast and achieving site specific objectives defined in the relevant district structure plan.

The key objectives of this plan were developed through consultation with various stakeholders with reference to broader planning objectives and consideration of possible development outcomes. These objectives have been agreed as follows:

- **Provide and protect a quality regional beach destination**. District planning identifies the area as an important "coastal focal point" providing access to a "regional beach" with "intensive lifestyle and a recreation node" incorporating "beach side facilities".
- **Provide and protect quality tourism accommodation.** It is an objective that the coastal zone supports a local tourism economy. The district structure plan suggests that "the opportunity to integrate tourism, beachside facilities and activity nodes with the coastal foreshore reserve should be explored and pursued" in the context of an "opportunity for review of coastal setbacks". Consistent with this outcome the ACNLSP envisages high density commercial activity including hotel developments along the foreshore.
- **Provide and protect a thriving coastal community.** In line with the objectives above, structure planning has identified the coastal node as supporting high density housing and a local economy consistent with the function of Local Activity Centre. Proximity to the coast and access to coastal recreation opportunities is considered essential to maintain vibrancy of the coastal community.
- **Maintain functions of the coastal dunes.** To maintain the coastal dunes and the social, environmental and economic services which they currently provide. Some of the key functions of coastal dunes identified in the Guidelines are relevant to the study area including: a role in coastal processes contributing to beach stability; protection of inland areas from coastal processes; and provision of visual amenity.
- **Manage public safety and protect public infrastructure.** The area is expected to accommodate and encourage high levels of public interaction with the coast and include development of public infrastructure within the coastal zone. As such, there is an increased need to manage public safety and consider protection and maintenance of public infrastructure which could be affected by coastal processes.

These objectives form a critical component of the risk assessment framework used to assess the consequence of hazards and the suitability of management or adaptation options. Further detailed discussion on aspects which have informed identification of these objectives is presented below.

2.3 Study area

The study area is part of the foreshore adjacent to the ACNLSP area at Alkimos Beach, approximately 40 km north of Perth's CBD. Alkimos Beach is identified as a significant regional beach and the identified location of a future coastal node.

The study area is limited to that area considered to be affected by coastal processes within the next 100 years, which is considered to be 2110 consistent with SPP2.6. The study area therefore does not include land east of the 100 year coastal processes line illustrated in Figure 1.

This coastal hazard risk management and adaptation plan will be used to assist in the delineation of the foreshore reserve proposed by the ACNLSP. Also, while it is acknowledged that the site of a proposed marina is included within the study area, it has not been considered as part of this plan due to a lack of available information. A marina development could have significant impact on coastal processes and so revised coastal hazard risk management and adaptation planning will be required in support of any future marina development.

2.4 Planning context and controls

Various planning controls are in place to direct land use outcomes for the site and the proposed adjacent urban development. Local Planning Schemes set zoning and statutory requirements for current and future land uses. Current zonings facilitate preparation of structure planning documents to provide detail on land use and development of the land.

Decisions about land use and development outcomes at different levels of detail are made at different stages of the planning process to ensure proper and orderly planning of the land is achieved. There are four key processes from which planning outcomes are established as follows.

- **State Planning Policy**. The WAPC prepares statements of planning policy which provide guidance on the recommended approach to various planning matters across the state. Of particular relevance to this site is SPP2.6 which outlines the recommended approach to coastal planning.
- **Regional planning**. The Metropolitan Region Scheme (MRS), which is administered by the State Government (through WAPC) sets out broad scale zoning and patterns of land use for the greater Perth metropolitan area.
- **District planning**. The process of preparing and approving the *Alkimos Eglinton District Structure Plan* (City of Wanneroo, 2010) provided the required analysis and justification needed to establish viability of development in the area, set patterns of settlement within the broader district scale and support rezoning of the land in the MRS and the City of Wanneroo Local Planning Scheme.
- **Local planning**. Local land use planning for the study area and for the adjacent coastal village will be established by the ACNLSP.

2.4.1 State planning policy

There is recognition within *SPP 2.6* that *"development may need to occur within an area identified to be potentially impacted by physical coastal processes within the planning time frame."* Circumstances where this may be an accepted outcome include:

- Public recreation facilities with finite lifespan

- Coastally dependent and easily relocatable development
- Industrial and commercial development that is dependent on a foreshore location
- Coastal nodes
- Surf lifesaving clubs

The area covered by the ACNLSP is a key site identified within state and local strategic planning documents and in particular is identified within the *Alkimos Eglinton District Structure Plan* (City of Wanneroo 2010) as the site of a "regional beach" and a coastal village, as described above.

Development of the ACNLSP area will require construction of assets located within the area identified to be potentially impacted by physical coastal processes within the planning time frame. These assets are consistent with a number of the identified circumstances. SPP 2.6 stipulates that such proposed development may occur as long as it is considered within a CHRMAP process and adequate management and adaptation planning measures have been agreed.

It is important to note the definition of a "coastal node" as considered by SPP 2.6 is

> *"a distinct and discrete built area that may be located within a coastal foreshore reserve. Excluding residential development, it may vary in size from a grouping of recreational facilities to an area of commercial or tourism facilities or accommodation."*

It is noted that the "Alkimos Coastal Node", as per ACNLSP, is not the same as a "coastal node" considered by the definition in SPP2.6 as described above. Notwithstanding, some of activity and physical infrastructure proposed within the coastal foreshore reserve will fall under the definition of a "coastal node" under the SPP. The vision and outcomes sought by local planning provide important information about the functions of the study area, and local objectives for coastal planning.

The ACNLSP area has been entitled the "Alkimos Coastal Node Local Structure Plan" yet it is noted that the ACNLSP covers an area and associated infrastructure which is much larger than a "costal node" as defined by SPP 2.6 and includes land outside the foreshore area. The proposals for infrastructure to be located within the foreshore reserve are consistent with the definition in the SPP 2.6, being infrastructure which could be considered a "coastal node". In order to improve clarity within this document, recreational facilities which might be constructed within the foreshore reserve will at a "coastal node" (per the definition in SPP2.6) will be referred to as such, and the "Alkimos Coastal Node Local Structure Plan" will be referred to as the "ACNLSP" or by name in full.

2.4.2 Regional and district planning

The Metropolitan Region Scheme was amended in 2006 to reflect outcomes of the Alkimos Eglinton District Structure Plan upon recommendation from the WAPC and the EPA. Zoning under the MRS in the vicinity of the study area establishes and 'urban' zone (for the ACNLSP area), a parcel zoned 'Public Purpose – Water Authority of WA', and a narrow strip of land zoned 'Parks and Recreation' along the western boundary which supports establishment of a foreshore reserve.

Key outcomes and discussion that were considered during the process of adopting the District Structure Plan and amending the MRS provide relevant information to set objectives for the coastal hazard risk management and adaptation plan.

Alkimos Eglinton District Structure Plan

Alkimos Eglinton District Structure Plan (City of Wanneroo, 2010) identifies the establishment of a coastal village at Alkimos and the adjacent foreshore as an area of concentrated recreational activity within the context of maintaining the natural state of the foreshore in other parts of the district structure planning area. Infrastructure and large numbers of people will need to be located within the study area (the area affected by coastal processes) in order to facilitate the area to function as a "Regional Beach" and vibrant "Coastal Village". The description of the Alkimos coastal village contained within the district structure plan provides useful context as to the agreed vision for the urban development:

> *"Physically and visually linked to the Alkimos Secondary Activity Centre the Alkimos Coastal Village (Local Activity Centre) is located at the southern end of the Alkimos Regional Beach, and provides an important coastal focal point for the community. It will be a place of "vitality" engendering the coastal lifestyle, being an essential element in delivering the vision for the project.*
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> *This node has a strategic location centred on an excellent regional swimming beach with panoramic views northward up the coastline.*
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> *Whilst addressing the need for good environmental outcomes, coastal development should be integrated with, and provide for strong connectivity with adjacent land uses. At the local structure planning and detailed design stages, the opportunity to integrate tourism, beachside facilities and activity nodes with the coastal foreshore should be explored and pursued. This process will provide an opportunity for a review of coastal setbacks, which would require appropriate environmental and planning assessment and approvals.*
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> *The possibility of a new marina adjacent to the Alkimos Coastal Village as recommended in the recently released Department for Planning and Infrastructure, Draft Perth Recreational Boating Facilities Study will add a new dynamic dimension to this activity centre and will provide a further catalyst to enabling a wider range of tourist, community, recreation and aquatic activities and uses to be incorporated.*
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> *The opportunity to incorporate this marina into the development and integrating it with the Alkimos Coastal Village is still at a very premature stage, however the implications of this facility being developed need to be explored at the local structure*

planning stage along with the early identification of protocols and process needed to achieve necessary environmental and planning approvals. "

Environmental Protection Authority Bulletin 1207

Documentation produced by the Environmental Protection Authority (EPA) during assessment of the district structure plan and associated rezoning of the land in the MRS (Amendment 1029/33) provides further useful context that assists in establishing vision for the area and critical functions of the foreshore reserve.

The principle change made by Amendment 1029/33 that directly affected the ACNLSP area was the rationalisation and reductions to coastal foreshore reservations (Area 7). The foreshore reservation within the ACNLSP area was the subject of Area 7a. The purpose of the change at Area 7A was described in the EPA report as follows:

"The coastal foreshore reservation is proposed to be reduced in the western part of Lot 102 to accommodate a coastal node".

The WAPC noted in their response to submissions that the proposed reduction in width in Area 7a was supported *"because of the overall sustainability benefits that will arise from a well designed coastal village, providing amenity to the Alkimos regional beach..."*

The EPA made an assessment of environmental values at the site and made recommendation that proposals for areas 7b and 7c were rejected in order to maintain ecological linkages, and to protect the parabolic coastal dunes and Karli Springs. Conversely the EPA concluded that the change in the area 7a could be supported on the basis that:

"values within Area 7a, while significant and desirable to retain if possible, are protected elsewhere on the site."

2.4.3 Local planning

The zoning of land under the City of Wanneroo District Planning Scheme No. 2 reflects the outcomes of regional and district scale planning by setting "public purpose" and "parks and recreation" regional reservations to the equivalent parcels, and setting the area of the ACNLSP area as "urban development zone". The "urban development" zoning facilitates more detailed local planning in that area through the requirement for a Local Structure Plan to be adopted by the WAPC prior to subdivision.

A local structure plan titled "Alkimos Coastal Node Local Structure Plan" (ACNLSP) has been prepared for the urban development zone.

Alkimos Coastal Node Local Structure Plan

The *Alkimos-Eglinton District Structure Plan* acknowledges the broader vision for the northern growth corridor within which the ACNLSP area is located. It nominates a 'Coastal Village Activity Centre' over the site, strategically positioned at the southern end of the Alkimos Regional Beach. It is envisioned in the Alkimos-Eglinton District Structure Plan that the ACNLSP area will provide an important coastal focal point for the community providing an intensive lifestyle and recreational node, incorporating regional beach facilities, including a Surf Life Saving Club.

Overall the ACNLSP will deliver above average residential densities and provide a vibrant destination connecting the greater Alkimos community to the regional beach. It is expected to support approximately 24,000 m^2 gross floor area of shop-retail, commercial, office, medical and health, community services and hotel development land uses.

The 'core' of the activity centre will be located in the north of the ACNLSP area and will be characterised by high density urban form, with buildings up to 5 storey's to provide a well-defined village centre. The height and scale of buildings within the 'core' area will seek to create a more urban feel to activate the village centre. Local retail uses will be accommodated at the ground level of buildings, with opportunity for office and residential to be located above.

A vibrant foreshore promenade will extend nearly the entire length of the ACNLSP, abutting the coast, with active ground floor frontages and alfresco dining opportunities. Higher density built form will identify and complement the foreshore promenade, comprising 3-4 storey buildings. Cafe's restaurants and short stay accommodation are features of the foreshore promenade capitalising on view towards the coast, and to complement the local retail uses provided within the 'core' area of the village centre.

Some higher density development between 6-8 storeys is also provided for in appropriate landmark locations between the foreshore promenade and Secondary Transit System (STS) route. Medium density residential terraces and semi-detached dwellings are proposed to the east of the STS route to provide housing diversity and choice.

2.5 Functions of the foreshore reserve

SPP 2.6 indicates that the coastal foreshore reserve should be defined to *"include a component to allow for coastal processes and be of an appropriate width to ensure a coastal foreshore reserve continues to provide the values, functions and uses prescribed should the coastal processes be realised over the planning timeframe."*

SPP2.6 notes that the functions and uses of a coastal reserve can include but are not limited to; *public access, recreation and safety, biodiversity and ecosystem integrity, landscape, visual landscape, indigenous and cultural heritage.*

2.5.1 Regional beach - recreation and safety

A "regional beach" is defined as a beach attracting members from the local area and region and typically provides a high level of facilities, infrastructure, commercial development and use. The foreshore reserve within the ACNLSP area is identified by the District Structure Plan as the location of a coastal node providing access and amenity to the 'Regional Beach'. In order to facilitate this outcome, it is expected that infrastructure will be required within the area affected by coastal processes and opportunities for passive recreation functions will be provided for within the foreshore reserve.

The establishment of a surf lifesaving club and key facilities such as toilets and change rooms will be necessary to ensure the level of service provided is consistent with the functions of a 'Regional Beach'. The surf lifesaving club and associated facilities will also assist in addressing safety within the foreshore reserve. Additional public recreation facilities such as landscaped areas, shelters, seating, tables, barbeques and a playground will be established where space

and resources permit to provide for community and recreation functions and establish connectivity between the coastal activity centre and the beach.

2.5.2 Public access

The primary function of the foreshore reserve within the ACNLSP area will be to provide public access to the beach, thereby maintaining connectivity and interaction between the coastal village and the beach. A significant level of public access is appropriate given the designation of this location as a 'Regional beach'. The high level of access is required to support outcomes of the District Structure Plan which sought to protect environmental values of the foreshore reserve in adjacent areas by focussing recreational activity in a small number of key locations.

Provision of public access will also deliver an indirect recreational function by allowing the community access to beaches for swimming, walking, surfing and attractive landscapes and seascapes.

2.5.3 Biodiversity and ecosystem integrity

The foreshore area is part of Bush Forever Site 397 which stretches from Mindarie to the northern boundary of the City of Wanneroo approximately five kilometres north of Two Rocks. This site is only a very small proportion of a significant expanse of coastal dune vegetation.

The ACNLSP proposes to protect the significant vegetation through the establishment of a foreshore reserve which contains all of the part of Bush Forever Site 397 within the subject land. It is recognised; however, that this area is subject to coastal processes.

An environmental assessment of the study area supporting the ACNLSP and detailing the results of flora, vegetation and fauna surveys (RPS, 2009) states that no threatened ecological communities, declared rare and priority 1 flora species were identified within the study area. In addition, good quality foraging habitat and food sources for federally protected species Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) was considered limited within the study area, as compared to other areas in Alkimos-Eglinton and surrounds, and the then protected but recently de-listed Graceful Sun Moth (*Synoemon gratiosa*) was not considered likely to occur at the time of the fauna review.

Functions relating to biodiversity and ecosystem integrity are not considered to be critical services that need to be provided for within the foreshore reserve in this location beyond the planning timeframe. These functions will be maintained into the longer term by the ecological link established through the Environmental Protection Authority's assessment of the Alkimos – Eglinton Metropolitan Region Scheme Amendment No. 1029/33 (EPA Bulletin 1207, EPA, 2005) that links the foreshore areas through the buffer for the wastewater treatment plant.

2.5.4 Landscape and visual landscape

The landscape of the site is undulating, with semi continuous sand dune ridges generally aligned parallel to the beach and depressions in between.

Generally the fore dune is quite low with intermittent limestone outcrops evident. There are a number of blowouts present and several existing pathways have been formed through the vegetation. The secondary dune is more elevated and provides a 360º view of the site.

The Water Corporation's pump station site is located on a levelled and cleared area which is served by a limestone track. The area is located immediately behind the secondary dune.

2.5.5 Indigenous and cultural heritage

The Department of Aboriginal Affairs' Aboriginal Heritage Inquiry System shows one Registered Aboriginal heritage site is located directly south of the study area (ID 3509 – Karli Spring). Any significant indigenous or cultural heritage sites that may be discovered as part of the future development of the site will require further investigation and actions as appropriate and consistent with the requirements of the Aboriginal heritage Act. The presence of any heritage sites is not expected to change the outcomes of this adaptation plan; however.

2.6 Natural and community assets

Given the identification of the ACNLSP area as the site of a "regional beach" and the primary function of its foreshore reserve described above as providing public access and recreational facilities, this plan must consider a number of natural and community assets which currently exist or are proposed to be constructed within the study area. In order to provide context for assessing possible hazards and risks, it is necessary to consider a base case scenario of infrastructure and assets which might be developed under existing development controls (i.e. in the absence of CHRMAP). Figure 3 illustrates such a development scenario and will be used for the purposes of identifying adaptation planning actions in the risk assessment process.

Constructed assets will assist in providing an adequate level of connectivity and interaction between the beach and the coastal village, which will support vibrant local activity and a tourism economy. Landscaping elements which are expected to support the regional beach recreation and access values include large capacity car parks, cycle tracks, toilets, showers, a kiosk, parkland, lifesaving facilities and shade. These facilities constitute a proposed "coastal node" per the definition in SPP2.6.

All infrastructure assets have a limited functional and physical lifespan as a result of changing community needs and expectations and physical wear and tear. This results in a continuous process of renewal and periodic replacement of assets in line with expectations of the community at the time. The lifecycle of assets varies depending on the functional, physical and social requirements and may be affected significantly by changes in community expectations and technology. Many assets will become redundant and thus not require replacement as a result of changes in coastal landscape, available resources or social expectation and demographics. Similarly some assets will become more valuable to the community over time and may require renewal to extend initial design life in response to community expectations. Understanding the factors affecting the need for and lifespan of assets will ensure that they are not replaced unnecessarily and that assets which are highly valuable to the community can be maintained for future generations.

An estimate of the design life for different assets is presented in Table 1 which generally aligns with the City of Wanneroo's current asset management plans. It should be noted the estimated design life of an asset is not necessarily the same as its functional life due to changes in expectations and limits to resources of the community.

Assets have been grouped into preliminary 'value categories' as follows:

1. **High value assets operated privately under leasehold and connected to services (H1)** (water, wastewater and power)– these assets may be publicly owned but leased to third parties for time periods less than the total 100 year planning timeframe but will require consideration of future need for relocation or reconstruction:
    - Surf lifesaving club room and facilities and associated service infrastructure
    - Café and toilets and associated service infrastructure
2. **Publicly owned and operated high value assets connected to services (H2)** (water, wastewater and power) – these are typically larger assets that provide necessary public functions and will require consideration of future need for relocation or reconstruction:
    - Public toilets and associated service infrastructure
3. **Publicly owned and operated high value assets not connected to services (H3)** – these are typically larger assets that provide necessary public functions and will require consideration of future need for relocation or reconstruction:
    - Playgrounds
    - Shelters
4. **Low value landscaping assets connected to services (L1)** (water, wastewater and power) – these are typically smaller assets that may be considered as less 'necessary' and also may be more easily relocated or reconstructed:
    - Drinking fountains and associated service infrastructure
    - Lighting and associated service infrastructure
5. **Low value landscaping assets not connected to services (L2)** – these are typically smaller assets that may be considered as less 'necessary' and also may be more easily relocated or reconstructed:
    - Picnic tables
    - Bike racks
    - Waste bins
    - Seating
    - Fencing
    - Shades
    - Landscaped areas
    - Irrigation bores
6. **Car parks (CP)** – these are categorised separately to provide for their specific consideration, similar to other high value assets car parks may be considered 'essential' but the extent to which their physical degradation as a result of coastal processes is accepted may be lower than for other similarly valued assets.
7. **Low value natural assets (N1) –** natural assets which are likely to have low ecological and community value for which physical degradation is likely to be acceptable.
8. **High value natural assets (N2) –** natural assets which are likely to have high ecological and/or community value for which physical degradation is not likely to be acceptable and planning controls or physical defences may be required to maintain their function.

A detailed list of assets and preliminary assignment into value categories is provided in Table 1.

Table 1: Possible asset inventory

ID	Short Description	Value ($)	Qty	Type	Category	Nominal design life
Northern end						
a01	Seat	$2,500	1	Park / street Furniture	L2	20
a02	Picnic table	$5,500	1	Park / street Furniture	L2	20

ID	Short Description	Value ($)	Qty	Type	Category	Nominal design life
a03	Bike Rack	$450	1	Park / street Furniture	L2	20
a04	Bin	$2,500	1	Park / street Furniture	L2	20
b01	Northern beach		1	Beaches	N2	
b06	Northern foreshore dune			Dunes	N2	N/A
c01	Concrete / sealed pathway	$95,140	1420	Park / street furniture	L2	50
c02	Unsealed pathways	$8,925	595	Park / street furniture	L2	10
Central North						
a05	Café and public toilets	$350,000	1	Leasehold buildings	H1	50
a06	Non-irrigated landscaping zone	$300,000	2000	Non irrigated landscape	L2	10
a07	Car parking, 20 bays	$220,000	20	Carparks	CP	85
a08	Lookout shelter	$110,000	1	Park / street Furniture	L2	40
a09	Large shelter	$55,000	1	Landscape structures	H3	40
a10	Picnic table	$5,500	1	Park / street furniture	L2	20
a11	Drinking fountain	$6,000	1	Park infrastructure - serviced	L1	20
a12	Seats x 4	$10,000	4	Park / street furniture	L2	20
a13	Bins x 3	$7,500	3	Park / street furniture	L2	20
a14	Bike Rack	$450	1	Park / street furniture	L2	20
b02	Central north beach			Beaches	N2	N/A
b05	Limestone cliff			Limestone Cliffs	N2	N/A
b08	Central foreshore dune (north)			Dunes	N2	N/A
c03	Concrete / sealed pathway	$87,770	1310	Park / street furniture	L2	50
c04	Unsealed pathways	$14,850	990	Park / street furniture	L2	10
Central South						
a15	Surf Life Saving Club Room	$1,200,000	1	Leasehold buildings	H1	90
a16	Public Toilets and Change Rooms	$650,000	1	Public buildings	H2	50
a17	Car parking, 50 bays	$550,000	50	Carparks	CP	85
a18	Car parking, 20 bays	$220,000	20	Carparks	CP	85
a19	Irrigated landscaping zone	$500,000	2000	Irrigated landscape	L1	10
a20	Large playground	$250,000	1	Playgrounds	H3	20
a21	Large playground shade	$50,000	1	Landscape structures	H3	40
a22	Feature light poles	$120,000	20	Park infrastructure - serviced	L1	40
a23	Electrical connection, meter etc.	$7,500	1	Services infrastructure	L1	15
a24	Lookout shelter	$110,000	1	Landscape structures	H3	40
a25	Irrigation bore	$105,000	1	Services infrastructure	L1	20
a26	Picnic table x 2	$11,000	2	Park / street furniture	L2	20
a27	Drinking fountain	$6,000	1	Park infrastructure - serviced	L1	20
a28	Seats x 2	$5,000	2	Park / street furniture	L2	20
a29	Bins x 4	$10,000	4	Park / street furniture	L2	20
a30	Barrier fencing to limestone cliff	$80,000	1	Landscape structures	H3	20
a31	Bike Rack	$450	1	Park / street furniture	L2	20
b03	Central south beach			Beaches	N2	N/A
b09	Central foreshore dune (south)			Dunes	N2	N/A
c05	Concrete / sealed pathway	$82,946	1238	Park / street furniture	L2	50

ID	Short Description	Value ($)	Qty	Type	Category	Nominal design life
c06	Unsealed pathways	$4,710	314	Park / street furniture	L2	10
	Southern end					
a32	Car parking, 20 bays	$220,000	20	Carparks	CP	85
a33	Small playground	$125,000	1	Playgrounds	H3	20
a34	Small playground shade	$20,000	1	Landscape structures	H3	20
a35	Small shelter	$30,000	1	Landscape structures	H3	20
a36	Picnic table	$5,500	1	Park / street furniture	L2	20
a37	Drinking fountain	$6,000	1	Park infrastructure - serviced	L1	20
a38	Seats x 2	$5,000	2	Park / street furniture	L2	20
a39	Bins x 2	$5,000	2	Park / street furniture	L2	20
a40	Bike Rack	$450	1	Park / street furniture	L2	20
b04	Southern beach			Beaches	N2	N/A
b07	Southern foreshore dune			Dunes	N2	N/A
c07	Concrete / sealed pathway	$96,480	1440	Park / street furniture	L2	50
c08	Unsealed pathways	$7,050	470	Park / street furniture	L2	10

2.7 Risk evaluation criteria

The standard approach to risk management is to undertake qualitative assessments of possible hazards in terms of their likelihood and consequence and combine those aspects to determine a risk rating. The risk rating can then be used to evaluate and/or rank hazards in terms of risk and determine those which can be tolerated or the need for management actions.

In order to undertake a risk assessment it is therefore necessary to establish an agreed risk management framework including qualitative definitions of likelihood and consequence and risk rating evaluation criteria. Development of this risk framework has considered the City of Wanneroo Risk Management Policy (CS04-10/13 – 15 October 2013) that documents the City's commitment to the identification and management of risks that may impact on the achievement of its business objectives.

2.7.1 Scale of likelihood

Management of assets is commonly established through definition of an acceptable recurrence of service exceedance or failures that can result from environmental or usage characteristics. In this way, decision-maker's design of future infrastructure or management interventions to addresses key issues such as the acceptable level of service, safety and the risk of damage to private and/or public infrastructure from hazardous events. The three main ways which are commonly used to express the probability of an occurrence are: annual recurrence intervals (ARI), annual exceedance probabilities (AEP) and design life failure probabilities.

To properly consider respective measures of probability in a common scale of likelihood it is necessary to understand the relationship between them. Measures of annual recurrence intervals and annual exceedance probability assume by definition that events have the same probability of occurring each year regardless of how long it is since they last occurred. Under these conditions we can consider the translation to cumulative exceedance probabilities as illustrated in Table 2.

It is noted that in the case of a changing environment (such as that driven by expected climate variability) the annual exceedance probability of an event may change over time and there is no longer a direct relationship between that measure and design life probability. It is therefore important to understand the difference and that in a changing environment annual exceedance probability may not properly characterise likelihood that an event will occur within a specified design life / planning timeframe.

For many hazards there is insufficient data or analysis to formally quantify the probability of occurrence. This is especially the case when considering relatively low probability events, long planning / design timeframes and changing environments. For these hazards / events it is necessary to establish a qualitative scale of likelihood.

Table 2: Likelihood of exceedance

Average Recurrence Interval (ARI)	Annual Exceedance Probability (AEP)	Design Life (cumulative) exceedance probability		
		20 years	50 years	100 years
2 years	39.3%	100.0%	100.0%	100.0%
10 years	9.5%	86.5%	99.3%	100.0%
20 years	4.9%	63.2%	91.8%	99.3%
50 years	2.0%	33.0%	63.2%	86.5%
100 years	1.0%	18.1%	39.3%	63.2%
500 years	0.2%	3.9%	9.5%	18.1%
1000 years	0.1%	2.0%	4.9%	9.5%

A suitable scale of likelihood incorporating quantitative and qualitative descriptions for use in the risk assessment was developed through consultation with stakeholders and is presented in Table 3. Key requirements of the scale are (1) that it is able to adequately represents and distinguish between events of different likelihood in the context of the decisions being made, and (2) that a consistent outcome is achieved when assessing hazards or events under qualitative and quantitative descriptions.

2.7.2 Scale of consequence

The second component of a risk analysis framework is to categorise the severity of the hazard event through a scale of consequence. Similar to the scale of likelihood a key requirement of the scale is that it adequately represents the range of consequences being considered and that it allows differentiation between events which will drive different management responses. In developing the scale we need to consider that consequences in the same "level" will be afforded the same level of urgency in the evaluation and should warrant a similar tolerance or management action / investment.

A suitable scale of consequence incorporating qualitative descriptions for use in the risk assessment was developed through consultation with stakeholders and presented in Table 3. The scale provides qualitative descriptions of outcomes in respect to; community amenity, infrastructure, the environment and human health.

Table 3: Scale of likelihood

Level	Descriptor	Example description
A	Rare	Highly unlikely that the event will occur. Not recorded historically and not expected to occur. 0 – 20% probability of occurring over the timeframe. (inc 0.1% AEP)
B	Unlikely	Low possibility that the event will occur. Infrequent and isolated occurrence. 20 – 40% probability of occurring over the timeframe. (inc 0.2% AEP)
C	Possible	Might occur or should be expected to occur. 40 – 60% probability of occurring over the timeframe.
D	Likely	Likely the event will occur. History or probability of casual occurrence. 60 – 80% probability of occurring over the timeframe. (inc 1% AEP)
E	Almost certain	High possibility the event will occur. History or probability of periodic occurrence. 80 – 100% probability of occurring over the timeframe. (inc >2% AEP)

Table 4: Scale of consequence

Level	Descriptor	Description of consequence		
		Property and services	Environment	Health
1	Insignificant	Little or no impact on communities and services. Minor temporary impact to private property or infrastructure. Temporary treatments required to maintain amenity.	Minor naturally assimilated environmental damage. No treatments / interventions required.	No health impacts. No treatments / interventions required.
2	Minor	Minor or temporary impact on services for small population. Minor impact to private properties or infrastructure. Temporary, isolated treatments are required to maintain services or protect property and infrastructure. Permanent treatments required to maintain amenity.	Potential harmful impact to local ecosystem with impacts contained to a specific site. Site specific intervention to assist in ecosystem recovery.	Minor injury to individual. First aid or medical treatment.
3	Moderate	Minor impact on services large population. Moderate impact to private properties or infrastructure. Temporary treatments are required to maintain services or protect property and infrastructure. Relocation of temporary infrastructure.	Potential harmful impact to local ecosystem with impacts contained but occurring at multiple sites. Site specific interventions and monitoring to assist in ecosystem recovery.	Minor injury to more than one person. First aid or medical treatment.
4	Major	Major impact on services for small population. Major impact to private properties or infrastructure. Permanent treatments are required to maintain services or protect property and infrastructure. Relocation of permanent infrastructure.	Long term, potentially irreversible damage to local ecosystem with impacts primarily contained, but potential for regional impacts. Widespread interventions and monitoring to assist in ecosystem recovery.	Significant injury to small number of people causing lost time or restricted capacity. Medical treatment or hospitalisation required with expected full recovery.
5	Catastrophic	Major impact on services for large population. Irreversible impact to large number of private properties or infrastructure. Permanent treatments are required to maintain services or protect property and infrastructure. Viability of land uses compromised, relocation of permanent infrastructure.	Temporary injury to large number of people causing lost time or restricted capacity. Long term damage to regional ecosystem or loss of threatened species. Widespread interventions and monitoring to assist in ecosystem recovery.	Fatality or permanent injury to one or more individuals. Ongoing medical treatment for permanent injury. Isolated medical treatment or hospitalisation required for large number of people.

2.7.3 Evaluation matrix

The purpose of a risk assessment process is to formalise decision making allowing consistent actions to be undertaken that will reduce risk to a tolerable / acceptable level.

In order to evaluate risks and consider the need for risk management actions or controls it is necessary to define the level of acceptable risk. In order to do this the following definitions are considered.

- **Low risk** is tolerable and no further action is required.
- **Moderate risk** is tolerable but should be further reduced where possible and requires ongoing monitoring and communication to affected people.
- **High risk** is unacceptable and further action is required to reduce risk where possible.
- **Very high risk** is unacceptable and further actions are required before activities should be allowed to continue.

The definitions of risk, likelihood and consequence have been considered to derive a qualitative assessment of risk presented in Table 4.

It is noted that the proposed assessment of a risk evaluated as "Rare" but "Catastrophic" is "Moderate" and therefore a tolerable outcome. This is important to reflect the fact that in some cases it is not possible to eliminate risk of a catastrophic event. By example, there are hazards which with current resources and social constraints cannot be eliminated and which could generate a fatality. It is important that in assessment of hazards that fall within this evaluation category there is a formal recognition that there are limits on the resources of the responsible authority and that there must be some acceptance of the principle and the community that not all hazards can be eliminated.

The relevance of the evaluation matrix can be tested by considering possible scenarios and assessing if the corresponding evaluation rings true with community expectations and our capacity to respond.

Table 5: Risk evaluation matrix

Likelihood		Consequence				
		1 - Insignificant	2 - Minor	3 - Moderate	4 - Major	5 - Catastrophic
A	Rare	LOW	LOW	MODERATE	MODERATE	MODERATE
B	Unlikely	LOW	MODERATE	MODERATE	HIGH	VERY HIGH
C	Possible	LOW	MODERATE	HIGH	HIGH	VERY HIGH
D	Likely	MODERATE	MODERATE	HIGH	VERY HIGH	VERY HIGH
E	Almost Certain	MODERATE	HIGH	VERY HIGH	VERY HIGH	VERY HIGH

3 HAZARD IDENTIFICATION

The second task in understanding coastal hazards and preparing an appropriate management and adaptation response is to clearly define the hazards which might affect specific assets and/or otherwise prevent attainment of the previously defined objectives (success criteria).

To adequately identify coastal hazards we need to understand what processes might affect assets in the coastal zone. It is then necessary to make some assessment as to whether or not that effect (event) is mitigated by the adaptive capacity of those assets. This will determine the vulnerability of the assets and values and influence the ability to meet defined objectives (success criteria). The level of vulnerability, within the context of the determined level of risk, assists in the identification of opportunities and potential management and adaptation responses.

The WAPC's Coastal planning and CHRMAP guidelines recommend that the CHRMAP process considers a clear distinction between potential impacts - the result of exposure and sensitivity *(what might happen)*, and vulnerability - the subsequent result of potential impacts and adaptive capacity *(what outcomes occur*).

The task of the risk identification stage is therefore to identify a list of coastal hazards (possible outcomes) as they relate to our defined objectives (success criteria) which can be assessed through the risk assessment and evaluation process.

3.1 Coastal processes assessment

The *Alkimos Coastal Processes Assessment* (MP Rodgers 2013) has considered the requirements of *SPP 2.6* and established the potential landward extent of the effects of coastal physical processes for a range of planning horizons up to and including 100 years.

The processes assessment provides an assessment of possible impacts at 20yr, 42yr, 50yr, 75yr and 100yr planning horizons using the methodology and allowances for uncertainty defined in Schedule 1 of SPP2.6. The assessment includes investigation into the effect of:

- Severe storm erosion.
- Long term shoreline movement, and
- Storm surge inundation.

These site specific assessments are combined with additional allowances (1) for possible shoreline recession as a result of sea level rise, and (2) for uncertainty, to define a possible extent of impact from coastal processes.

The key outcome of the assessment, being the extent of land projected to be impacted by coastal processes at various timeframes, is reproduced in Figure 1.

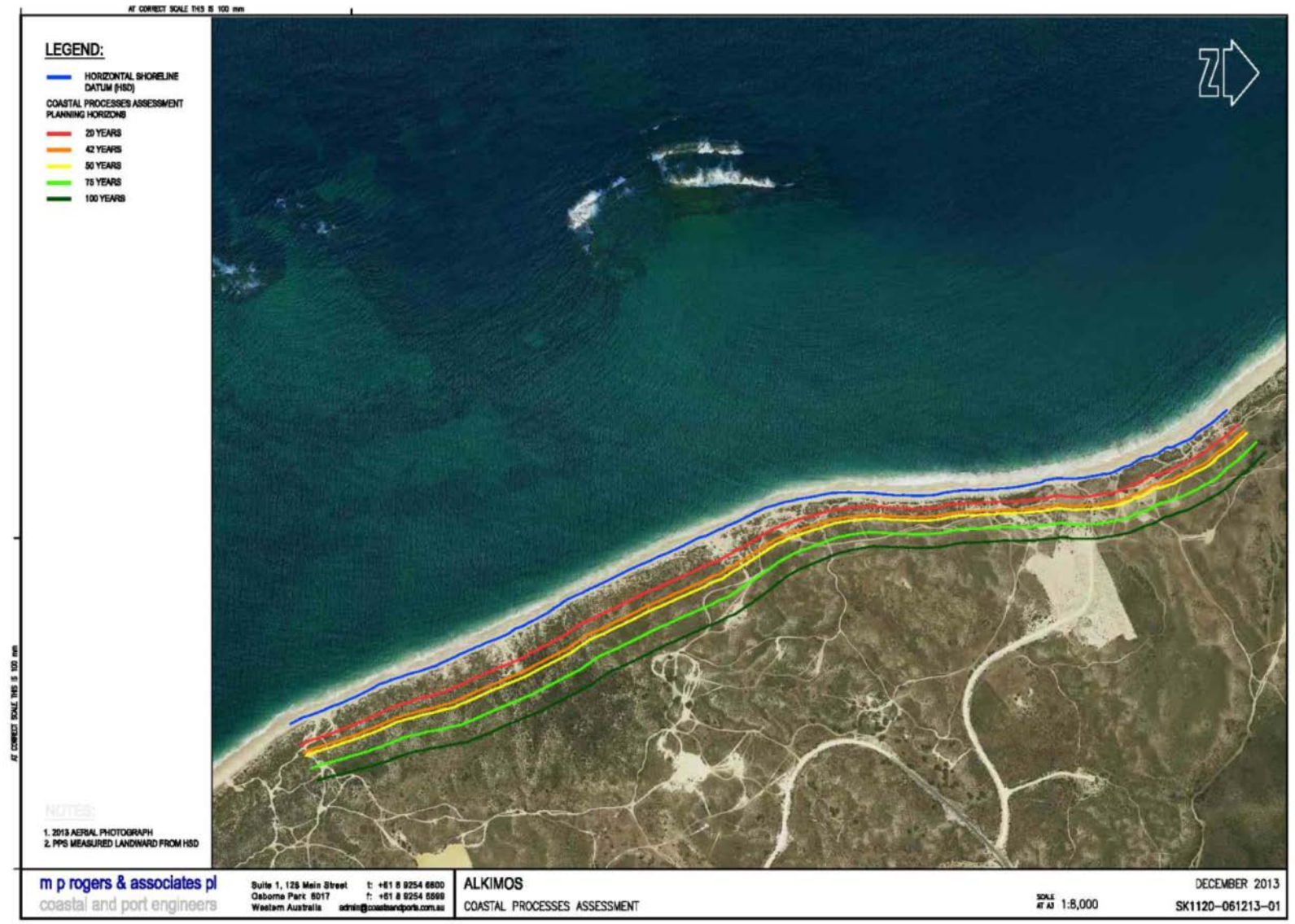


Figure 1: Coastal Processes Assessment (MP Rogers 2013)

3.2 Potential impacts

In developing a list of potential impacts it is necessary to consider the effect that coastal processes may have on assets and also how human interactions and assets might result in additional impacts.

Potential impacts on natural features include:

- naturally occurring acute erosion of beach and/or dune, including loss of vegetation during a storm event;
- recession of coastline as a result of natural variability and/or climate change leading to loss and/or degradation of beach and dunes;
- increased impact (erosion) during storm events and/or accelerated rates of chronic erosion resulting from human activities undermining stability of foredunes; and
- increased impact (erosion) during storm events and/or accelerated rates of chronic erosion to adjacent parts of the coastline resulting from physical obstructions within the coastal zone (natural and/or relating to built assets).

Potential impacts on built assets and the community include:

- built assets (infrastructure) undermined and/or damaged as a result of coastline recession and acute erosion events;
- built assets (infrastructure) affected by inundation during storm surge event; and
- increased winds and/or transport of sand to previously protected sites following dune degradation or loss.

3.3 Vulnerability

The potential impacts described above need to be considered in the context of the adaptive capacity presented by expected natural and human responses to those events to determine the vulnerability of the assets.

3.3.1 Adaptive capacity of natural assets

Natural assets such as the beach and dune systems respond to naturally occurring acute and chronic erosion through subsequent processes which act to assimilate the changed environment and/or restore the previous condition by counteracting forces. In simple terms, the natural environment is a product of a naturally occurring balance between erosion and accretion. If there is adequate space for these naturally occurring processes to occur and erosion occurs with a frequency of occurrence that allows other physical and ecological processes to take place, then the environment is able to adapt to these events.

Projections of sea level rise resulting from climate change are expected to result in some significant changes to the balance between chronic erosion and accretion in the near shore environment. Climate change could also result in changes to weather systems and subsequently the nature of coastal forces driving acute erosion events.

Human activities and built assets that create a physical obstruction can increase and/or concentrate wave energy resulting in changes to the severity of erosion such that natural processes cannot readily assimilate damages. Human induced blowouts and erosion associated with piers and groynes are examples of these impacts. In these cases, significant changes to conditions can occur and result in step changes in forces acting on the local

environment. Notwithstanding, the adaptive capacity to these potential impacts is provided through human social institution and active community interaction with the coastline whereby the human desire for short term and ongoing use of the coast (including maintenance of environmental systems) will result in design and management actions which respond to those impacts. In simple terms, our community provides resilience and demands appropriate action to address these impacts.

3.3.2 Adaptive capacity of built assets and the community

The built environment and social / political processes provide a level of adaptive capacity that assists in responding to hazards at different timescales.

All infrastructure assets have a limited useful life as a result of changing community needs and expectations and physical wear and tear that comes from exposure to natural forces and usage. The social / political response to these factors is a continuous process of renewal and periodic replacement of assets over time. In some communities management of assets is through an informal process (largely political) driving investment of public funds. Larger communities, such as that represented by the City of Wanneroo, employ asset management professionals who assist in prioritising investment to achieve the equitable distribution of funds and best overall level of service and amenity for the community.

In addition to the processes surrounding management of physical assets it is important to note community expectations and technologies change over time in response to social, economic and environmental drivers. This is particularly relevant for the long timeframes which are being considered by this plan which presents a significant challenge in forecasting future community needs. Two examples relating to changing needs are useful to consider:

- An example of changing infrastructure needs over the last 100 years is the invent and widespread use of motor vehicles which has resulted in the desire / need for vehicle access to almost all parts of our urban environment, and provision of parking facilities at destinations. This is stark contrast to planning of urban centres in the 19th century when roadways where wider in town centres (to accommodate turning of horse drawn carts) and the majority of local transport was by foot or public transport.
- The influence of social drivers can best be observed in some medium and low value assets, where a relatively long design life creates significant cultural / heritage value which adds to the cost renewal and results in continued use of assets well beyond their intended design life. This is particularly relevant in coastal areas where the heritage value of assets may drive the need for protection of assets from damage by coastal processes, where those same assets would simply be abandoned, relocated or replaced if the heritage value did not exist.

These examples highlight the difficulty in accurately considering the adaptive capacity of built assets over the planning timeframe. Notwithstanding, there are three key aspects of the social / political environment which provide some capacity to adapt to changing conditions and coastal hazards. Specifically:

- Infrastructure assets have a limited design life, which presents the opportunity to relocate assets over time,
- There are established social / political processes which allow continuous reflection on service provision, which allows functions that are provided by assets now, to be provided by other means in the future, and
- Expectations of the community will respond to changing conditions.

3.4 Coastal hazards

Through consideration of the potential impacts and adaptation capacity as described above, identification of coastal hazards which might affect objectives of the plan may be summarised as follows.

Provide and protect a quality regional beach destination

- Inundation or acute damage to natural assets during a storm event
- Provision of Surf Life Saving Club becomes unviable due to coastal erosion
- Provision of selected built assets not viable due to coastal erosion
- Degradation / loss of the beach due to inadequate space for shoreline recession
- Changes to environment in nearby coastline due to protection of the infrastructure at the site.

Provide and protect a thriving coastal community

- Economic viability of proposed activity node is compromised due to large setbacks from current coastline.
- Increased winds and/or transport of sand into coastal village due to loss or degradation of dunes.

Provide and protect quality tourism accommodation

- Increased winds and/or transport of sand into affecting tourism appeal due to loss or degradation of dunes.

Maintain functions of coastal dunes

- Inadequate space for coastline recession such that foredunes are no longer available to provide beach stability.
- Inadequate space for coastline recession results in dunes no longer available to protect inland areas from coastal forces.
- Unsustainable ecological response to SLR results in dunes no longer available to protect inland areas from coastal forces.
- Modification to landscape and/or ongoing human activities undermine stability of dunes such that they no longer provide protection to inland areas from coastal forces.

Manage public safety and protect public infrastructure

- Loss of life or injury as a result of damage to natural assets (dunes and cliffs).
- Damage to assets through coastal erosion or inundation that causes injury to patrons.
- Damage to assets through coastal erosion or inundation that causes need for repair or premature replacement of assets.

4 RISK ANALYSIS AND EVALUATION

The risk analysis and evaluation phase of the CHRMAP process uses the risk evaluation criteria established in Section 2 to assess whether the coastal hazards which have been identified are acceptable. This phase of the analysis required consideration of those hazards in view of existing controls. Existing controls are considered to be those actions (eg: planning and management) which would be in place without formal recognition of the risks identified in this process.

Each of the coastal hazards which has been identified is assessed in respect of the likelihood and consequence of the event occurring. The resulting risk evaluation provides guidance to identify the need for actions in the management and adaptation plan.

4.1 Existing controls

In the absence of this CHRMAP there are a number of formal and informal processes that are or will be in place which will affect the likelihood and consequence of the coastal hazards which have been identified.

In particular it is useful to consider:

- State and local planning policies require preparation of a foreshore management plan to address ongoing management of the foreshore reserve. That plan will address access through the study area and is expected to include recommendations for ongoing monitoring and maintenance of infrastructure and environmental assets.
- After development of the site, the City of Wanneroo will be responsible for the maintenance and replacement of infrastructure on behalf of the community. To this end, ongoing maintenance will follow established asset management processes to optimise effective and efficient control of cost and service provision.

4.2 Likelihood

To consider the likelihood of different hazards it is necessary to understand the relationship between the location of infrastructure (positioned using existing controls), the projected shoreline and possible extent of acute erosion at different planning horizons. Figure 2 illustrates a possible development scenario showing the extent of land and infrastructure which could be affected by coastal processes.

It should be noted that the primarily driver for possible shoreline recession considered by the coastal processes assessment is sea level rise.

Unfortunately, ocean and climatic models that consider global warming and possible sea level rise and site specific consideration of geomorphology and landform responses do not provide sufficient level of certainty that would allow us to estimate the likelihood of shoreline recession from these processes. In addition to the uncertainty in sea level rise, the available assessment of the possible landform / coastline response to an increased sea level uses a theoretical assessment without considering the impact of local geological variability or dynamic responses of the nearshore marine environment or terrestrial ecosystems.

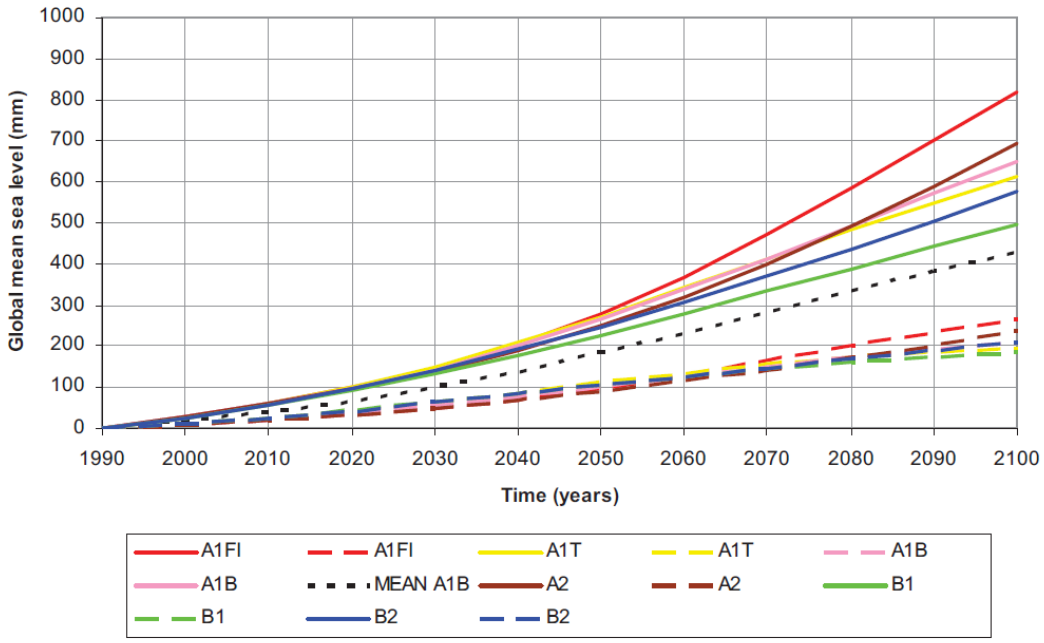


Figure 2: IPCC AR4 sea level rise predictions (dashed for 5th percentile, solid lines 95th percentile)

The uncertainty presented above means that it is not possible to adequately characterise the likelihood of coastal erosion for use in a risk assessment framework. All we can reliably say is:

- that sea level rise over the next 100 yrs is likely to be between 200 mm and 900 mm,
- some shoreline recession may occur as a result, and
- that the coastal processes assessment provides an assessment of a possible landform response to the upper estimate of sea level rise.

Therefore, in order to provide a useful assessment of possible hazards it has been necessary to assume that the likely landform response is correct and the worst case scenario (considered by SPP2.6) does occur. This allows us to consider the following assessments of likelihood:

1. Erosion of land which is east (landward) of the coastal processes lines at each planning horizons has a very low probability and should be considered “Rare”.
2. Erosion of land which is west (seaward) of the coastal processes lines at each planning horizon may or may not occur and will be considered “Possible”.

These assessments together with more specific hazard related considerations have been used to inform the assessment of likelihood outlined in Table 6.

4.3 Consequence

The consequence of each hazard occurring is assessed individually in the context of the assets at risk, the impact on the delivery of objectives and the scale of consequence which was outlined in section 2.3.

4.4 Evaluation

The risk assessment as presented in Table 6.

The following five hazards were identified as having a "VERY HIGH" or "HIGH" risk rating which is unacceptable. Actions should be undertaken to ensure the likelihood and/or consequence of the hazards are reduced.

1.02 Provision of the Surf Club not viable within the foreshore reserve due to coastal erosion.

1.04 Provision of public facilities (H2, CP) assets not viable within the foreshore reserve as a result of coastal erosion.

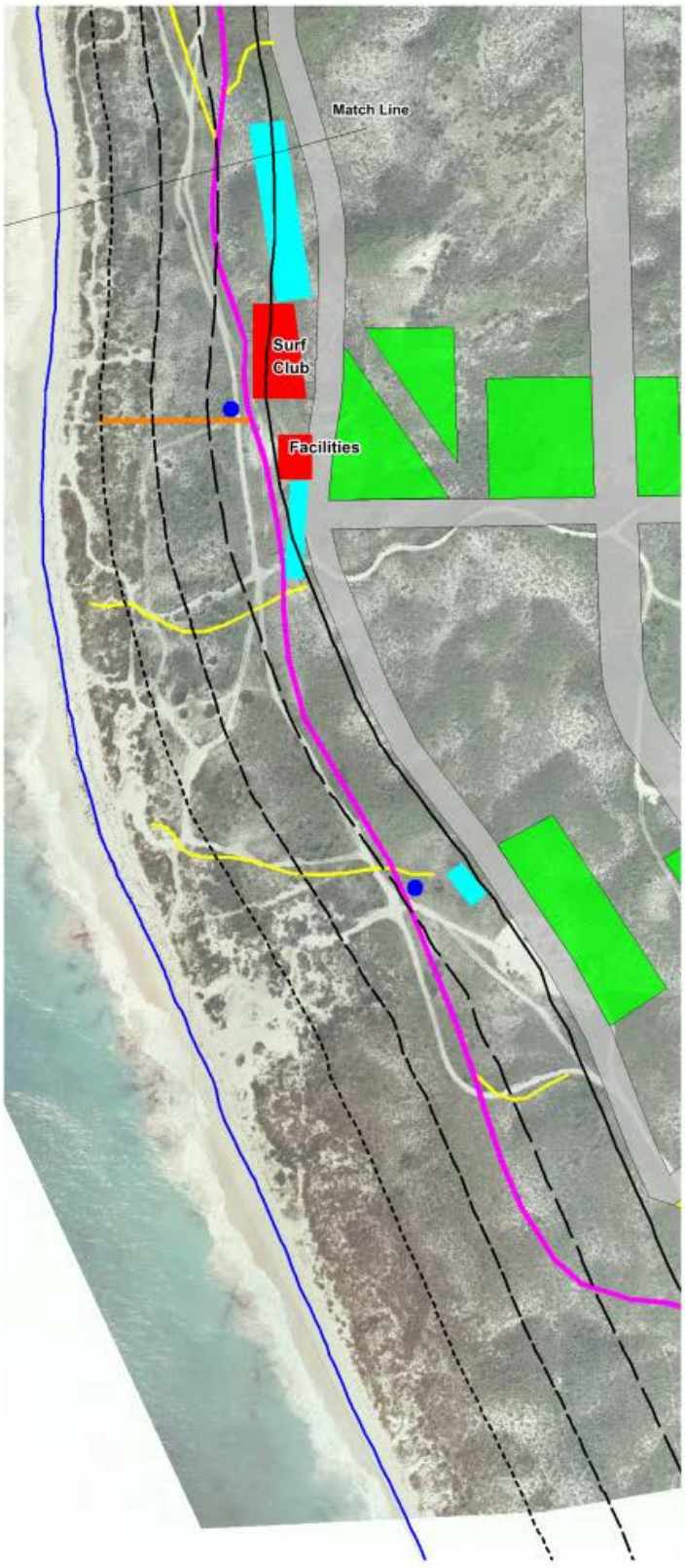
1.09 Regional beach destination not realised due to separation of coastal node from beach.

2.01 Economic viability of proposed activity node is compromised due to large setbacks from current coastline.

5.03 High value assets (H1, H2, H3, CP) could be inundated or damaged by erosion during storm event, causing need for repair or early replacement.

Of the remaining hazards considered, 14 had a risk rating of "MODERATE" for which actions to further reduce the risk should be considered and ongoing monitoring and communication will be required.

LandCorp, Alkimos Coastal Node CHRMAP
Figure 3: Development scenario by existing controls



LEGEND

- 2013 HSD
- 100yr coastal processes line
- 75yr coastal processes line
- 50yr coastal processes line
- 20yr coastal processes line
- Roads outline
- Conservation
- POS / Drainage

Landscape Concept

- Buildings
- Carpark
- Lookout point (seating, shade, interpretation)
- Primary pedestrian / dual use path
- Primary foreshore access (steps / ramp)
- Seconday foreshore access
- Limestone cliffs

Data source: Landgate, MP Rogers, AECOM.
Created by: K Norris. Projection: MGA50: zone 50.

Scale 1: 3000 at A3
0 60m 120m

essential environmental

Table 6: Risk assessment

Objective		Hazard	Likelihood		Consequence		Risk Rating
Provide and protect a quality regional beach destination	1.01	Natural assets (N1, N2) inundated of subject to erosion causing damage during storm event	D	LIKELY - Beaches, foredunes and natural coastal features are expected to be inundated based on probabilities	1	INSIGNIFICANT - Environments would naturally be subjected to these events and are likely to naturally assimilate any damage.	MODERATE
	1.02	Provision of Surf Club not viable within the foreshore reserve due to coastal erosion	B	UNLIKELY - The indicative location of the proposed surf club (SC) is at/intersected by the 100yr coastal processes line. While direct impacts west of the processes line are generally considered "possible" it is reasonable to consider reduced likelihood at this specific location because it is only at the end of the planning timeframe, under worst case scenario when impacts might occur.	5	CATASTROPHIC - facility is intended to provide services to "regional" population. Loss of the facility would have a major impact on a large population.	VERY HIGH
	1.03	Provision of Café (H1) assets not viable within the foreshore reserve due to coastal erosion	C	POSSIBLE - Proposed Cafe (H1) assets is illustrated within the area west of the 100yr coastal processes line. Shoreline recession within this area is considered possible, as per the discussion presented in the report.	1	INSIGNIFICANT - functions of the facility would easily be accommodated within the adjacent urban area. Loss of the facility would have no significant impact the community.	LOW
	1.04	Provision of public facilities (H2, CP) assets not viable within the foreshore reserve as a result of coastal erosion	B	UNLIKELY - Proposed H2 and CP assets are at/intersected by the 100yr coastal processes line. Probability as per 1.02	5	CATASTROPHIC - facility is intended to provide services to "regional" population. Loss of the facility may compromise the viability of the "regional beach". Major impact on large (regional) population. Viability of landuses compromised, relocation of permanent infrastructure.	VERY HIGH
	1.05	Provision of playgrounds and landscape structures (H3) assets not viable within the foreshore reserve as a result of coastal erosion	C	POSSIBLE - Landscape structures will be co-located with lookouts and/or between the major facilities and the shoreline to making use of the foreshore reserve and provide connection between the coastal node and the regional beach. Natural adaptation through replacement cycles may not be possible if there is limited space within the foreshore reserve. Shoreline recession within this area is considered possible, as per the discussion presented in the report.	2	MINOR - The primary purpose of this infrastructure is to enhance the connection between the built environment and the regional beach. If the shoreline has moved closer to the built environment then these assets will no longer be required which would suggest "INSIGNIFICANT" consequence. Notwithstanding, there may be some minor impact on the local community if they rely upon these facilities for local recreation which would generate a "MINOR" consequence.	MODERATE
	1.06	Provision of landscaped areas (L1 and L2) assets not viable within the foreshore reserve as a result of coastal erosion	C	POSSIBLE - Likelihood as per 1.05	1	INSIGNIFICANT - Consequence as per 1.05	LOW

Objective		Hazard	Likelihood		Consequence		Risk Rating
Provide and protect a quality regional beach destination	1.07	Beach degradation due to inadequate space for coastline recession	A	RARE - The setback of roads and private properties is such that there is adequate space to accommodate the coastal processes scenario through to 2110. The coastal processes line includes allowances for acute erosion and uncertainty which can be expected to provide sufficient space at the end of the planning timeframe to accommodate a foredune that could support the beach.	5	CATASTROPHIC - the regional beach is intended to provide services to "regional" population. Loss of the facility would have a major impact on a large population.	MODERATE
	1.08	Degradation of nearby coastline caused by protection of development	C	POSSIBLE - The proposed location of any community infrastructure within the area west of the 100yr coastal processes line presents a risk that the future community may expect protection works to be undertaken to prevent erosion of specific infrastructure assets. Shoreline recession within this area is considered possible, as per the discussion presented in the report.	2	MINOR - Offsite impacts resulting from protection works have potential to cause harmful impact to an adjacent local ecosystem and require site specific interventions to assist in ecosystem recovery.	MODERATE
	1.09	Regional beach destination not realised due to separation of coastal node from beach	C	POSSIBLE - "Avoiding" development within the area affected by coastal hazards and provision of additional width in the foreshore reserve has been identified by the DoP as the preferred approach to management of hazards. It is possible that this preference will be enforced which would undermine the viability of the regional beach destination.	5	CATASTROPHIC - the regional beach is intended to provide services to "regional" population. If this facility is not realised it would have a major impact on a large population.	VERY HIGH
Provide and protect a thriving coastal community	2.01	Economic viability of proposed activity node is compromised due to large setbacks from current coastline	C	POSSIBLE - Likelihood as per 1.09	5	CATASTROPHIC - the regional beach is intended to provide services to "regional" population. Amenity of this facility is dependent on co-location with the proposed activity node. If the regional beach destination is not realised it would have a major impact on a large population.	VERY HIGH
	2.02	Increased winds and/or transport of sand onto the site caused by dune degradation or loss impacting on the amenity within the coastal community.	C	POSSIBLE - degradation of the dune environment is considered possible due to the significant uncertainty in local ecosystem responses to climate change.	2	MINOR - temporary impacts on small population. Permanent treatments required to maintain amenity. Site specific interventions required to assist in ecosystem recovery	MODERATE
Provide and protect quality tourism accommodation.	3.01	Increased winds and/or transport of sand onto the site caused by dune degradation or loss impacting on the amenity for tourism.	C	POSSIBLE - likelihood as per 2.02	2	MINOR - consequence as per 2.02	MODERATE
Maintain functions of the coastal dunes.	4.01	Inadequate space for coastline recession such that foredunes are no longer available to provide beach stability.	A	RARE - Likelihood as per 1.07	4	MAJOR - permanent treatments may be required to maintain services	MODERATE

Objective		Hazard	Likelihood		Consequence		Risk Rating
Maintain functions of the coastal dunes.	4.02	Inadequate space for coastline recession results in dunes no longer exist to protect inland areas from coastal forces.	A	RARE - The setback of roads and private properties is such that there is adequate space to accommodate the coastal processes scenario through to 2110. The coastal processes line includes allowances for acute erosion and uncertainty and is therefore expected to be sufficient for protection of inland areas through to the end of the planning timeframe.	5	CATASTROPHIC - Viability of land uses could be compromised. Permanent structures may be required to protect property and infrastructure.	MODERATE
	4.03	Unsustainable ecological response to SLR results in dunes no longer available to protect inland areas from coastal forces.	B	UNLIKELY - the ecological response to climate change and SLR is unknown. Notwithstanding, the coastal processes assessment considers a conservative scenario such that there is a large amount of space and time for adaptive capacity of the community to intervene.	3	MODERATE - Potentially harmful impact to local ecosystems at multiple sites. Site specific interventions and monitoring required to assist in ecosystem recovery.	MODERATE
	4.04	Changes to the natural landscape as a result of development cause accelerated degradation of dunes such that they are no longer effective to provide protection to inland areas from coastal forces.	B	UNLIKELY - works approvals and/or foreshore management plans will be required to allow modification of the landscape. Development of these plans will consider possible impacts on dune stability.	2	MINOR - Site specific interventions may be required to assist in ecosystem recovery	MODERATE
	4.05	Human activities undermining stability of foredunes such that they are no longer able to provide protection to inland areas	B	UNLIKELY - implementation of foreshore management plans and ongoing monitoring by future community is likely to address any issues as they arise.	2	MINOR - Site specific interventions may be required to assist in ecosystem recovery	MODERATE
Manage public safety and protect public infrastructure.	5.01	Loss of life or injury caused damage to natural assets (N1 or N2) caused by coastline recession.	A	RARE - There are established processes to prepare and implement foreshore management plans and design landscaping treatments which consider public safety.	5	CATASTROPHIC - possible loss of life or permanent injury.	MODERATE
	5.02	SC, CP & H assets affected by coastal erosion, damage resulting in injury to patrons	A	RARE - Assets will remain in public ownership and therefore subject to established asset management processes which allow early identification of future safety concerns.	5	CATASTROPHIC - possible loss of life or permanent injury.	MODERATE
	5.03	High value assets (H1, H2, H3, CP) could be inundated or damaged by erosion during storm event, causing need for repair or early replacement	C	POSSIBLE - Some high value assets will be located in the area west of the 100yr coastal processes line. Shoreline recession within this area is considered possible, as per the discussion presented in the report.	3	MAJOR - Permanent treatments are required to maintain services. Relocation of permanent infrastructure may be required.	HIGH
	5.04	Low value assets (L1, L2) inundated or damaged by erosion during storm event, causing need for repair or early replacement	D	POSSIBLE - Some low value assets will be located in the area west of the 100yr coastal processes line. Shoreline recession within this area is considered possible, as per the discussion presented in the report.	2	MODERATE - Temporary treatments and/or minor repairs may be required to maintain amenity and maintain services. Relocation of temporary infrastructure may be required.	MODERATE

5 MANAGEMENT AND ADAPTATION PLAN

Strategies have been developed to address the unacceptable risks identified Section 4. In selecting suitable management and adaptation options it has been necessary to consider a variety of constraints such as flow on effects from one hazard to another, capacity of the current and future communities to resource the action and whether the action can contribute further to the adaptive capacity of the system.

5.1 Categories of action

Adaptation options fall within one of five broad categories, which are generally consistent with the guidance provided in SPP 2.6.

The preferred action will generally be that which allows all objectives to be achieved at the lowest cost to the community. By example, if all objectives can be achieved by avoiding development in the affected area, then there is unlikely to be any future management or adaptation cost to the community.

Categories of action that were considered for the ACNLSP, in order of potential complexity and cost to the future community are as follows:

1. Maintain the Status Quo:

Maintaining the status quo refers to a continuation of the existing use and geomorphology in an area (i.e. no development effects within the "at risk area".

2. Avoid:

Avoid the presence of new development within the area impacted by the coastal hazard. Slightly different from above because whilst the "at risk area" may be avoided by development, there may be some effects of development that change the use and/or geomorphology of the area.

3. Retreat:

This option includes actions to remove the assets at risk from the area impacted by the coastal hazard over time. This option could be achieved through leasehold arrangements and asset management planning which accommodates relocation of infrastructure.

4. Accommodate:

Provide tolerance to periodic storm tide inundation or erosion events by means of innovative designs for buildings and infrastructure (e.g. elevating, strengthening or change in use). This entails undertaking actions that will reduce the impacts from coastal hazards to an acceptable level.

Actions to "accommodate" impacts can generally be broken into two categories:

- Physical works (e.g. reinforced structures and raised land levels); and
- Planning strategies, e.g:
    - Ongoing monitoring and review of hazards;
    - Targeted public education on hazards;

- A hazard note on property searches;
- Emergency planning, which recognises the changing risk profile;
- Infrastructure planning to reflect longer term intentions regarding services;
- Infrastructure in the area as the risk profile changes; and
- Rates reduction of properties in the area.

5. Defend:

Protect sectors of the coastal hazard area with either hard or assimilating coastal engineering structures to reduce or remove storm tide inundation or erosion risks. Defend strategies may include maintaining the existing use or intensifying development on the land.

Coastal defence may combine long-term strategies for defence and maintenance including regenerative and structural options such as beach nourishment, dune construction, dykes and storm tide barriers.

This option may also include provision for landowners to defend their own properties within specified parameters.

5.2 Evaluation of options

Proposed management and adaptation options to address each of the "VERY HIGH", "HIGH" and "MODERATE" rated hazards were considered on a case by case basis. A risk evaluation of the hazards with the preferred adaptation options in place as presented in Table 7. This assessment confirms that all hazards can be reduced to "MODERATE" or "LOW" risk rating using the proposed adaptation strategy.

Table 7: Evaluation of proposed adaptation strategy

Objective		Hazard	Initial Risk Rating			Proposed action / control	Likelihood		Consequence		Risk Rating
Provide and protect a quality regional beach destination	1.01	Natural assets (N1, N2) inundated of subject to erosion causing damage during storm event	D	1	MODERATE	ACCOMMODATE: Monitor impacts of inundation and undertake minor environmental works to assist in natural recovery if required.	D	No change	1	No change	MODERATE
	1.02	Provision of Surf Club not viable within the foreshore reserve due to coastal erosion	B	5	VERY HIGH	AVOID / RETREAT: allow sufficient space within the foreshore reserve to accommodate permanent infrastructure outside the 100yr processes line. Plan for managed retreat for any infrastructure which is required to be located closer to the shore and ensure that there is sufficient space to accommodate this infrastructure within the foreshore reserve at the end of the planning timeframe.	A	RARE - Measures will ensure that there is space to accommodate required infrastructure landward of the 100yr coastal processes line at end of the planning timeframe. Impacts landward of the 100yr coastal processes line is considered rare	5	No change	MODERATE
	1.03	Provision of Café (H1) assets not viable within the foreshore reserve due to coastal erosion	C	1	LOW	No action proposed	C	No change	1	No change	LOW
	1.04	Provision of public facilities (H2, CP) assets not viable within the foreshore reserve as a result of coastal erosion	B	5	VERY HIGH	AVOID / RETREAT: identify long term options for relocation of public facilities into parts of the foreshore reserve which are outside the 100yr processes line	A	RARE - Measures will ensure that there is space to accommodate required infrastructure landward of the 100yr coastal processes line at end of the planning timeframe. Impacts landward of the 100yr coastal processes line is considered rare	5	No change	MODERATE
	1.05	Provision of playgrounds and landscape structures (H3) assets not viable within the foreshore reserve as a result of coastal erosion	C	2	MODERATE	RETREAT: identify long term options for provision of local recreation facilities in POS associated with the development.	C	No change	1	INSIGNIFICANT - Measures insure that services to the local community will be maintained reducing the level of consequence	LOW
	1.06	Provision of landscaped areas (L1 and L2) assets not viable within the foreshore reserve as a result of coastal erosion	C	1	LOW	No action proposed	C	No change	1	No change	LOW
	1.07	Beach degradation due to inadequate space for coastline recession	A	5	MODERATE	No action proposed	A	No change	5	No change	MODERATE
Provide and protect a quality regional beach destination	1.08	Degradation of nearby coastline caused by protection of development	C	2	MODERATE	No action proposed	C	No change	2	No change	MODERATE

Objective		Hazard	Initial Risk Rating			Proposed action / control	Likelihood		Consequence		Risk Rating
	1.09	Regional beach destination not realised due to separation of coastal node from beach	C	5	VERY HIGH	AVOID / RETREAT: Position the development such that it provides maximum connectivity, promoting active use of areas which might be affected by future coastal processes to link the coastal node to the beach. Design landscaping to allow retreat of essential infrastructure in response to observed impacts and maintain ongoing connection.	A	RARE - connectivity with the shore can be maintained through activating the foreshore reserve.	5	No change	MODERATE
Provide and protect a thriving coastal community	2.01	Economic viability of proposed activity node is compromised due to large setbacks from current coastline	C	5	VERY HIGH	Action as per 1.09	A	RARE - connectivity with the shore can be maintained through activating the foreshore reserve. Maximum development potential and activity density realised through minimising setback.	5	No change	MODERATE
	2.02	Increased winds and/or transport of sand onto the site caused by dune degradation or loss impacting on the amenity within the coastal community.	C	2	MODERATE	PROTECT: undertake ongoing monitoring and environmental works to maintain stability of foredunes.	A	RARE - Ongoing program of monitoring and environmental works will limit likelihood of occurrence	2	No change	LOW
Provide and protect quality tourism accommodation.	3.01	Increased winds and/or transport of sand onto the site caused by dune degradation or loss impacting on the amenity for tourism.	C	2	MODERATE	PROTECT: undertake ongoing monitoring and environmental works as required to maintain stability of foredunes.	A	RARE - Ongoing program of monitoring and environmental works will limit likelihood of occurrence	2	No change	LOW
Maintain functions of the coastal dunes.	4.01	Inadequate space for coastline recession such that foredunes are no longer available to provide beach stability.	A	4	MODERATE	No action proposed	A	No change	4	No change	MODERATE
	4.02	Inadequate space for coastline recession results in dunes no longer exist to protect inland areas from coastal forces.	A	5	MODERATE	PROTECT: monitor long term coastal processes and identify the need to protection works to be undertaken as required.	A	No change	4	MAJOR - Permanent treatments may be required to protect property and infrastructure.	MODERATE
	4.03	Unsustainable ecological response to SLR results in dunes no longer available to protect inland areas from coastal forces.	B	3	MODERATE	PROTECT: undertake ongoing monitoring and environmental works as required to assist in ecological adaptation to climate change.	B	No change	3	No change	MODERATE

Objective		Hazard	Initial Risk Rating			Proposed action / control	Likelihood		Consequence		Risk Rating
Maintain functions of the coastal dunes.	4.04	Changes to the natural landscape as a result of development cause accelerated degradation of dunes such that they are no longer effective to provide protection to inland areas from coastal forces.	B	2	MODERATE	No action proposed	B	No change	2	No change	MODERATE
	4.05	Human activities undermining stability of foredunes such that they are no longer able to provide protection to inland areas	B	2	MODERATE	No action proposed	B	No change	2	No change	MODERATE
Manage public safety and protect public infrastructure.	5.01	Loss of life or injury caused damage to natural assets (N1 or N2) caused by coastline recession.	A	5	MODERATE	No action proposed	A	No change	5	No change	MODERATE
	5.02	SC, CP & H assets affected by coastal erosion, damage resulting in injury to patrons	A	5	MODERATE	No action proposed	A	No change	5	No change	MODERATE
	5.03	High value assets (H1, H2, H3, CP) could be inundated or damaged by erosion during storm event, causing need for repair or early replacement	C	3	HIGH	RETREAT: Manage retreat of infrastructure such that assets are not within the area of possible impact within their design life.	A	RARE: the likelihood of impacts landward of the coastal processes assessment at different planning horizons can be considered rare.	3	No change	MODERATE
	5.04	Low value assets (L1, L2) inundated or damaged by erosion during storm event, causing need for repair or early replacement	D	2	MODERATE	RETREAT: Manage retreat of infrastructure such that assets are not within the area of possible impact within their design life.	A	RARE: the likelihood of impacts landward of the coastal processes assessment at different planning horizons can be considered rare.	2	No change	LOW

5.3 Recommended Management and Adaptation Plan

The management and adaptation strategies outlined below are proposed to address the key risks identified. These strategies form the basis of the recommended management and adaptation plan and are explored further in the implementation section.

Strategy 1. ACCOMODATE damage to natural assets caused by storm events (hazard 1.01)

Acute damage to environmental assets is a natural occurrence which is generally accommodated by natural processes. In the context of a regional beach with a high level of public access there will be a need to manage expectations of the community and may be a need to implement environmental works to assist in ecosystem recovery. These aspects should be included in the foreshore management plan to be developed for the site and implemented by the responsible authorities.

Strategy 2. AVOID and RETREAT to ensure public facilities can be provided that are necessary to support the regional beach (hazards 1.02 & 1.04)

Key public assets have been identified (eg: Surf Club, change rooms, toilets and car parking) as being needed to enable the area to function as a regional beach. The strategy of "AVOID and RETREAT" provides flexibility to allow location of facilities in areas of future vulnerability while maintaining the option of avoiding risks over the longer term.

It was considered that a pure "AVOID" strategy was not appropriate because of potential impacts on risks 1.09 (Regional beach destination not realised due to separation of coastal node from beach) and 2.01(Economic viability of proposed activity node is compromised due to large setbacks from current coastline).

Planning for retreat will be a process of considering the location of assets in the context of expected design life; the worst case exposure assessment (coastal processes lines) at different planning horizons; and the ability of the asset to function in alternative locations.

Strategy 3. RETREAT local facilities provided in the foreshore reserve to other parts of the development (hazards 1.05)

The key function of landscaping assets is to provide for the recreational needs of the community and facilitate functional connection and amenity between the urban activity node and the regional beach. Provision of these specific assets is; however, not considered to be essential to achieving objectives of the plan in a future scenario where the shoreline has retreated. This is because many of the recreational needs of the community will also be provided for within the ACNLSP area, outside the area potentially impacted by coastal processes.

It is acknowledged that, incidental to this function, some of the facilities may come to be relied upon by the local community and the loss of those facilities may be unacceptable. In order to adequately address this hazard it is therefore necessary to plan for managed retreat of facilities that are highly valued by the local community to local POS.

Planning for retreat will be a process of considering the location of assets in the context of their value to the community and the expected design life; the worst case exposure assessment

(coastal processes lines) at different planning horizons; and the ability of the asset to function in alternative locations.

Strategy 4. AVOID and RETREAT such that landscaping assets provide the required connectivity between the urban activity node and the beach, and assets can be managed in a sustainable manner (hazards 1.09, 2.01, 5.03 & 5.04)

Connectivity between the urban activity node and the beach may be compromised by conservative planning assumptions that might prevent short to medium term development of landscaping assets within the foreshore area or through increased setbacks. In order to prevent this from occurring structure planning will need to properly acknowledge the importance of limiting setbacks from the coast and allow the provision of amenity (landscape assets) in the area which may be subject to coastal processes in the future.

Key aspects of this adaptation strategy are:

- Setback of permanent infrastructure (eg roads) and private property should be behind the landward extent of possible erosion at the 100yr planning horizon as identified by the coastal processes assessment.
- Landscaping will be installed within the area which could be affected over the short to medium term in order to provide the amenity and connectivity required to that enable the area to function as a regional beach.
- Planning for retreat of specific assets will be a process of considering the location of assets in the context of their value to the community, expected design life, the worst case exposure assessment (coastal processes lines) at different planning horizons and the ability of the asset to function in alternative locations.
- The acknowledgement that the majority of low value landscaping assets will not need to be provided in the longer term if climate change results in significant landward movement of the shoreline (as considered by the coastal processes assessment).

Strategy 5. PROTECT the stability of dunes as they respond to changes in coastal processes resulting from climate change (hazards 2.02, 3.01, 4.02 & 4.03)

There is significant uncertainty as to the physical and ecological response to changes in coastal processes that may occur as a result of projected climate change. Coastal dunes provide important ecosystem services, including protecting inland areas from coastal forces.

A program of ongoing monitoring and environmental works will assist natural processes in adapting ecosystems to changed conditions and reduce the likelihood of dune destabilisation. Design and implementation of the program will need to ensure it focuses on the aim of maintaining relevant ecosystem services provided to the coastal community.

6 IMPLEMENTATION, MONITORING AND REVIEW

6.1 Proposed actions

Implementation of the management and adaptation strategies outlined previously requires a number of actions to be undertaken now and in the future. These actions may be broadly categorised as:

- Planning actions
- Physical works
- Asset management
- Communication

Table 8 identifies each proposed action and outlines the resource requirements, responsibilities and timing for their delivery and any associated performance measures and reporting requirements. Each of the actions is further discussed below.

6.1.1 Planning actions

The ACNLSP needs to establish a foreshore reserve which will ensure that the area can continue to provide the values, functions and uses required if coastal hazards are realised over the planning timeframe. To provide a site specific response to this objective, planning outcomes will need to consider the functions of the reserve as outlined in Section 2.5 and any specific land areas that are required to facilitate the proposed adaptation responses derived from the risk assessment. Key aspects of the foreshore reserve as proposed by the ACNLSP are illustrated in Figure 4.

A foreshore management plan is required to formally establish and identify the future management requirements of the full extent of the required foreshore reserve. The foreshore reserve should provide the assets and functions necessary to deliver the objectives appropriate to a regional beach destination at the end of the 100yr planning timeframe. Assets identified in the plan as requiring close proximity to the beach should be designed with a lifespan such that they are not expected to outlive the viability of their location.

Setback of permanent infrastructure (eg: roads) and private property should be behind the landward extent of possible erosion at the 100yr planning horizon as identified by the coastal processes assessment.

Setback of temporary infrastructure (eg: landscape assets) should be behind the landward extent of possible erosion at the planning horizon appropriate to the design life of the asset as identified by the coastal processes assessment.

Alternative locations for temporary infrastructure should be identified within the foreshore reserve or at alternative locations if they are not essential to the function of the foreshore.

6.1.2 Physical works

Relocation of temporary infrastructure (eg: landscape assets) to alternative locations when required. The assessment of the need for relocation of assets should be based on the extent of coastal process risks observed and predicted for the future, as well as the design life of the asset (refer to Table 1) and a review of its value to the community.

6.1.3 *Asset management, monitoring and review*

Asset management includes monitoring of asset condition to ensure that required maintenance and replacements are carried out before their condition degrades to a point that may lead to an accident or incident. Asset management within the coastal foreshore reserve should be consistent with the recommendations of the foreshore management plan.

Natural assets (beach and dunes) should be regularly (annually and following significant events) monitored for damage, including quality and extent of vegetation, expansion of blowouts, stability of dunes and general accessibility. Where acute damage occurs there may be a need for stabilisation and/or revegetation works to be undertaken.

Built assets should be regularly monitored for safety as a normal part of asset management processes.

In the same way that staged reviews are usually required for asset management plans, a review of the coastal processes assessment and foreshore management plan will be required periodically to refine relocation requirements for temporary assets and to update asset management actions. The first of these staged reviews should be undertaken in approximately 10 years' time. An interim review should be undertaken in response to any severe erosion and/or inundation event prior to that date.

6.1.4 *Communication*

Periodic stabilisation and/or revegetation works and relocation of landscape assets should be communicated to the public principally through the use of interpretive and public safety signage.

Where significant assets (eg. playgrounds) require relocation it is advisable to provide interpretive and public safety signage well in advance of the works introducing the effects of coastal physical processes ("our changing coasts") and clearly identifying the new proposed location.

Community engagement will be necessary during review of the coastal processes assessment and/or foreshore management plan to refine relocation requirements for temporary assets and to update asset management actions.

6.2 Resource requirements and timing

In addition to the normal resource requirements for ongoing future management of foreshore reserves and regional beach destinations there will be a need to plan for future review and update of both the Coastal Processes Assessment and Foreshore Management Plan. The indicative budget for these tasks would not be expected to exceed $100,000 at today's costs.

The first staged review of the Coastal Processes Assessment and Foreshore Management Plan is proposed for 2024 (10 years).

An additional budget should be provided for community engagement during review of coastal processes assessment to refine relocation requirements for temporary assets and to update asset management actions. The indicative budget for these tasks would not be expected to exceed $50,000 at today's costs.

There may also be a need to provide interpretive and public safety signage and/or undertake community consultation activities when beach or dune stabilisation occurs or when assets are scheduled for replacement and relocation. The typical cost for interpretive or public safety signs could range from $750 for standard designs to around $3,000 or more for a complex or bespoke design.

There are several sources of potential funding to assist local governments with coastal management plans and projects. Currently the WAPC administers two grant funds which are specifically targeted at coastal works; the Coastal Management Plan Assistance Program and Coastwest Grants. Other opportunities for consideration may also include State Natural Resource Management Program grants or Caring for our Country grants.

The **Coastal Management Plan Assistance Program** assists rural and regional coastal land managers to develop coastal strategies and management plans for coastal areas that are, or predicted to become, under pressure from a variety of land uses and users.

Up to $50,000 is available per project and the Coastal Management Plan Assistance Program will fund:

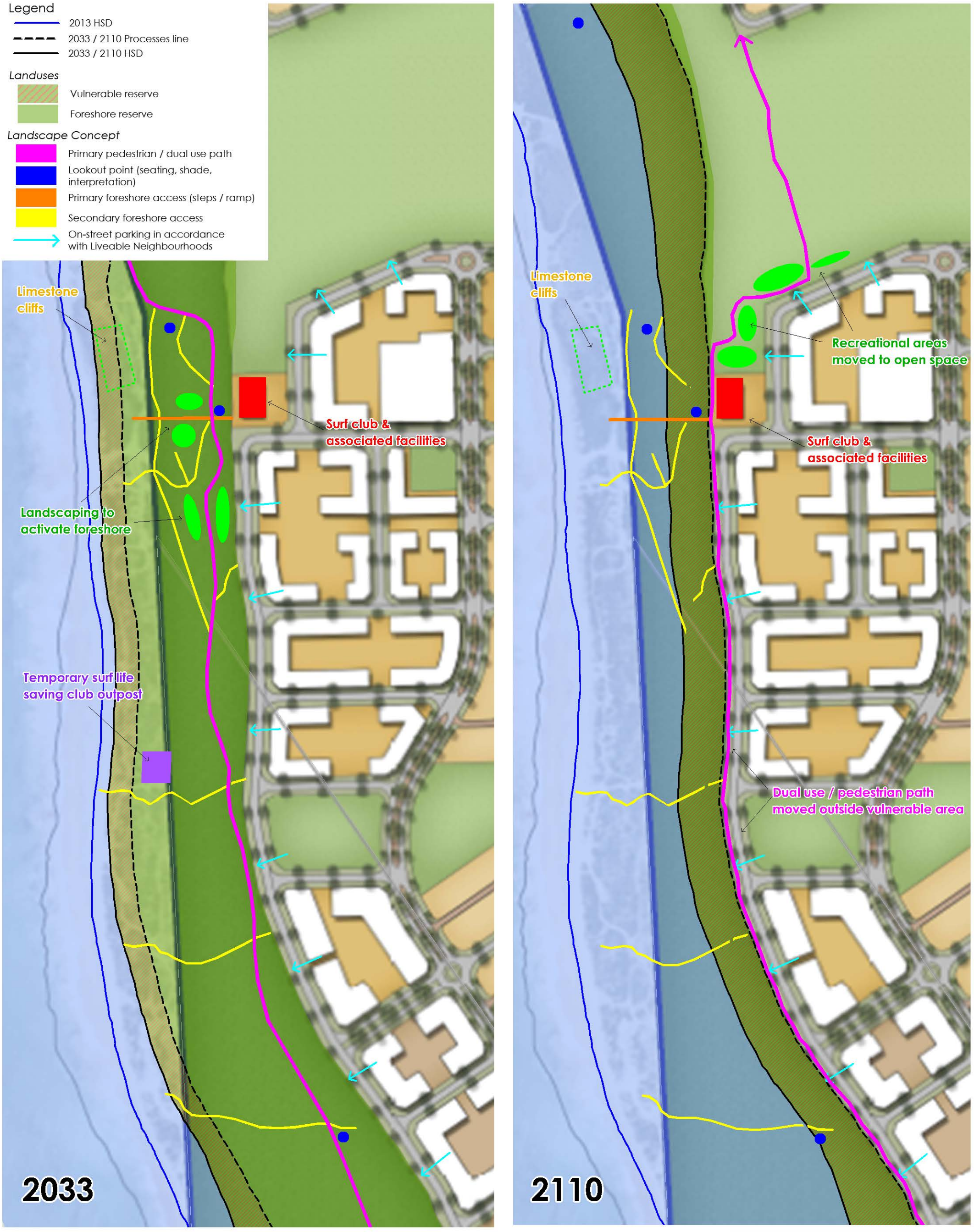
- Development of a coastal strategy.
- Development of a coastal management plan.
- Development of a coastal hazard risk management and adaptation plan.

Coastwest Grants are provided by the Western Australian Planning Commission to support projects designed as a response to these challenges, which improve the condition and amenity of these coastal environments.

Grants are provided to partnerships of community groups and coastal managers to undertake on-ground coastal and marine rehabilitation, restoration and preventative conservation projects. The grants also look to build the skills and capacity of Western Australian communities and to encourage and maintain their involvement in coastal planning and management.

Applications for grants of up to $150 000 will be considered although applications for lesser amounts, particularly between $20 000 and $50 000, are encouraged.

LandCorp, Alkimos Coastal Node CHRMAP
Figure 4: Landuse planning response



Data source: Landgate, MP Rogers, AECOM,
Created by: H Lamparski. Projection: MGA50: zone 50.

Scale 1: 3000 at A3
0 60m 120m

essential environmental

Table 8: Implementation plan

Proposed actions	Resource requirements	Responsibility	Timing	Performance measures	Reporting
Planning actions					
A foreshore management plan is required to formally establish and identify the future management requirements of the full extent of the required foreshore reserve. The foreshore reserve should provide the assets and functions necessary to deliver the objectives appropriate to a regional beach destination at the end of the 100yr planning timeframe. Assets identified in the plan as requiring close proximity to the beach should be designed with a lifespan such that they are not expected to outlive the viability of their location.	None in addition to normal foreshore management plan development costs	LandCorp	To support the ACNLSP	Approval by City of Wanneroo and WAPC	Foreshore Management Plan
Setback of permanent infrastructure (eg: roads) and private property should be behind the landward extent of possible erosion at the 100yr planning horizon as identified by the coastal processes assessment.	None in addition to normal foreshore management plan development costs	LandCorp	To support the ACNLSP	Approval by City of Wanneroo and WAPC	Foreshore Management Plan
Setback of temporary infrastructure (eg: landscape assets) should be behind the landward extent of possible erosion at the planning horizon appropriate to the design life of the asset as identified by the coastal processes assessment.	None in addition to normal foreshore management plan development costs	LandCorp	To support the ACNLSP	Approval by City of Wanneroo and WAPC	Foreshore Management Plan
Alternative locations for temporary infrastructure should be identified within the foreshore reserve or at alternative locations if they are not essential to the function of the foreshore.	None in addition to normal foreshore management plan development costs	LandCorp	To support the ACNLSP	Approval by City of Wanneroo and WAPC	Foreshore Management Plan

Proposed actions	Resource requirements	Responsibility	Timing	Performance measures	Reporting
Physical works					
Relocation of temporary infrastructure (eg: landscape assets) to alternative locations when required.	None in addition to normal asset replacement requirements t.	City of Wanneroo	As identified in the foreshore management plan	Appropriate asset replacement undertaken on time and within budget	City of Wanneroo Annual Report
Asset management					
Natural assets (beach and dunes) should be regularly (annually and following significant events) monitored for damage, including quality and extent of vegetation, expansion of blowouts, stability of dunes and general accessibility. Where acute damage occurs there may be a need for stabilisation and/or revegetation works to be undertaken.	None in addition to normal manpower and budget provision for maintenance of regional beach and associated dunes.	City of Wanneroo	From handover of assets	Monitoring and management record complete No public safety incidents	Record annual and significant event monitoring inspections and report maintenance requirements in City of Wanneroo Annual Report
Built assets should be regularly monitored for safety as a normal part of asset management processes.	None in addition to normal manpower and budget provision for maintenance of public assets.	City of Wanneroo	From handover of assets	Monitoring and management record complete No public safety incidents	Record monitoring inspections and report maintenance requirements in City of Wanneroo Annual Report
Review of coastal processes assessment and foreshore management plan to refine relocation requirements for temporary assets and to update asset management actions	Suggested budget $100,000 (2014 rates) to undertake review and update of Coastal Processes Assessment and Foreshore Management Plan	City of Wanneroo	First review and update recommended in 2024 (10 years)	Completion of review and update of Coastal Processes Assessment and Foreshore Management Plan	Publish Coastal Processes Assessment update and Foreshore Management Plan update

Proposed actions	Resource requirements	Responsibility	Timing	Performance measures	Reporting
Communication					
Periodic stabilisation and/or revegetation works and relocation of landscape assets should be communicated to the public principally through the use of interpretive and public safety signage.	$750-$2,500 per sign	City of Wanneroo	As required	Appropriate signage provided No public safety incidents	City of Wanneroo Annual Report
Where significant assets (eg. playgrounds) require relocation it is advisable to provide interpretive and public safety signage well in advance of the works introducing the effects of coastal physical processes ("our changing coasts") and clearly identifying the new proposed location.	$750-$3,000 per sign	City of Wanneroo	As required	Appropriate signage provided No public safety incidents No significant public relations issues	Coastal Processes Assessment update and Foreshore Management Plan update
Community engagement will be necessary during review of coastal processes assessment to refine relocation requirements for temporary assets and to update asset management actions.	Suggested budget $50,000 (2014 rates) to undertake community engagement	City of Wanneroo	First review and update recommended in 2024 (10 years)	Completion of review and update of Coastal Processes Assessment and Foreshore Management Plan with community support	Publish Coastal Processes Assessment update and Foreshore Management Plan update

7 REFERENCES

Standards Australia (2009), *Australian Standard for Risk Management* (AS/NZS ISO 31000:2009)

Rollason et. al. 2010. *Applying the ISO 31000 Risk Assessment Framework to Coastal Zone Management.* 19th NSW Coastal Conference. Available online: http://www.coastalconference.com/2010/default.asp

City of Wanneroo, 2010. *Alkimos Eglinton District Structure Plan*

City of Wanneroo, 2010. *Pathways Asset Management Plan*

City of Wanneroo, 2010. *Roads Asset Management Plan*

City of Wanneroo, 2013. *Risk Management Policy* (CS04-10/13 – 15 October 2013)

LandCorp, 2014 (draft, Unpub.) *Alkimos Coastal Node Local Structure Plan*

MP Rodgers, 2013. *Alkimos Coastal Processes Assessment*

Western Australian Planning Commission (WAPC), 2006. State Planning Policy 3.4: Natural Hazards and Disasters, www.planning.wa.gov.au

Western Australia Planning Commission (WAPC), 2013. *State Planning Policy 2.6*: State Coastal Planning Policy. www.planning.wa.gov.au

Western Australia Planning Commission (WAPC), 2013b. *State Planning Policy 2.6* Guidelines. www.planning.wa.gov.au

Western Australian Planning Commission (WAPC) 2013c. (Draft – unpub.), *Coastal Hazard Risk Management & Adaptation Planning Guidelines*, www.planning.wa.gov.au

Environment Protection Authority (EPA), 2005. Alkimos – *Eglinton Metropolitan Region Scheme Amendment No. 1029/33* (EPA Bulletin 1207, EPA, 2005)

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