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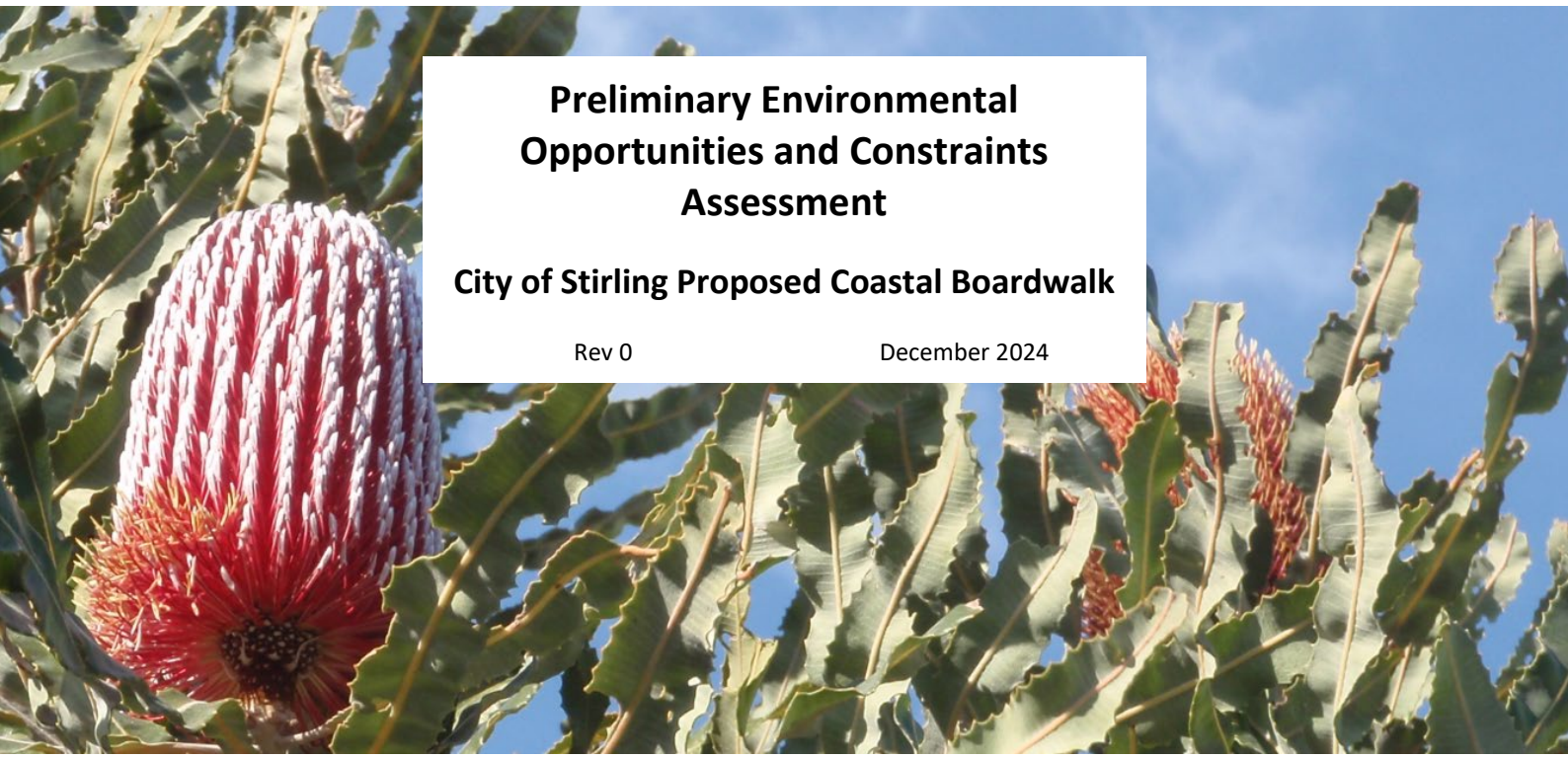

Preliminary Environmental Opportunities and Constraints Assessment

City of Stirling Proposed Coastal Boardwalk

Rev 0 December 2024

CALIBRE | COMMITMENT | COLLABORATION

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Executive Summary

The City of Stirling is investigating the potential to construct a coastal boardwalk linking Trigg Beach in the north, to Scarborough Beach in the south. Both Trigg Beach and Scarborough Beach are recognised as iconic locations by local Western Australians and tourists alike, and the proposed boardwalk would serve both functionally to improve safety as well as providing an important asset, by increasing social amenity, recreation value, tourism assets and community resources.

This report has been prepared in consultation with the City of Striling, to inform preliminary environmental values of the site. This report is proposed to be utilised to identify the potential environmental impacts, and preliminary environmental opportunities and constraints of the proposed coastal boardwalk. A gap analysis has also been completed identifying further studies and technical reports recommended to be undertaken to inform the future alignment of the boardwalk.

There are many considerations to balance when locating and designing such an asset. Some of the key recommendations for this proposal outlined within this report are:

- Ensure that the location and design of the boardwalk minimises potential impacts to coastal processes and landform stability, taking into account predicted coastal hazards such as coastal erosion and climate change.
- To minimise risk to the proposed coastal boardwalk from coastal erosion, the proposed boardwalk should in the most part be situated to the east of the 2070 coastal erosion hazard extent detailed in the City's CHRMAP.
- Protect, enhance and minimise impact to coastal zone values, particularly regarding landscape, biodiversity and ecosystem integrity.
- Ensure design does not substantially alter existing natural drainage patterns.
- Disturbance of existing vegetation during construction should be minimised to the smallest footprint practicable. The loss of vegetation and flora within the site is a significant constraint to the proposed development and minimising the impact to this vegetation should be one of the highest priorities considered in the boardwalk design and construction techniques.
- If disturbance to vegetation is unavoidable, the area should be rehabilitated after disturbance with native species of local origin to stabilise landforms in and around the infrastructure.
- Places of unique landscape and scientific significance should be avoided during the design process including the *Callitris preissii* (or *Melaleuca lanceolata*) Forests and Woodlands of the Swan Coastal Plain Threatened Ecological Community, which is listed as Critically Endangered under the State *Biodiversity Conservation Act 2016*. This should be protected with a suitable buffer applied.
- Development should be designed, and construction managed to minimise invasion by introduced species, disease and pests.
- Development should be designed to not occur on or adjacent to unstable or mobile dune landforms susceptible to erosion.
- Natural sediment processes, including lithification and wind or water transport should not be significantly or permanently altered by the development.
- Public access should be controlled either side of the accessway through fencing or balustrading. This type of access may be susceptible to erosion or require frequent or costly maintenance to ensure safety.
- The proposed boardwalk should be sustainably designed to minimise erosion, wind tunnelling and maintenance.

- Visual amenity is a significant factor requiring careful consideration during the design of the boardwalk.
- Siting and design of the infrastructure to minimise fire risk, and assist in quick response times when fires occur.
- Pedestrian access paths should be justified in terms of a coastal public access purpose and potential impacts described and managed through preparation of a Construction Environmental Management Plan and ongoing maintenance and management outlined within a Foreshore Management Plan.

1 Introduction

1.1 Background

The City of Stirling is investigating the potential to construct a coastal boardwalk linking Trigg Beach in the north, to Scarborough Beach in the south. Current access between these beaches partially lies immediately adjacent to West Coast Highway, and safety concerns have been raised by community members due to the shared pathway between cyclists and pedestrians being located next to a busy highway.

Both Trigg Beach and Scarborough Beach are recognised as iconic locations by local Western Australians and tourists alike, and the proposed boardwalk would serve both functionally to improve safety as well as providing an important local asset, by increasing social amenity, recreation value, tourism assets and community resources.

The proposed project footprint spans from the southernmost end of the Trigg Beach carpark, connecting to the northernmost end of the Scarborough Beach carpark, bound by the foredune to the west and West Coast Highway to the east (the site; Figure 1). Alignment of the proposed boardwalk will be developed in consultation with various stakeholders, including community members, and through this consultation, in combination with environmental investigations, engineering and construction factors and feasibility of landscaping works the project is expected to achieve a sustainable outcome.

1.2 Rationale for Boardwalk

There has been recent concern raised by the local community that utilise the pathway linking the two beaches regarding the existing shared pathway and safety.

The existing shared path adjacent to West Coast Highway is 3 metres (m) wide, however it is recognised that the desired width for a shared path is a minimum of 4 m (DoT, 2021). The 2011 Council Resolution document (dated 8 March 2011) notes that the Perth Bicycle Network and Draft WA Bike Network Plan both feature a coastal cycling route from Fremantle to Yanchep, showcasing a significant recreational shared pathway. The City's 'Long Term Cycle Network' (LTCN) plan (endorsed by both Council and DoT) recognises the coastal route as a 'Primary Route' with a high use by cyclists. Alongside West Coast Drive (50 km/hr soon lowering to 40 km/hr) fast cyclists can use the adjacent road, however, as West Coast Highway is 60/80 km/hr, cyclists cannot use the adjacent road in this location, which makes this path highly conflicted and hostile to pedestrians. For that reason, to function as part of the "coastal cycling route from Fremantle to Yanchep", pedestrians should be redirected (via the boardwalk) and that section of path adjacent to the highway can then be reclassified a 'Bike Path'.

Additionally, the boardwalk would provide a unique opportunity to showcase the visual amenity of the area, whilst also providing environmental protection to restrict informal access, and associated damage, to the current dune systems.

1.3 Objective and Scope of this Report

This report has been prepared in consultation with the City of Stirling, to inform preliminary environmental values of the site. This report is proposed to be utilised to identify the potential environmental impacts, and preliminary environmental opportunities and constraint considerations of the proposed coastal boardwalk. A gap analysis has also been completed identifying further studies and technical reports recommended to be undertaken to inform the future alignment of the boardwalk and to obtain more detail for this opportunities and constraints report prior to it being made publicly available.

2 Key Legislation and Guidance Documents

2.1 Environmental Protection Act 1986

The *Environmental Protection Act 1986* (EP Act) is the pre-eminent environmental legislation in Western Australia. All development and infrastructure projects are regulated under Part IV of the Act and can be referred and assessed by the Environmental Protection Authority (EPA) under Section 38 of the Act if there is a potential for the proposal to have a significant environmental impact.

The EPA considers the key 'Land' based factors of flora and vegetation, landforms, terrestrial environmental quality and terrestrial fauna in its assessment of significant projects. The EPA's key objectives for these environmental factors are as follows:

- Flora and Vegetation - to protect flora and vegetation so that biological diversity and ecological integrity are maintained.
- Landforms - to maintain the variety and integrity of significant physical landforms so that environmental values are protected.
- Terrestrial Environmental Quality - to maintain the quality of land and soils so that environmental values are protected.
- Terrestrial Fauna - to protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

The Act also has produced Environmental Factor Guidelines, Environmental Protection Policies and regulations which provide guidance on environmental management to minimise impacts.

2.2 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection Biodiversity and Conservation Act* 1999 (EPBC Act) is Australia's primary national environmental legislation, aiming to protect and manage internationally important plants, animals, habitats and places. The EPBC Act aims to protect Australia's environment by:

- conserve our biodiversity - the variety of all life forms in Australia
- protect and manage our important natural and cultural places
- assess the environmental impact of projects, and decide whether to approve them
- control how plants and animals, including specimens and products, move in and out of Australia
- promote ecologically sustainable development through careful use of our natural resources
- appreciate the role of Indigenous peoples in protecting and sustainably using the environment
- promote using Indigenous peoples' knowledge, with their permission and cooperation

The EPBC Act protects plants, animals, habitats and places, listed as 'Matters of National Environmental Significance' (MNES) under the below nine MNES categories:

- World Heritage areas
- Commonwealth Heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Listed threatened species and listed ecological communities
- Listed migratory species (protected under international agreements)

- Commonwealth marine areas
- Great Barrier Reef Marine Park
- Nuclear actions (including uranium mines)
- Water resources (relating to coal seam gas development and large coal mining development).

2.3 State Planning Policy 2.6 - State Coastal Planning Policy

The key policy governing coastal planning in WA is the State Planning Policy No. 2.6: State Coastal Planning Policy (SPP 2.6) (Western Australian Planning Commission (WAPC), 2013). SPP 2.6 recognises there are pressures on the coastal zone for land use and development for a variety of purposes, requiring a balanced approach to these often competing needs. SPP 2.6 provides guidance for land use and development decision-making within the coastal zone including managing development and land use change whilst protecting, conserving and enhancing coastal values.

The objectives of this policy are to (WAPC, 2022):

- Ensure that the location of coastal facilities takes into account coastal processes, landform stability, coastal hazards, climate change and biophysical criteria
- Ensure the identification of appropriate areas for the sustainable use of the coast for housing, tourism, recreation, ocean access, maritime industry, commercial and other activities
- Provide for public coastal foreshore reserves and access to them on the coast
- Protect, conserve and enhance coastal zone values, particularly in areas of landscape, biodiversity and ecosystem integrity, indigenous and cultural significance.

The policy provides a framework to undertake risk management process in relation to coastal erosion and inundation. Within the SPP 2.6 Guidelines, published 30 July 2013, Section 4 provides a brief introduction to coastal hazard risk management and adaptation planning (CHRMAP). These were later supplemented by the Coastal Hazard Risk Management and Adaptation Planning Guidelines in July 2019 (WAPC, 2019).

The process outlined in SPP 2.6 follows a standardised approach adapted from the risk management and vulnerability assessment processes identified in *Australian Standard: Risk management - Guidelines* (2018), *Australian Standard: Climate change adaptation for settlement and infrastructure - A risk based approach* (2013), *Climate Change Impacts and Risk Management: A Guide for Business and Government* (2007), *Australian Standard Environmental risk management - Principles and Processes* (2006), and *Climate Change Risk and Vulnerability: Promoting an efficient adaptation response in Australia*, *Report to the Australian Greenhouse Office* (2005).

2.4 Coastal Hazard Risk Management and Adaptation Planning Guidelines

The Coastal Hazard Risk Management and Adaptation Planning Guidelines are designed to assist statutory decision-makers, landholders and those conducting investigations on their behalf to (WAPC, 2019):

1. Consider the risks arising from coastal hazards through evaluating their consequence and likelihood, and the vulnerability of specific assets
2. Identify risk management responses to those risks arising from coastal hazards
3. Prioritise and implement the risk management responses
4. Explain the process for undertaking CHRMAP and determining appropriate content for CHRMAP.

A CHRMAP is an integral part of decision-making, as it provides a method for testing risk (uncertainty) arising from coastal hazards and timeframes, and the treatment of this risk (WAPC, 2019). Given that there is a direct

relationship between risk and opportunity in all decision making (trade-offs), decision-makers need to identify, measure and manage the risk arising from coastal hazards, to ensure they capitalise appropriately on those opportunities and achieve their goals and objectives (WAPC, 2019).

2.5 State Coastal Planning Policy Guidelines

The State Coastal Planning Policy Guidelines assist with the interpretation and practical application of SPP 2.6 and provide information for decision-making authorities, planners, landowners, proponents, and referral agencies to achieve the SPP 2.6 objectives and implement the SPP 2.6 measures (WAPC, 2020).

These guidelines provide detail on how land use and development is to be addressed when planning, designing and assessing a proposal in the coastal zone by (WAPC, 2020):

- Determining appropriate land use and development in the coastal zone across the State of Western Australia
- Specifying the requirements to be met in the application of the SPP 2.6 measures including:
  - Provision of an adequate coastal foreshore reserve and access to it
  - Application of the precautionary principle and ensuring that necessary coastal planning measures are incorporated into decision-making.

When considering development along the coast, the policy identifies the following relevant elements for consideration (WAPC, 2020):

- Coastal planning should result in sustainable development which recognises the need to balance competing economic, social and environmental demands
- Development should not result in discharges such as sewerage, fertilisers or toxic chemicals into the coastal environment
- Development should not result in changes to nearshore water circulation patterns. Such changes may have an adverse impact on the biodiversity or public use of foreshore areas
- Development should not substantially alter existing natural drainage patterns, nutrient and organic matter cycling processes, near shore sediment transport patterns or water quality
- Disturbance of existing vegetation during construction should be minimised. However, if unavoidable, the area should be rehabilitated after disturbance with native species of local origin to stabilise land in and around developments
- Coastal vegetation corridors should be retained, not fragmented, and where possible, enlarged (widened and lengthened), and rehabilitated if necessary
- Places of unique landscape, scientific and cultural significance should be conserved and managed including geomorphological, ecological, anthropological and historical sites
- Coastal areas that provide nesting and feeding sites for marine reptiles, mammals, resident and migratory shorebirds, and sea birds should be protected from impacts of development
- Development should be designed to prevent invasion of native habitats by introduced species/pests and disturbance of any endangered, threatened or priority listed species and communities present in the area should be avoided and assessed based on the applicable legislation
- Development should not occur on or adjacent to unstable or mobile dunes
- Natural sediment processes, including lithification and wind or water transport should not be significantly or permanently altered by development

- Topsoil should be stockpiled (for as short a time as possible) and respread on bare areas. While being stockpiled topsoil should be reasonably protected from moisture to preserve the viability of the seed bank
- Subdivision and development may be restricted during certain times of the year when high wind rates may impact upon the amenity of surrounding land uses, particularly residential uses.

In relation to public access specifically, the policy advocates that public use and enjoyment of the coast should be facilitated and promoted through the following approaches (WAPC, 2020):

- Include consideration of attributes that attract people to the coast such as safe swimming beaches, surfing spots, and interesting landscape or seascape features
- Ensure connectivity with adjacent uses such as public open space, public transport access, cafes, shops, entertainment, established car parking facilities, higher density development etc
- Provide obvious and logical public access to the coast especially in the design of new subdivisions and developments to encourage the local community to walk and cycle, rather than drive to the beach
- Provide a level of public access consistent with appropriate use of the coastal location (e.g. a remote coastal foreshore will not require the same level of access as an urban area)
- Include consideration of safety to users. Where a known danger exists, either natural (e.g. undermined cliff, slippery rock platform or strong ocean rip) or man-made (port facilities, industry including inlets or outfalls), consideration should be given to discouraging or managing access to the coast to promote safety of coastal users (i.e. safety to lives). For example, major access to a location adjacent to a known dangerous rip may encourage people to swim there. Where such access is supported, additional management will be required to address safety
- Minimise public access (in particular off-road vehicles) over eroding or steep dunes, rocky areas or other difficult terrain. This type of access may be susceptible to erosion or require frequent or costly maintenance to preserve safety
- Ensure protection of significant conservation or heritage areas through controlled access, by utilising existing access tracks or cleared areas to avoid clearing existing vegetation.

For coastal pedestrian accessways the policy provisions state (WAPC, 2020):

- Fenced pedestrian access paths should provide access to and between coastal car parks, roads, adjacent residential or other developments; and the coast. In urban areas, pedestrian access paths should be spaced approximately 150 metres apart, unless public access needs or local topography demonstrates a need for greater or lesser pedestrian access
- Pedestrian access paths should be located to enable the community to safely access coastal areas such as safe swimming beaches and direct people away from environmentally sensitive or unsafe areas
- Pedestrian access paths should be sustainably designed to minimise erosion, wind tunnelling and maintenance
- Pedestrian access paths should be justified in terms of a coastal public access purpose (usually through a foreshore management plan). Their design should incorporate maximum retention of natural topography and vegetation; access to sheltered or popular locations; respect historical patterns of access such as existing tracks (if sustainable); be located on stable landforms; and if possible, be located to encourage regeneration and/or rehabilitation of degraded areas
- Pedestrian access paths should be constructed in a manner that encourages visitors for attraction reasons such as taking in areas of cultural, indigenous and natural splendour. In these instances, path

design should include public furniture and interpretation/signage. Pedestrian access should provide for a range of coastal access options including universal access (e.g. wheelchair, pram or visually impaired access) at strategic locations (e.g. coastal nodes).

The policy requires that all development applications likely to be impacted by coastal hazards during the 100-year planning timeframe should be accompanied by a CHRMAP. The CHRMAP is to be in accordance with the CHRMAP Guidelines, indicating the risk management measures to be implemented to reduce coastal hazard risk to tolerable levels for the development. If a CHRMAP already exists and cover the development site (for example one completed and adopted by a local government), the existing CHRMAP should be included with detail of how the development is consistent with it (WAPC, 2020).

2.6 Coastal Planning and Management Manual

The *Coastal Planning and Management Manual – A Community Guide for Protecting and Conserving the Western Australian Coast* was published by the WAPC in 2003 and provides a useful reference and practical guide to coastal planning and management within Western Australia. The manual provides an overview of important considerations for planning and management projects seeking to protect and conserve the coast. Information has been included on planning for management; common coastal management problems; techniques for stabilisation and rehabilitation of coastal landscapes; coastal plants and revegetation; and coastal weeds and weed management (WAPC, 2003).

2.7 City of Stirling Coastal Hazard Risk Management and Adaptation Plan

The City of Stirling recently completed a CHRMAP to provide strategic guidance for coordinated, integrated and sustainable land use planning and management along its coastline. The CHRMAP will inform the City's future decision-making with respect to areas and assets identified as being at risk from coastal hazards (Cardno, 2023a).

The City's CHRMAP has been developed in a staged approach, with the various stages documented in separate chapter reports. The chapter reports prepared as part of the City's CHRMAP include:

- Chapter 1 – Establish the Context (Stage 1)
- Chapter 2 – Risk Identification (Stage 2); (Cardno, 2023a)
- Chapter 3 – Vulnerability Analysis and Risk Evaluation (Stages 3 and 4) (Cardno, 2023b);
- Chapter 4 – Risk Treatment (Stage 5) (Cardno, 2023c); and
- Chapter 5 – Implementation (Stage 6)

Relevant aspects of the CHRMAP are discussed where relevant throughout this document, as well as in Section 3.4.4.

2.8 City of Stirling Policies and Guidance

2.8.1 Beach Recreational Activity Policy

The objective of this policy is to minimise the risks associated with the interaction between the various ocean and beach recreational activities on those reserves along the City's coastline that the City has accepted the management, care and control over (CoS, 2020a).

This policy provides guidance on beach and coastal zone, including identification of specific exclusion zones for certain activities or identification of designated zones where activities can occur. There are no specific requirements identified in this policy relevant to the proposed coastal boardwalk area.

2.8.2 Community and Stakeholder Engagement Policy

The objectives of this policy are to (CoS, 2021):

- Provide a clear statement of Council's commitment to best-practice community and stakeholder engagement as it applies to informing decision-making
- Define the guiding principles that will ensure appropriate, effective and inclusive community and stakeholder engagement is achieved consistently across the City
- Outline the required mechanisms to be established and continually reviewed to ensure best-practice engagement practices are integrated into strategic and operational planning

The policy notes that the City will take a planned and purposeful approach when engaging with stakeholders and the community. Methods will be appropriate to the purpose, level of engagement, resources available and stakeholders impacted (CoS, 2021).

2.8.3 Weed and Pest Management Policy

The objective of this policy is to ensure that the City meets its environmental, legal and community obligations for weed and pest management on land owned and or managed by the City, in a manner that is environmentally, socially and economically acceptable to Council (CoS, 2020b).

The policy notes that the City will, amongst other items (CoS, 2020b):

- Seek to reduce the use of chemical based herbicides and pesticides to control weeds and pests and replace with environmentally sustainable alternatives, where practicable and within financial resources
- Apply best practice methods as well as clear and accountable management systems for weed control and pesticide application to minimise environmental and human impacts
- Apply a risk assessment approach to weed and pest control in the provision of essential infrastructure and recreation and environmental reserves and spaces.

3 Existing Environment

3.1 Climate

The City of Stirling experiences a Mediterranean climate with warm, dry summers and cooler, wet winters. The closest Bureau of Meteorology (BoM) weather station to the site is the Swanbourne station (No. 009215), located approximately 6 km south of the site (BoM, 2024).

3.1.1 Rainfall and Temperature

Swanbourne experiences an average rainfall of 727.6 mm annually, with the lowest mean rainfall experienced in February (average 12.1 mm) and highest mean rainfall in July (average 151.1 mm). The mean maximum temperature is experienced in February (30.5°C) and mean minimum temperature is in July (10°C) (Plate 3-1; BoM, 2024).

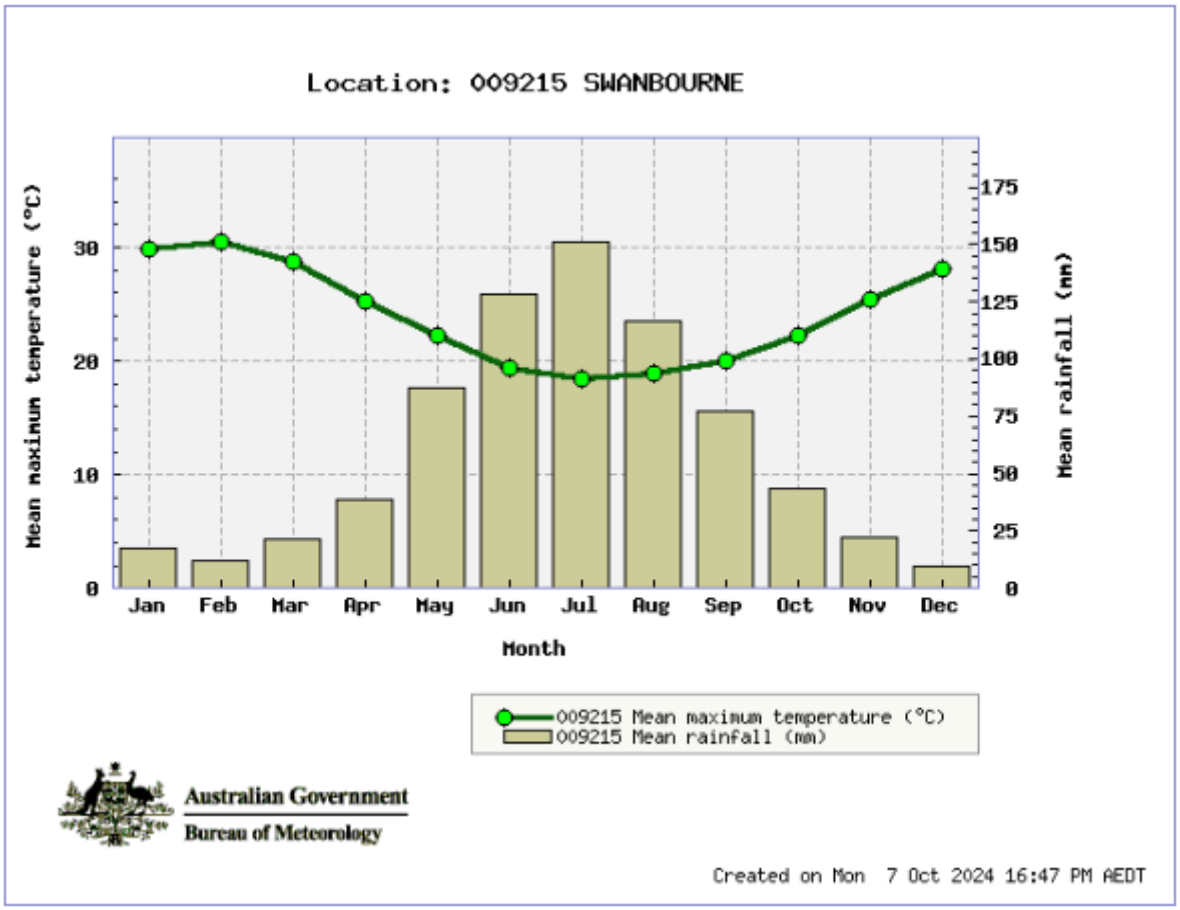

Plate 3-1: Mean Rainfall and Mean maximum Temperature

Source: BoM, 2024

3.1.2 Wind

The site experiences winds typical of the meteorological conditions of the Perth metropolitan region, influenced by two dominant seasonal weather patterns. Predominant summer wind conditions include morning easterly winds (Plate 3-2), and stronger afternoon south westerly winds (Plate 3-3). Winter wind directions predominantly come from an easterly direction in the mornings (Plate 3-4) and a westerly direction in the afternoons (Plate 3-5), with intermittent storms attributed to low pressure systems (BoM, 2024).

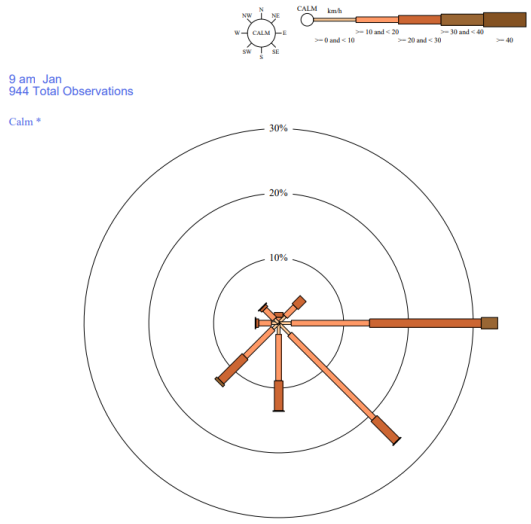

Plate 3-2: January 9am Wind rose

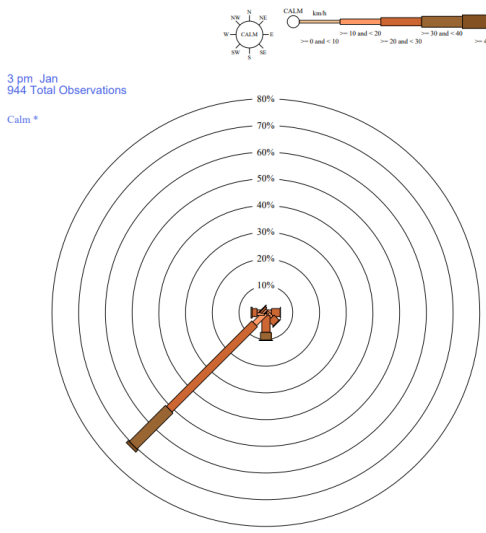

Plate 3-3: January 3pm Wind Rose

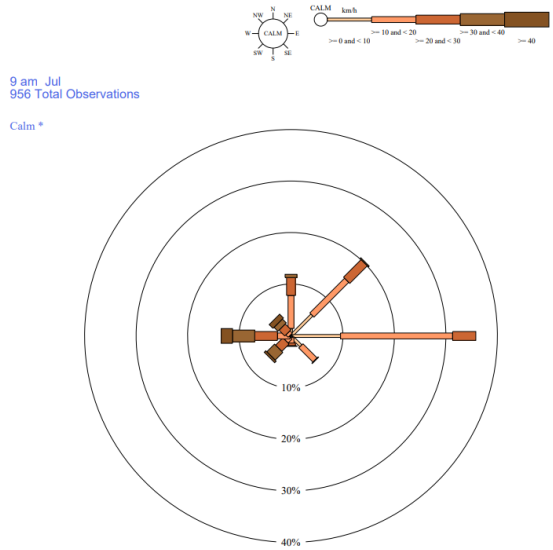

Plate 3-4: July 9am Wind Rose

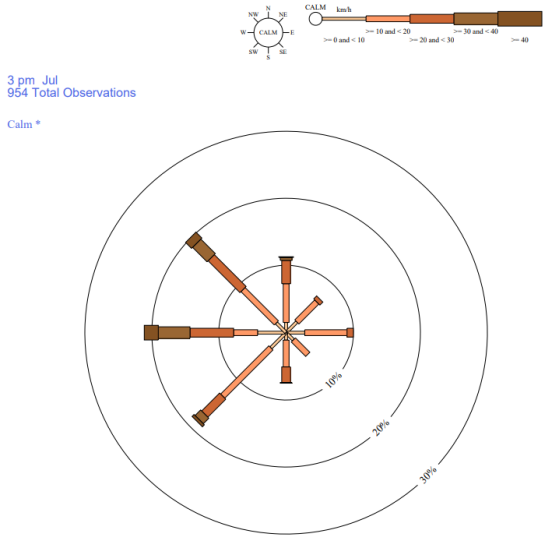

Plate 3-5: July 3pm Wind Rose

Source: BoM, 2024

3.1.3 Climate Change

Climate change is experienced globally and is defined as long-term weather patterns and temperatures on Earth change. Climate change can naturally occur due to changes in the sun's activity or events such as large volcanic eruptions, however since the 1800's anthropogenic causes have been the main driver of climate change. Key ways in which climate change is affecting south-west Western Australia include (GoWA, 2024):

- The region is experiencing one of the fastest rates of rainfall decrease and drying in the world
- Extreme rainfall events are more frequent and intense, leading to flooding and damage
- Bushfire weather is changing, with fires burning more intensely and bushfire season getting longer

- The marine environment is being impacted through increases in average sea surface temperatures and marine heatwaves
- Rise in global sea levels by over 100 mm since 1990.

The National Aeronautics Space Administration (NASA) has found that global mean sea level has risen by 10.1 cm since 1992, and by 21 to 24 cm in the last 140 years (NASA, 2022).

The Department of Transport (DoT) provides specific guidance on coastal planning in the *Sea level Change in Western Australia: Application to Coastal Planning* document. Future projections of sea level are based on understanding of historical change, short term natural variability estimations and project of long-term changes. Key recommendations relevant to the project include (DoT, 2010):

- It is recommended that a vertical sea level rise of 0.9 m be adopted when considering the setback distance and elevation to allow for the impact of coastal processes over a 100 year planning timeframe
- It is recommended for planning timeframes beyond 100 years that a vertical sea level rise of 0.01 m/year be added to 0.9 m for every year beyond 2110.

3.2 Topography

Topography of the site varies greatly, with steeply sloping dunes forming a valley adjacent to West Coast highway in some areas, and flatter, elevated points throughout the site. Undulations are greater at the southern end of the site, with the northern side varying less consisting of gradual slopes. Topographic elevations range from 0 metres Australian Height Datum (mAHD) to 22 mAHD (Figure 2; Plate 3-6, Plate 3-7).

Plate 3-6: Undulations typical of the site

Plate 3-7: Example elevated area within western boundary of site

Source: Coterra Environment, 7 October 2024

3.3 Geomorphology and Soils

3.3.1 Geomorphological Setting

Within the City of Stirling, the beaches form part of the Quindalup soil and landform system, with soils described as white, medium grained and rounded calcium carbonate sands with varying silica content. Shell material originating from seagrass meadows and algal communities in nearby offshore reefs and the Rottnest Island sediment transport pathway forms the skeletal calcareous component of the beaches. Coastal barriers have retained terrigenous sediment from the late Holocene era, however ongoing supply of this sediment is low in present day (Cardno, 2023a).

Within the site, noted in Stul's (2015) review of physical characteristics of Perth beaches, the predominant representative sediment lacks limestone and is comprised of wide, sandy beaches with foredune of varying size and form (Cardno, 2023a).

The site falls within the Secondary Cell 26, as defined by Stul et al. (2015). Secondary cells incorporate contemporary sediment movement on the shoreface and potential landform responses to inter-decadal changes in coastal processes. Secondary Cell 26 is a sandy stretch of coastline bound by rocky outcrops (Cardno, 2023a).

3.3.2 Soils

Soils systems within the site comprise the Quindalup South System (Unit 211Qu). This system is described as 'Coastal Dunes, of the Swan Coastal Plain, With Calcareous Deep Sands and Yellow Sands. Coastal Scrub'.

System 211Qu soils within the proposed site comprise the below units (DPIRD, 2024; Figure 3):

- 211Qu_S1: CALCAREOUS SAND – white fine to medium-grained, sub-rounded quartz and shell debris of eolian origin

- 211Qu_S2: CALCAREOUS SAND - white, fine to medium-grained, sub-rounded quartz and shell debris, of eolian origin

These soils are considered to have 'low' slope stability and 'low' bearing capacity (Gozzard, 1986).

Each soil unit has an associated risk categories for water and wind erosion, flood hazard, salinity risk and waterlogging and inundation. These are outlined below (Table 3-1).

Table 3-1: Land Degradation Risk Categories

Land Degradation Risk Category	211Qu_S1	211Qu_S2
Water Erosion	45% of map unit has a very high to extreme hazard	40% of map unit has a very high to extreme hazard
Wind Erosion	100% of map unit has a high to extreme hazard	70% of map unit has a high to extreme hazard
Flood Hazard	0% of the map unit has a moderate to high hazard	0% of the map unit has a moderate to high hazard
Salinity Risk	0% of map unit has a moderate hazard	0% of map unit has a moderate hazard
Waterlogging and Inundation	0% of map unit has a moderate to very high risk	0% of map unit has a moderate to very high risk

Source: DPIRD, 2024

3.3.3 Acid Sulphate Soils

The site is not mapped as containing soils which pose an Acid Sulfate Soil (ASS) risk (Landgate, 2024).

3.4 Hydrology

3.4.1 Groundwater

Groundwater flows from the east toward the Indian Ocean, with groundwater levels declining down to sea level (Figure 4). There will be a saltwater interface within the superficial aquifer beneath the site. The saltwater interface is a groundwater / ocean water interface that is influenced by groundwater flow rates, piezometric heads and tidal interactions. Rather than a sharp interface, the interface is usually a zone where the salinity grades from that of ocean water through to the relatively fresh groundwater. The zone is diffuse (usually less than 10 m thick) due to tidal movements and seasonal variations in groundwater flows. The interface can influence groundwater elevations and flow directions (Cardno, 2023a).

Groundwater discharge to the ocean will occur over the saltwater interface (or saltwater wedge), due to the higher density of ocean water. Where saltwater intrusion is present, it will generally extend no more than 250 m inland (DoE, 2004), however it has been estimated to extend inland up to 1 km (Davidson, 1995).

3.4.2 Surface Water

The site does not contain any naturally occurring surface water features, such as wetlands, river or streams, however, is bound by the Indian Ocean to the west, meaning tidal waves may occasionally inundate the site.

Stormwater Drains direct water away from nearby urban areas into surrounding areas, with two drainage line extending underneath West Coast Highway and terminating within the site (CoS, 2024; Figure 4).

3.4.3 Oceanography

Tidal ranges within the City of Stirling range from 0.3 m during neap tides to 0.7 m during spring tides, with the coastline being a predominantly diurnal, microtidal environment. Astronomical tidal regime at Fremantle is outlined below (Table 3-2) (Cardno, 2023a).

Wind is the major driver of currents within the nearshore zone adjacent to the site, with small tidal movements facilitating this movement. Currents correspond to seasonal wave and wind conditions and rip currents can be formed from interactions between northward summer currents and southern winter currents, notably when swell is driving substantial water movements perpendicular to the shore (Cardno, 2023a).

Prevailing currents over the summer period drive sediment movement along the Perth coastline northward, and during the winter period these sediments are driven southward. Trigg Point nearby the site experiences a notable accumulation of suspended sediment along its shoreline to its south in summer and erosion of the southern shoreline in winter (opposing effects to its north). Sporadic swell moves sediment onto the shore, steepening the beach profile seasonally and influenced by winter storms eroding the beach and redepositing sand offshore. Winter storm sand movement form stable sand bars and prevent waves breaking at the shore and limiting substantial sediment shifting (Cardno, 2023a).

Table 3-2: Astronomical tide regime at Fremantle Fishing Boat Harbour

Parameter	Tidal Water Level (m AHD)
Highest Astronomical Tide (HAT)	0.63
Mean High Water Spring (MHWS)	0.38
Mean High Water Neap (MHWN)	0.27
Mean Sea Level (MSL)	0.00
Mean Low Water Neap (MLWN)	-0.20
Mean Low Water Spring (MLWS)	-0.30
Lowest Astronomical Tide (LAT)	-0.51

Source: Cardno, 2023a

3.4.4 Coastal Hazard Risk

The Western Australian coastal zone is vulnerable to physical process hazards and adverse impacts from inundation and erosion. Climate change has the potential to increase some of these impacts. Early consideration of these matters and the adaptation and management of appropriate planning responses can provide economic, environmental and social benefits (WAPC, 2019).

Coastal Hazard Risk Management and Adaptation Planning (CHRMAP) as advocated by the State government includes the following elements (WAPC, 2019):

- Establishing the context
- Coastal hazard risk identification/vulnerability assessment
- Coastal hazard risk analysis
- Coastal hazard risk evaluation
- Coastal hazard risk adaptation planning
- Monitoring and review.

Relevant aspects of the City's CHRMAP are discussed where relevant throughout this document, as well as in Section 2.6.

3.5 Flora and Vegetation

3.5.1 Pre-European Vegetation Association

The site is mapped broadly as being within the Spearwood 1007 vegetation association extent. This vegetation association is described as 'Mosaic: Shrublands; *Acacia lasiocarpa* & *Melaleuca acerosa* heath / Shrublands; *Acacia rostellifera* & *Acacia cyclops* thicket' (GoWA, 2019a).

3.5.2 Vegetation Complex

The site is mapped as being representative of the Quindalup Vegetation Complex which is described as 'Coastal dune complex consisting mainly of two alliances - the strand and fore-dune alliance and the mobile and stable dune alliance. Local variations include the low closed forest of *Melaleuca lanceolata* (Rottnest Teatree) - *Callitris preissii* (Rottnest Island Pine), the closed scrub of *Acacia rostellifera* (Summer-scented Wattle) and the low closed *Agonis flexuosa* (Peppermint) forest of Geographe Bay.' (GoWA, 2019b).

3.5.3 Vegetation Types

In summer 2014, Natural Areas Consulting (NAC) undertook a flora and vegetation assessment of the site as part of a broader project. The following vegetation types were recorded (NAC, 2014; Plate 3-8):

- OaRbScFn: *Olearia axillaris* Open Heathland over *Rhagodia baccata, Scaevola crassifolia* and other low shrubs, *Ficinia nodosa* and other sedges and herbs
- ArOaScSlLg: Mixed Open Mixed Open Heathland of *Acacia rostellifera, Olearia axillaris, Scaevola crassifolia* and other low shrubs over *Spinifex longifolius* and *Lepidosperma gladiatum*
- AaOaSh: Marram Grass (*Ammophila arenaria*) Grassland with scattered shrubs of *Olearia axillaris* and small areas of *Spinifex hirsutus*

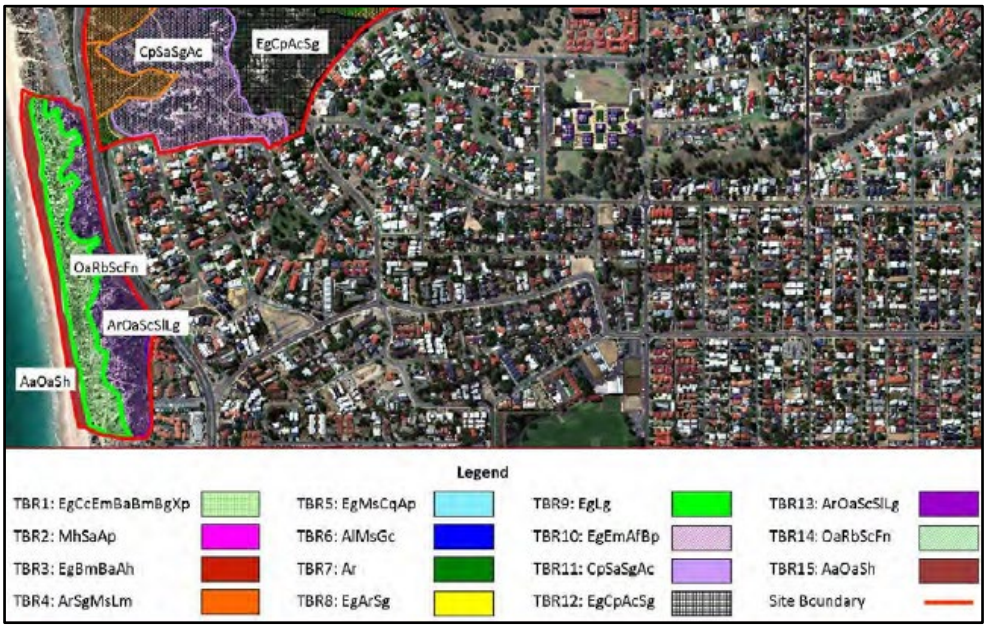

Plate 3-8: Vegetation Units

Source: NAC, 2014

During the site inspection undertaken by Coterra Environment on 7 October 2024, several areas of revegetation works were being undertaken by the City of Stirling. It was noted that the revegetation areas appeared largely successful with few plant deaths noted (Plate 3-9; Plate 3-10). The total extent of revegetation works within the site to date includes installation of approximately 16,500 tubestock across a 3.5 ha area, with further tubestock installation proposed for 2025 (Plate 3-11).

Plate 3-9: Revegetation across flatter areas within the site

Plate 3-10: Revegetation areas on undulating areas within the site

Source: Coterra Environment, 7 October 2024

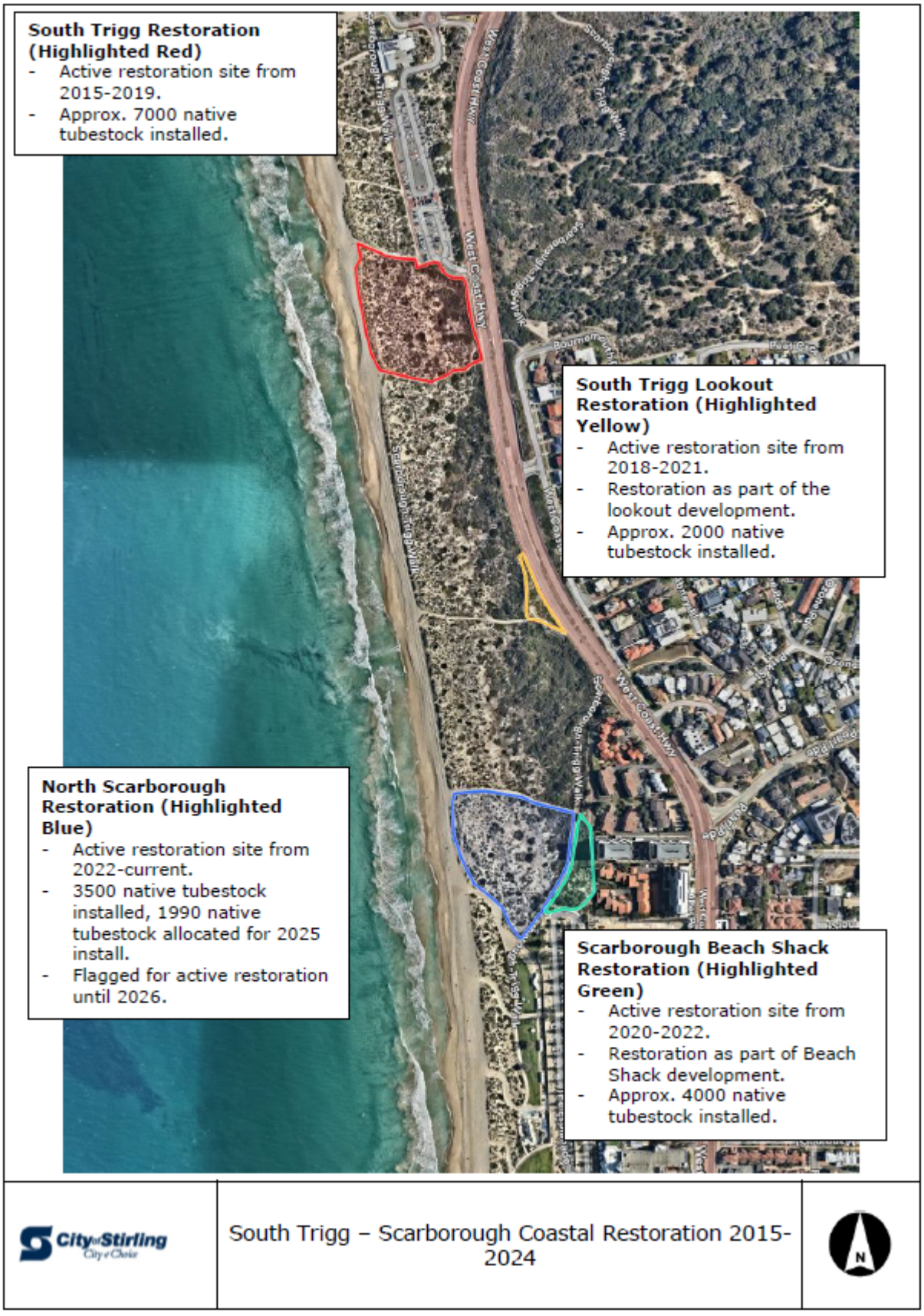

Plate 3-11: Revegetation Extent

Source: City of Stirling

3.5.4 Vegetation Condition

During the NAC (2014) survey, vegetation condition assessment was undertaken as defined in the Keighery Scale, as described in Bush Forever Volume 2 (NAC, 2014). The areas where vegetation condition was mapped partially overlaps the site's extent.

The condition of the vegetation as recorded across the surveyed extent of the site by NAC (2014) is outlined below (Table 3-3; Plate 3-12).

Table 3-3: Vegetation Condition of recorded areas within site boundary

Condition	Condition Description*
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
Good	Vegetations structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it.
Very Good	Vegetation structure altered, obvious signs of disturbance.

Source: NAC, 2014

**As defined in Condition Scale used in Bush Forever VOL 2, from Keighery (1994)*

Plate 3-12: Vegetation Condition

Source: NAC, 2014

3.5.5 Conservation Significant Vegetation

The site contains a known occurrence of the *Callitris preissii* (or *Melaleuca lanceolata*) Forests and Woodlands of the Swan Coastal Plain Threatened Ecological Community (TEC), which is listed as Critically Endangered under the State *Biodiversity Conservation Act 2016* (BC Act). This TEC is not currently listed under the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The total extent of the TEC on site (as recorded by NAC, 2014) is 0.93 ha and includes 13 trees of the *Callitris preissii* species (Figure 5). The TEC is considered partially groundwater dependant, and is naturally low in species richness. Typical and common native plant taxa in the community are: *Callitris preissii, Melaleuca lanceolata, Spyridium globulosum, Acanthocarpus preissii, Rhagodia baccata, Austrostipa flavescens* and *Trachymene pilosa* (Gibson et al. 1994). Introduced herbs *Galium murale, Asparagus asparagoides* and *Trachyandra divaricata* are common in the understorey.

3.5.6 Weeds and Pathogens

In 2014, Fisher Research Pty Ltd undertook a review of the 2011 City of Striling coastal weed mapping. The exercise examined the coastline within the City of Striling area and mapped the percentage weed cover divided into various sections, with the site falling under the map sections T1, U1, V1, V2 and W1. These maps displayed varying levels of weed cover ranging from 0-20% cover to 81-100% cover. A copy of the extracted maps relevant to the site is provided in Appendix 1.

A total of 30 weed species were recorded by NAC (2014) within the broader Trigg Bushland Reserve survey. Weeds which were recorded in quadrats within the site during the NAC (2014) survey included:

- **Ammophila arenaria* (European Marram Grass)
- **Avena barbata* (Wild Oat)
- **Bromus diandrus* (Great Brome)
- **Euphorbia paralias* (Sea Spurge)
- **Lagurus ovatus* (Hare's Tail Grass)
- **Leptospermum laevigatum* (Coastal Tea Tree/ Victorian Tea Tree)
- **Lolium rigidum* (Annual Ryegrass)
- **Oenothera drummondii* (Beach Evening-primrose)
- **Pelargonium capitatum* (Rose Pelargonium)
- **Schoenus* sp.
- **Tetragonia decumbens* (Dune Spinach)
- **Trachyandra divaricata* (Dune Onion Weed)

The pathogen *Phytophthora* dieback is known to be present within the Trigg Bushland area (NAC, 2014), however it has not been previously recorded within the site. It is considered unlikely that any vegetation within the site will be susceptible to dieback, as the site lacks characteristic species known to be susceptible to the disease (e.g., Banksias, Eucalyptus spp. and Grass Trees).

The fungus *Armillaria luteobubalina* has previously been recorded in the drain located within the site and is a known cause of death of *Acacia rostellifera* in the nearby greater Trigg Bushland area, however no observations of *A. luteobubalina* have been recorded since at this site (NAC, 2014).

3.6 Fauna and Habitat

As described in the Bush Forever (BF) documentation BF Site 308 – 'Trigg Bushland and Adjacent Coastal Reserve, Trigg/ Scarborough' contains potential habitat for a diversity of reptiles and birds. This includes the following (DEP, 2000):

- 30 bird species
  - Notable species include White-browed Scrubwren, Broad-tailed Thornbill, Variegated, White-winged and Splendid Fairy Wrens
- 24 reptile species
  - Notable species include the Western blue tongue (*Tiliqua occipitalis*), Bardick Snake (*Echiopsis curtus*), Black-Striped Snake (formerly *Simoselaps calonotos*, now *Neelaps calonotos*) and Western Heath Dragon (formerly *Tympanocryptis adelaidensis*, now *Ctenophorus adelaidensis*)
- One amphibian species

Although fauna species noted above were related to the entire BF 308 area, the proposed coastal boardwalk area is likely to provide less fauna habitat opportunities due to the harsh nature of the coastal dune environment and limited habitat types present. As such this area is not expected to house such a diverse assemblage of species.

A desktop level fauna assessment was undertaken by NAC in 2015 (NAC, 2015a) as a part of the Scarborough Redevelopment Project which included part of the proposed coastal boardwalk site. As the area in which the NAC 2015 survey was undertaken is continuous with the proposed boardwalk site, it can be assumed fauna assemblage is likely similar. Conservation significant species considered most likely to be encountered were the State-listed Priority 3 Black-striped snake (*Neelaps calonotos*) and the Federally listed Marine Rainbow Bee-eater (*Merops ornatus*). Field sightings of species included (NAC, 2015a):

- *Anthochaera lunulata* (Western Wattle Bird)
- *Camponotus terebrans* (Ant)
- *Corvus coronoides* (Australian Raven)
- *Falco cenchroides* (Nankeen Kestrel)
- *Grallina cyanoleuca* (Magpie-Lark)
- *Gymnorhina tibicen* (Magpie)
- *Hirundo neoxena* (Welcome Swallow)
- *Larus novaehollandiae* (Silver Gull)
- *Lichenostomus virescens* (Singing Honeyeater)
- *Pieris rapae* (Cabbage Butterfly)
- *Pseudonaja affinis* (Dugite)
- *Rhipidura leucophrys preissi* (Willie Wagtail)
- *Sterna bergii* (Crested Tern)
- *Tiliqua rugosa* (Bobtail)
- **Apis mellifera* (European Honey bee)
- **Canis Lupis familiaris* (Domestic Dog)
- **Ommatoiulus moreleti* (Portuguese Millipede)
- **Oryctolagus cuniculus* (European Rabbit)
- **Streptopelia senegalensis* (Laughing Turtle Dove)
- **Trichoglossus haematodus* (Rainbow Lorikeet)

*Note: * denotes a non-endemic species*

As a part of the preliminary assessment of any conservation significant fauna, a database search for Matters of National Environmental Significance (MNES) was undertaken using the Department of Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters Search Tool (PMST). The PMST identifies species or communities protected the EPBC Act which are considered to 'may' occur, are 'likely' to occur or are 'known' to occur in an area. To limit misidentification of species present given the diversity of the landscapes adjacent to the site, those considered 'known' are listed below, with solely marine species excluded from this list:

- *Limosa lapponica menzbieri* (Northern Siberian Bar-tailed Godwit/ Russkoye Bar-tailed Godwit): Endangered

- *Zanda latirostris* (Carnaby's Black Cockatoo): Endangered
- *Pandion haliaetus* (Osprey): Listed Marine, Listed Migratory
- *Caretta caretta* (Loggerhead Turtle): Endangered, Listed Marine, Listed migratory
- *Chelonia mydas* (Green Turtle): Vulnerable, listed marine, Listed Migratory
- *Dermochelys coriacea* (Leatherback Turtle): Endangered, Listed Marine, Listed Migratory
- *Natator depressus* (Flatback Turtle): Vulnerable, Listed Marine, Listed Migratory

Although a comprehensive assessment of each MNES has not been undertaken, given the disturbed nature of the site as well as frequent public usage and lack of suitable habitat, it is not anticipated that any of these species, if present, would be reliant on the habitat at the site for survival.

3.7 Conservation Areas

3.7.1 Bush Forever

As noted above the site forms part of the 134.6 ha area of BF Site No. 308, known as Trigg Bushland and Adjacent Coastal Reserve, Trigg/Scarborough. The key environmental features recorded as part of this BF site include:

- Soils comprising Spearwood Dunes (eastern portions of BF 308) and Quindalup Dunes (western portions of BF 308)
- Vegetation comprising the Cottesloe Complex (associated with the Spearwood Dunes soils) and Quindalup Complex (associated with the Quindalup Dunes)
- Floristic Community Types (FCT) comprising:
  - FCT 24 (Northern Spearwood shrublands and woodlands),
  - FCT 28 (Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands),
  - FCT 29a (Coastal shrublands on shallow sands),
  - FCT 29b (*Acacia* shrublands on taller dunes),
  - FCT S11 (Northern *Acacia rostellifera* – *Melaleuca systena* shrublands),
  - FCT S13 (Northern *Olearia axillaris* – *Scaevola crassifolia* shrublands); and
  - FCT S14 (*Spinifex longifolius* grassland and low shrubland)
- Vegetation condition ranging from >75% Very Good to Excellent Condition, <25% Good to Degraded and contained areas of severe localised disturbance
- Significant flora including *Callitris preissii,* which occurs as the most significant northern population
- A total of 55 different fauna species being recorded within BF Site No. 308 including 30 bird, 24 reptiles and 1 amphibian species

There is no connected linkage between any adjacent bushland, however it is part of a regionally significant fragmented bushland/wetland linkage.

3.7.2 Environmentally Sensitive Area

The entirety of the site is mapped as an Environmentally Sensitive Area (ESA) (Landgate, 2024). ESA's are excluded from obtaining a number of the identified exemptions under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

3.8 Bushfire Risk

The site is mapped as a Bushfire Prone Area (DFES, 2024). Bush Fire Prone areas are defined as being subject to, or likely subject to bushfire attack and are identified by the presence of and proximity to bushfire prone vegetation and include both the area containing the bushfire prone vegetation and a 100 m buffer zone immediately surrounding it (DFES, 2024).

It is noted that there is no specific requirement for a Bushfire Management Plan for the proposed boardwalk, however the City may wish to investigate management considerations during high risk bushfire days.

3.9 Other Environmental Considerations

The Department of Water and Environmental Regulation (DWER) Contaminated Sites Database does not identify any known contamination to be present onsite (Landgate, 2024).

During the site inspection on 7 October 2024, Coterra Environment recorded rubbish which may potentially contain asbestos containing material (ACM). Examples are provided below (Plate **3**-**13**, Plate 3-14)

Plate 3-13**: Potential Asbestos Containing Material**

Plate 3-14: Broken glass/ Rubbish

Source: Coterra Environment, 7 October 2024

3.10 Heritage

3.10.1 Aboriginal Heritage

The site does not contain any recorded Aboriginal Heritage places as identified within the Department of Planning, Lands and Heritage (DPLH) Aboriginal Heritage Inquiry System database, with the closest Registered Place being Lake Gwelup (place ID 3501), located approximately 3.2 km east of the site (Landgate, 2024; DPLH, 2024).

3.10.2 European Heritage

The site does not contain any recorded European Heritage places, with the closest European Heritage Place located approximately 750 m north of the site, being Trigg Island Beach House (Place No. 2150) (Landgate, 2024).

3.11 Surrounding Land Uses

The site is bound to the west by the Indian Ocean and associated beach. The beach is a popular location for recreation activities and is recognised as one of the busiest beaches in Western Australia.

To the east, the site is bound by West Coast Highway. West Coast Highway provides a linkage through Perth's north-western suburbs and contains a variety of urban and suburban land uses such as schools, shopping centres, housing and industrial uses.

4 Key Risks, Opportunities and Constraints

The Scarborough and Trigg coast is important to the lifestyle and livelihood of the people within the City of Stirling and within Western Australia generally. The coast is a significant asset that contributes to the environmental, economic, social and cultural fabric of the State as a tourism and recreation destination.

Proposed development within the environmentally sensitive coastal environment however faces several challenges and risks. Coastal environments are highly dynamic and subject to continuous changes in response to the weather, wave and sea level conditions (WAPC, 2003).

Coastal planning, design and management that is based on sound principles can mitigate the risks and impacts within this coastal resource. This section outlines the key risks, opportunities and constraints that the City of Stirling should consider in their decision making on the proposed coastal boardwalk (Figure 8).

4.1 Climate Change

The scientific community acknowledges that climate change is occurring and, as a result, forecast impacts should be considered when planning and designing developments in the coastal zone. The vulnerability of assets within the Western Australian coastal zone to coastal hazards such as erosion and inundation is expected to increase in the future (WAPC, 2019). Despite the uncertainty about the magnitude and extent of the impacts from these processes and changes, early consideration of coastal hazards and the management of appropriate planning responses can provide economic, environmental and social benefits (WAPC, 2019).

The Coastal Hazard Risk Management and Adaptation Planning (CHRMAP) Guidelines were prepared by the WAPC (2019) to assist statutory decision-makers to:

1. Consider the risks arising from coastal hazards through evaluating their consequence and likelihood, and the vulnerability of specific assets
2. Identify risk management responses to those risks arising from coastal hazards
3. Prioritise and implement the risk management responses
4. Explain the process for undertaking CHRMAP and determining appropriate content for CHRMAP.

A CHRMAP is an integral part of decision-making, as it provides a method for testing risk (uncertainty) arising from coastal hazards and timeframes, and the treatment of this risk (WAPC, 2019). Given that there is a direct relationship between risk and opportunity in all decision making (trade-offs), decision-makers need to identify, measure and manage the risk arising from coastal hazards, to ensure they capitalise appropriately on those opportunities and achieve their goals and objectives (WAPC, 2019).

For the City, the relevant effects from climate change will most likely be an increase in mean sea level, as well as possible changes to storm frequency, direction and intensity, changes to precipitation patterns and increased temperatures (Cardno, 2023a). The key risk calculated within the CHRMAP as a result of climate change is sea level rise, which was informed by figures produced by IPCC (2021) and DoT (2010). The calculated sea level rise at this section of coastline have been factored into the coastal inundation mapping discussed in the following section.

4.2 Coastal Inundation

Inundation is a potential hazard for any proposed development in close proximity to the coastline. The key sources and pathways for coastal inundation are outlined below in Table 4-1:

Table 4-1: Inundation coastal hazard sources and pathways (WAPC, 2019)

Coastal Hazard	Sources	Pathways
Inundation	• Sea level rise • Tides • Storm surges • Waves • Tsunami • Wind • Climate cycles (La Nina, El Nino)	• Direct inundation of low-lying land • Overtopping or breaching of dunes, natural or man-made barriers (protection works) • Back up of stormwater from rainfall unable to drain due to high sea level

The CHRMAP for the City of Stirling (Cardno, 2023a) made allowance for the extent of coastal inundation which was calculated as the maximum extent of storm inundation, defined as the peak steady water level, plus wave run-up, for 500-years average recurrence interval (ARI) storm event.

For the section of coast between Trigg Beach and Scarborough Beach the CHRMAP determined there to be no calculated risk from inundation up to 2122 within any of the coastal vegetation along this section (Figure 6). This calculated inundation risk includes the expected sea level rise as a result of climate change up to the year 2122. Coastal inundation and climate change are therefore not considered to be a constraint to the development of a coastal boardwalk in this location.

4.3 Coastal Erosion

Coastal zones are vulnerable to adverse impacts from erosion due to various coastal processes. The key coastal processes that affect coastal landforms and movement of the shoreline, particularly on sandy coasts, are (WAPC, 2003):

1. Weather and Climate: air pressure, wind direction and speed, temperature and rainfall
2. Tides: tidal environment, form and range
3. Sea levels: storm surge, water level ranging, long-term change in sea level
4. Waves: sea and swell, attenuation and breaking
5. Currents

The coastal erosion sources and pathways are summarised in the following Table 4-2:

Table 4-2: Coastal erosion hazard sources and pathways (WAPC, 2019)

Coastal Hazard	Sources/Impacts	Pathways
Coastal Erosion of Sandy Coasts	• Sediment supply (absence or reduction of sediment supply from offshore or from littoral drift) • Sea level rise (recession due to) • Tides • Storm surges • Waves • Wind • Climate cycles (La Nina, El Nino) • Modified currents, e.g. from introduction of protection measures or structures nearby	• Long-term continuous recession • Long-term fluctuating recession • Short-term fluctuations/cycles • Human induced changes

The relative intensity of the above factors determines the nature of shoreline change. Changes like those that occur during extreme storms will produce significant changes in the position of the shoreline and shape of the beach. One of the key risks to any proposed infrastructure within the coastal zone is therefore the highly dynamic nature and changes that occur continuously along the shoreline.

The City's CHRMAP Chapter 2 – Risk Identification (Cardno, 2023a) details the coastal hazard risk assessment at the time of reporting (2022), 2030, 2045, 2070 and 2122 planning horizons. The allowance for erosion on sandy coasts was calculated as the sum of the S1, S2 and S3 Erosion allowances, plus a 0.2 m/per year allowance for uncertainty (Cardno, 2023a):

- (S1 Erosion) Allowance for the current risk of storm erosion;
- (S2 Erosion) Allowance for historic shoreline movement trends;
- (S3 Erosion) Allowance for erosion caused by future sea-level rise; and
- (Su Erosion) Allowance for uncertainty.

The 2070 planning horizon for coastal erosion hazard extent (refer Figure 7) for this section of coast sits within 50-75m inland from the start of the coastal foredunes. If the City of Stirling desire the boardwalk to have a lifespan of 50+ years, then coastal erosion poses a significant constraint to the development to the west of the 2070 coastal erosion hazard extent.

To minimise risk to the proposed coastal boardwalk from coastal erosion, the proposed boardwalk should in the most part be situated to the east of the 2070 coastal erosion hazard extent. If desired, some components could be proposed closer to the coast, but with the understanding that these structures are at higher risk of being damaged in the future, perhaps as early as 2045. Any proposed structures west of the 2070 line would need to be specifically designed and likely 'over-engineered' for the possibility of coastal erosion.

Adaptation measures could also be considered to reduce that risk down to acceptable levels. Adaptation measures include:

- Minimise structural elements within the area identified to be affected by coastal hazards (e.g. use of a cantilever structure if west of the 2070 coastal hazard risk area).
- Planned or managed retreat – Locate structures within coastal hazard risk area, but plan for the removal/ demolishment/ relocation of the assets at the appropriate time.
- Accommodation adaptation measures including design and/ or management strategies that render the risk from the identified coastal hazard acceptable.
- Coastal protection works where there is a need to preserve the foreshore reserve, public access or public safety, property and infrastructure that is not expendable.

Coastal erosion is a significant risk and will be key determinant in the location and design of the proposed coastal boardwalk.

4.4 Landform Stability

Coastal sand dunes form wherever there is a supply of sandy sediment, and onshore winds are strong enough to blow sand landwards from the beach where it is trapped by vegetation to form dunes (WAPC, 2003). The size of the dunes is dependent on availability of sand, wind strength and stability of the beach, with high energy coasts tending to have higher foredune ridges (WAPC, 2003). Dunes will continue to grow for as long as there is sand supply from the beach, and it accumulates on pathways and against hard structures. This continual movement of sand was apparent at this section of coast, with several sections of fencing of the original 1.2 m high fenced pathways being almost engulfed by sand (Plate 4-1, Plate 4-2).

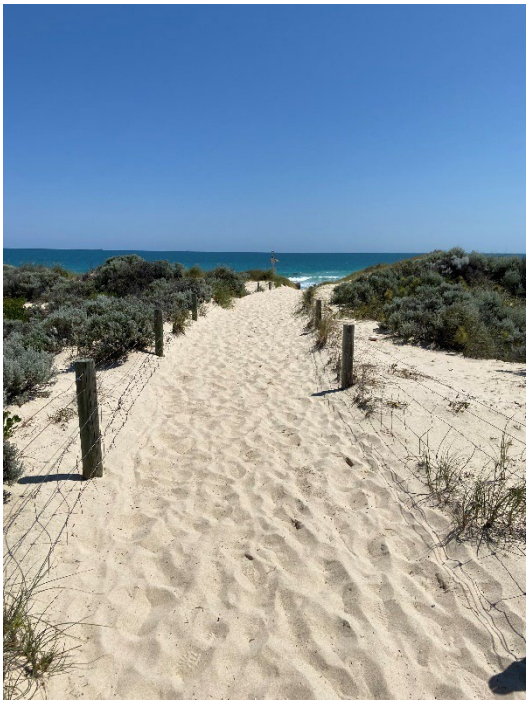

Plate 4-1: Fencing covered with sand

Plate 4-2: Fencing covered with sand

The disturbance or removal of vegetation cover from a foredune can affect the stability of the dunal landforms. Exposed parts of the dunes can be eroded by winds blowing onshore (e.g. summer afternoon south westerly winds) and displacing the sand further inland, as onshore winds are generally stronger than offshore winds. These windblown sands are redeposited in dunes with a U-shape, which are referred to as blowouts. A blowout continues to form for as long as it is supplied with sand or until the hollow is eroded down to groundwater level or bedrock (WAPC, 2003). The key sources and pathways for dune destabilisation are provided in the following Table 4-3.

Table 4-3: Landform destabilisation hazard sources and pathways

Coastal Hazard	Sources/Impacts	Pathways
Destabilisation of dunal landforms	• Human induced disturbance or removal of vegetation cover on the dunes • Partial or full removal/modification of dunal landforms • Sediment supply (absence or reduction of sediment supply from offshore or from littoral drift) • Sea level rise (recession due to) • Tides • Storm surges • Waves • Wind • Climate cycles (La Nina, El Nino) • Modified currents, e.g. from introduction of protection measures or structures nearby	• Long-term continuous recession • Long-term fluctuating recession • Short-term fluctuations/cycles • Human induced changes

To avoid the erosion and destabilisation of the coastal landforms, disturbance and removal of dune formations must be kept to the bare minimum. Removal of dunes removes the barrier to direct landward transport of sand and reduces the capacity of the coast to absorb phases of erosion during above-average storm activity, thereby increasing the likelihood of infrastructure damage (WAPC, 2003).

Further it is noted that linear disturbance corridors (e.g. beach access paths or other linear clearing corridors) should be orientated to avoid being in line with the predominant summer afternoon south-westerly winds.

Landform stability is therefore a significant risk to the development of a coastal boardwalk and will be key determinant and driver in the proposed location and design.

4.5 Hydrological Regime

4.5.1 Natural drainage patterns

Dependent on the method of construction, the proposed boardwalk could have the potential to change the natural drainage patterns of the site and increase the risk of erosion. Impermeable surfaces where water cannot penetrate will generate more runoff and lead to higher discharges to the surrounding environment. The greater the area of impermeable surface, the greater the discharge and potential for erosion in larger rain events, particularly on slopes. However, the sandy soils have high permeability, and overland runoff will dissipate quickly, and as such is not expected to pose any significant impact to existing drainage patterns.

Management measures such as having limits on batter grades, and installation of coir matting/rock pitching to stabilise slopes that have steeper gradients however may be recommended. Application of brushing and/or hydromulching (no seed impregnated) could also be undertaken in erosion prone areas to assist with surface stabilisation. Brushing could be comprised of cleared vegetation (if any clearing is necessary dependent on design), removed in the earthworks phase.

Should the path be impermeable, the Main Roads WA Drainage Standards should be applied to the path to ensure the safety of path users and protection of the path structure.

Dependent on the design of the coastal pathway and method of construction, there may be a risk of erosion from stormwater runoff. However, given the well-drained soils, this risk can be mitigated through appropriate design and management measures. Changes to the hydrological regime are therefore not likely to be a constraint to development of a coastal boardwalk in this location.

4.5.2 Stormwater drainage

Stormwater drainage infrastructure currently directs water away from nearby urban areas into the Trigg Bushland, with two drainage lines extending underneath West Coast Highway and terminating within the site, plus an additional drainage structure being present in the southern end of the site (Plate 4-3) (CoS, 2024).

Stormwater drainage has the potential to create a number of negative impacts, including (Natural Area Consulting, 2015b):

- Pollutant discharge, such as nutrients, herbicides, pesticides, hydrocarbons, and phenols from the surrounding catchment
- Discharge of sand, silt and sediment
- Movement of seeds from weeds and non-local native flora species
- Movement of pathogens, including *Phytophthora* Dieback and *Armillaria*.

Whilst the stormwater drainage poses no risk to the coastal boardwalk proposal (aside from needing to avoid the drainage structure areas), it is worth noting that regular monitoring and maintenance of the drainage

areas within the site will assist in maintaining and improving the natural features and ecological integrity of the site.

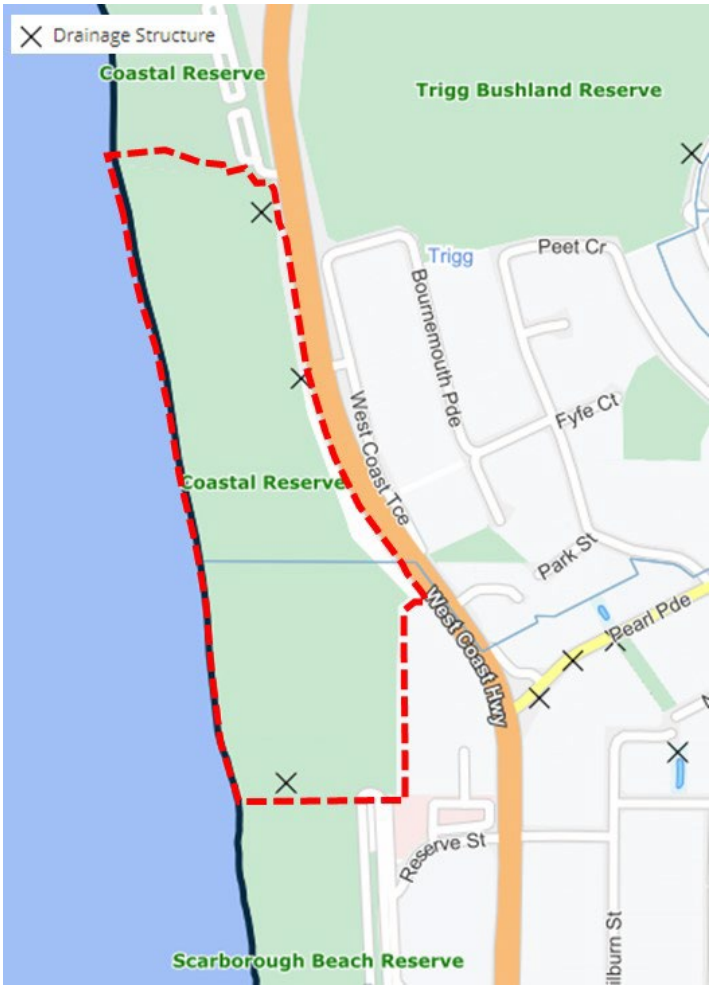

Plate 4-3: City of Stirling Drainage Structure Mapping

Source: CoS, 2024

4.6 Flora and Vegetation

4.6.1 Vegetation Removal

The site of the proposed boardwalk is situated within an A class reserve, as well as being part of Bush Forever Site 308. Bush Forever sites and reserves designated as Class A are those that have high conservation and/or high community values, with this classification providing the highest level of protection for Crown land reserves. The vegetation contained within the site is therefore considered to be regionally significant. As such any proposed development in this area should aim to minimise the impacts to the flora and vegetation so that biological diversity and ecological integrity are maintained. In addition, limiting the amount of clearing will assist in the attainment of the necessary approvals discussed in Section 7 and assist in responding to community concerns regarding impacts to this reserve and its natural values.

Actions associated with the boardwalk which have the potential to result in vegetation removal are summarised in Table 4-4.

Table 4-4: Vegetation removal sources and pathways (modified from WAPC, 2019)

Coastal Hazard	Sources/Impacts	Pathways
Removal of vegetation and flora	• Direct loss of vegetation through clearing for installation of infrastructure • Indirect loss of vegetation cover through trampling due to uncontrolled access, disturbance, disease or weed infestations • Dune destabilisation • Shading of plants from infrastructures • Erosion of dunal landforms	• Construction of infrastructure • Disturbance of landform and vegetation

The site consists of three separate vegetation types (NAC, 2014) ranging from Degraded to Very good condition based on the 2014 assessment. In order to reduce the impact on this vegetation and flora, the proposed coastal boardwalk should be designed to minimise the clearing and impact footprint in the first instance. This could be achieved by having elevated/suspended boardwalks with large spans and small footings for the majority of the route, rather than 'at grade' concrete/asphalt/crushed limestone/gravel pathways. To further limit direct and indirect impacts, offsite fabrication of sections could also be investigated as an option.

Whilst an elevated path has less clearing footprint than an at grade path, the shading of plants underneath the boardwalk can also affect the health and survival of flora underneath if at significant level. However, the higher the elevation of the boardwalk, the impacts of shading become less due to shadow moving more through the day. Although more shade will be present, there will be less of an effect on singular areas as the shaded parts will shift throughout the day, compared to a lower pathway where shade intensely affects one area greater.

Provided pedestrian access is controlled on both side of the boardwalk with fencing or balustrading, there is unlikely to be further physical damage to vegetation post construction. However, management of indirect impacts such as weeds will be an ongoing maintenance requirement as is currently the case.

The loss of vegetation and flora within the site is a significant constraint to the proposed development and minimising the impact to this vegetation should be one of the highest priorities considered in the design and construction techniques.

4.6.2 *Callitris preissii* (or *Melaleuca lanceolata*) Forests and Woodlands of the Swan Coastal Plain Threatened Ecological Community

The site contains a known occurrence of the *Callitris preissii* (or *Melaleuca lanceolata*) Forests and Woodlands of the Swan Coastal Plain Threatened Ecological Community (TEC) as discussed in Section 3.5.5.

Historically, Callitris forests were cut for timber and firewood with clearing for ongoing urban sprawl a more recent process that may have further reduced the community's extent (DPAW, 2014). The Callitris community would have been more common along the coastline, but only relatively small occurrences in Trigg, Woodman Point and Point Peron now remain as a consequence of historical clearing and following too frequent fires since European settlement. (DPAW 2014).

The potential loss of this TEC within the site is a significant constraint to the proposed development and avoiding any impact to this TEC should be one of the highest priorities considered in the design and construction techniques.

There is no formal advice regarding specific buffer requirements for TEC areas. As such, the buffer should respond to site specific conditions to afford protection to the environmental asset. Key items to note in relation to this TEC onsite include:

- The TEC is hydrological up-gradient of the proposed access, and also given the limited possibility of the boardwalk impacting site hydrology this factor is not considered to trigger a buffer requirement.
- The Local Biodiversity Guidelines (WALGA, 2004) note that as a general guide natural areas less than 50 m wide will contain mostly edge habitat with low viability, with edge effects typically observed up to 25 m into natural areas, however it is recommended that on-ground research is undertaken to determine edge effects. As such this small patch of TEC vegetation is very susceptible to edge effects such as weed invasion.

On the basis of the above it is recommended that where possible the boardwalk design should be setback approximately 15 m from the TEC patch. The patch should also be fenced prior to construction to provide additional protection from potential direct impacts.

The buffer to the TEC should be reassessed when the exact extent of the TEC is known, as the site is a relatively narrow strip of vegetation and determining the proposed buffer prior to further botanical assessment may impact project viability.

4.6.3 Weeds

A weed is defined as a plant which has, or has the potential to have, a detrimental effect on economic, social or conservation values. Weeds can either be introduced species or native plants growing outside of their known population range. Weeds impact the coast in various ways including (WAPC, 2003):

- Reducing biodiversity at a site, and so threatening local flora and fauna species
- Disrupting ecosystem processes, for example weeds may increase the frequency of fire
- Disrupting coastal processes, for example weeds may contribute to erosion at some sites and alter dune configuration
- Inhibiting coastal rehabilitation strategies
- Requiring resources for their control.

Weeds can be spread through construction activities by being present within any imported construction/ building materials or being present on equipment used during the construction process. Prevention is the best weed management tool followed by direct and continual management and maintenance alongside the boardwalk.

Weeds will require active management prior to, during and after construction but will not pose a risk or constraint to development of a coastal boardwalk in this location.

4.6.4 Disease

Thousands of Australia's native plants and ecological communities are threatened by the soil-borne plant pathogen *Phytophthora spp.* with over 2000 potential host species in Western Australia alone (Shearer et al., 2004). Although many root pathogens cause disease in Australian flora species, *Phytophthora* has had the greatest effect and poses the greatest threat (DEE, 2018).

The death of native plants caused by the introduced pathogen *Phytophthora* (referred to commonly as dieback) greatly decreases the biodiversity of Western Australia native vegetation. Apart from these biological costs, disease caused by the pathogen known as Phytophthora dieback also has a number of other costs for Local Government. The death and local extinction of vegetation greatly diminishes the recreation and aesthetic values of bushland and roadsides.

Dieback caused by *Phytophthora cinnamomi* is listed as a key threatening processes under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

The pathogen *Phytophthora* dieback is known to be present within the Trigg Bushland area (NAC, 2014), however it has not been previously recorded within the site. It is considered unlikely that any vegetation

within the site will be susceptible to dieback, as the site lacks characteristic species known to be susceptible to the disease.

The fungus *Armillaria luteobubalina* has previously been recorded in the drain located within the site and is a known cause of death of *Acacia rostellifera* in the nearby greater Trigg Bushland area, however no observations of *A. luteobubalina* have been recorded since at this site (NAC, 2014). *A. luteobubalina* has also been found associated with dead or dying *Callitris preissii* on Garden Island (McArthur 1990), which occurs within the TEC on this site.

Movement of any water, soil or plant material through the site can spread dieback or other pathogens. As a precaution, disease controls should be imposed on any construction within the site to reduce the threat of further spread of disease. The risk of disease will not constrain any proposed boardwalk within the site, however management measures will need to be implemented.

4.6.5 Rehabilitation

The site contains various targeted areas of rehabilitation which have been undertaken from 2015 to present, with future works also proposed. In summary, these works include (refer Plate 3-11 for further information):

- South Trigg Restoration – works undertaken from 2015 to 2019 with approximately 7000 native tubestock installed
- South Trigg Lookout Restoration – works undertaken from 2018 to 2021 as a part of the Lookout development with approximately 2000 native tubestock installed
- Scarborough Beach shack restoration – works undertaken from 2020 – 2022 as a part of the Beach Shack development with approximately 4000 native tubestock installed
- North Scarborough Restoration – restoration works began in 2022 and are currently ongoing with a proposed completion date set for 2026, approximately 3500 native tubestock have been installed to date, and 1990 are proposed for installation in 2025.

There is opportunity to consider further rehabilitation works as a part of the proposed boardwalk project and any offsets required under the environmental approvals process (anticipated to be at a State level).

4.7 Fauna Impacts

With a variety of fauna species potentially utilising the site, impacts on fauna species need to be considered to protect and maintain biological diversity and ecological integrity.

4.7.1 Potential Injury During Construction

The clearing of native vegetation has the potential to result in injuries and fatalities to native fauna during construction, particularly ground- or tree-dwelling mammals and lizards, if no impact management measures are established. The following management measures can minimise the risk to fauna during construction activities:

- Preference be given to construction techniques requiring minimal clearing envelopes, such as elevated boardwalks.
- Fauna relocation to be undertaken by a qualified wildlife handler prior to and during clearing.
- Where possible, clearing is to be undertaken outside of the main breeding season for bushland birds (i.e. between July and November), to avoid inflicting damage to nesting birds and their young. (Note: this is most relevant to sites where potential nesting trees are present, and is therefore less relevant to this site.)
- Any native fauna injured during the clearing of vegetation is to be attended to by a qualified wildlife carer / veterinarian.

- Feral fauna attractants and potential native fauna traps such as open skip bins to be located outside of the site during and post-construction.

4.7.2 Habitat Impact

Any direct or indirect loss of vegetation within the site would result in a loss of habitat for native fauna within the site described in Section 3.6. Depending on the design of the proposed boardwalk, the structure may also pose a barrier to fauna movement through the site.

Any proposed development in this area should aim to minimise the impacts to the flora and vegetation so that biological diversity and fauna habitats are maintained. In addition, limiting the amount of clearing will assist in the attainment of the necessary approvals discussed in Section 7 as well as responding to community concerns regarding impacts to this site.

Expert advice was sought from Bamford Consulting Ecologists regarding minimum heights for fauna movement to be accommodated under the boardwalk. It was noted that should the boardwalk be surrounded by shrubbery, some terrestrial fauna which could occur at the site (e.g., lizards, snakes), could be travelling at 'shrub height', and therefore aiming to keep these species off the boardwalk may present significant challenges. However, it is assumed that a boardwalk height of at least 20 cm may ensure most fauna goes under, rather than over, the boardwalk.

Given several fauna species can get onto the boardwalk, the boardwalk design should therefore also consider facilitating fauna movement off the boardwalk. Boardwalk designs where the deck is edged by raised ridges or has solid side walls may restrict fauna movement off the boardwalk, for instance.

Provided clearing is kept to a minimum, it is unlikely that the proposed boardwalk will have a significant impact on fauna habitat, however management measures will need to be implemented prior to and during clearing and construction to minimise potential impacts and impediments to fauna movement.

4.8 Social Impacts

4.8.1 Visual Amenity

City of Stirling has received submissions during previous consultations with the public that raised concern on how any artificial structure could detract from the visual amenity and 'unspoilt' nature of the dunal landscape. Elevated boardwalks can have a significant visual impact dependent on the location in the landscape, construction material, height, colour and treatment of the boardwalk surface.

The *Visual Landscape Planning in Western Australia - a manual for evaluation, assessment siting and design* was released by the WAPC in November 2007. The manual provides a suite of visual assessment techniques for incorporating landscape factors into the planning system and in Part 3, specifically addresses coastal landscapes in detail. Structure height, landscape, seascape and visual landscape elements of coastal planning should reflect consideration of the manual in the boardwalk design.

Once a design is drafted, it is recommended that an independent landscape architect or visual amenity specialist evaluate the proposal from various viewpoints and nearby residential areas. Careful positioning and material selection for the boardwalk will be paramount to minimise visual intrusion.

A key consideration of the City is the implementation of lookout points within the proposed boardwalk. Considerations of environmental impacts and disturbance to nearby residential views will inform the lookout siting.

Visual amenity is a significant factor requiring careful consideration during the design of the boardwalk.

4.8.2 Heritage

The site does not contain any known Aboriginal or European Heritage places and as such poses no constraint to the proposed boardwalk within the site, with no approvals required.

However historical use of the reserve offers an opportunity for educational signage or public art installations at nodes along the boardwalk.

Construction workers should be briefed prior to ground disturbing activities to ensure they are aware of the requirements under the *Aboriginal Heritage Act 1972* should any cultural sites and potential objects of significance be discovered during excavation activities.

4.8.3 Litter

Wherever there are pedestrians, there is the potential for rubbish and litter to be generated. This is more likely if the boardwalk offers areas to sit and potentially 'picnic' along the route. To avoid litter being discarded along the route, careful consideration of providing rubbish bins provided at the start and end points, and potentially also at intermittent intervals along the route, preferably near to any proposed seating areas may alleviate this risk.

However, by providing rubbish bins they will need to be serviced regularly by the City. It is noted that the City's maintenance 'buggies' have been proposed in the past to collect this rubbish, however this requires a potential wider path width. Litter does not pose a constraint to the proposed boardwalk but management is required to be incorporated into the landscape planning and ongoing management schedule for the area.

4.9 Bushfire Risks

Coastal areas are particularly vulnerable to degradation following fires as the vegetation cover is the primary means of stabilising coastal environments. Any loss of vegetation cover removes the protective barrier which protects the dunes from erosion in strong winds. The typically sparse nature of coastal vegetation, negligible nutrient storage in the soil, the low moisture content of coastal sands and strong onshore winds can also make plant establishment following fires very difficult (WAPC, 2003).

Fire management not only involves minimising the risk of a fire from the outset, but also ensuring an adequate capacity to respond to fires should they occur, hence minimising their impact. Some strategies that can reduce the risk of impact of fire at the site could include (WAPC, 2003):

- Siting and design of infrastructure to minimise fire risk and assist in quick response times should a fire occur in this location.
- Use of materials which are fire resistant
- Local governments and volunteer fire authorities could develop a fire control strategy
- Fire prevention can also be assisted by good on-ground maintenance and management practices. These include frequent rubbish removal and fencing to control access to bushland areas
- Education and awareness strategies that educate site users about minimising the risk of fire to coastal reserves, and the potential impacts of fires on conservation objectives of coastal reserves can assist with fire management. Messages should include education on potential sources of ignition, such as cigarettes, and inappropriate activities, such as illegal beach fires.

Bushfire risk does not pose a constraint to the proposed boardwalk but should be considered within the location and design of the pathway. The risk to assets, community and the environment can be reduced with adequate emergency response times to fires and ongoing fire prevention tasks for the area.

5 Recommendations for the Proposed Boardwalk

5.1 Coastal Management Guiding Principles

The following guiding principles are outlined in the WAPC's *Coastal Planning and Management Manual for protecting and conserving the Western Australian coast* (WAPC, 2003). In reviewing the proposed boardwalk development the City of Stirling could be guided by these key principles:

1. *Sustainable management*

The coast should be managed in a way that ensures that the opportunities for future generations to use and appreciate the coast are not diminished by current decisions and actions.

2. *Identifying the limits of acceptable change*

Coastal managers should be aware of the physical limits to change at their site. Where there is an imperfect understanding, the precautionary principle should be applied.

The precautionary principle in coastal decision-making requires decision-makers to act in response to the best available science, knowledge and understanding of the consequences of decisions and in the context of uncertainty, to make decisions that minimise adverse impacts on current and future generations and the environment (WAPC, 2020). In the application of the precautionary principle, private and public decisions must be guided by:

   a. Careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment and

   b. An assessment of the risk weighted consequence of various options

3. *Maintenance of ecosystem integrity*

The coast should be managed to ensure that fundamental physical and natural processes can continue indefinitely.

4. *Consultation*

Open and collaborative consultation with all interested parties about the coast is essential for fair and equitable planning and management.

5. *Respect for and protection of Indigenous rights, interests, culture and heritage*

The rights and interests of Indigenous people and their unique relationship with the coast should be recognised, and Indigenous culture and heritage protected.

6. *Identification of management objectives*

Clearly understood and measurable objectives should be identified for coastal areas. These objectives should govern planning and management decisions.

5.2 Design considerations

A pathway along the coastline can be an important, highly utilised community asset. There are many considerations to balance when locating and designing such an asset as described in the previous section. Some of the key considerations and recommendations for this proposal in accordance with SPP 2.6 are:

- Ensure that the location and design of the boardwalk minimises potential impacts to coastal processes and landform stability, taking into account predicted coastal hazards such as coastal erosion and climate change.

- To minimise risk to the proposed coastal boardwalk from coastal erosion, the proposed boardwalk should in the most part be situated to the east of the 2070 coastal erosion hazard extent detailed in the City's CHRMAP.
- Protect, enhance and minimise impact to coastal zone values, particularly in landscape, biodiversity and ecosystem integrity.
- Ensure design does not substantially alter existing natural drainage patterns.
- Disturbance of existing vegetation during construction should be minimised to the smallest footprint practicable. The loss of vegetation and flora within the site is a significant constraint to the proposed development and minimising the impact to this vegetation should be one of the highest priorities considered in the boardwalk design and construction techniques.
- If disturbance to vegetation is unavoidable, the area should be rehabilitated after disturbance with native species of local origin to stabilise landforms in and around the infrastructure.
- Places of unique landscape and scientific significance should be avoided during the design process including the *Callitris preissii* (or *Melaleuca lanceolata*) Forests and Woodlands of the Swan Coastal Plain TEC, which is listed as Critically Endangered under the State *Biodiversity Conservation Act 2016*. This should be protected with a suitable buffer applied.
- Development should be designed and construction managed to minimise invasion by introduced species, disease and pests.
- Development should be designed to not occur on or adjacent to unstable or mobile dune landforms susceptible to erosion.
- Natural sediment processes, including lithification and wind or water transport should not be significantly or permanently altered by the development.
- Control public access either side of the accessway through fencing or balustrading. This type of access may be susceptible to erosion or require frequent or costly maintenance to preserve safety.
- The proposed boardwalk should be sustainably designed to minimise erosion, wind tunnelling and maintenance.
- Visual amenity is a significant factor requiring careful consideration during the design of the boardwalk.
- Siting and design of the infrastructure to minimise fire risk, and assist in quick response times when fires occur.
- Pedestrian access paths should be justified in terms of a coastal public access purpose and potential impacts described and managed through preparation of a Construction Environmental Management Plan and ongoing maintenance and management outlined within a Foreshore Management Plan.

5.2.1 Construction Method

Any proposed construction method in this area should aim to minimise the impacts to the flora and vegetation so that biological diversity and fauna habitats are maintained. In addition, limiting the amount of clearing will assist in the attainment of the necessary approvals discussed in Section 7 as well as responding to community concerns regarding impacts to this site.

To avoid the erosion and destabilisation of the coastal landforms, disturbance and removal of dune formations should also be kept to the bare minimum. To achieve these objectives the design should focus on minimising the overall disturbance footprint. Preference should be given to construction techniques requiring minimal clearing envelopes, such as elevated boardwalks with larger spans and cantilevered

structures over potentially sensitive landforms and vegetation. Engineering advice should be sought in relation to this matter.

Measures and management proposed to achieve minimal impact during construction can be detailed in a Construction Environmental Management Plan for the proposed boardwalk (further discussed in Section 5.2.3).

5.2.2 Construction Materials

Visual amenity is a significant factor requiring careful consideration during the design of the boardwalk. The City of Stirling has received submissions during previous consultations with the public that raised concern on how any artificial structure in this area could detract from the visual amenity and 'unspoilt' nature of the dunal landscape. Elevated boardwalks in particular can have a significant visual impact dependent on the location in the landscape dependent on construction material, height, colour and treatment of the boardwalk surfaces.

Once a design is drafted, it is recommended that an independent landscape architect or visual amenity specialist evaluate the proposal from various viewpoints and nearby residential areas. Careful positioning and material selection for the boardwalk will be paramount to minimise visual intrusion.

No machinery, equipment or material storage/laydown areas should be located within areas of native vegetation to be retained. If possible a site compound should be established at one of the carparks at either end of the site to accommodate construction materials, equipment and machinery. This can be detailed in a Construction Environmental Management Plan for the proposed boardwalk.

5.2.3 Construction Controls

Unmanaged construction at the site has the potential to cause significant environmental impacts including:

- Poor management and/or supervision during construction activities may lead to the loss and/or degradation of native vegetation and fauna habitat outside of clearing boundaries.
- Uncontrolled access into the reserve may result in vandalism or damage to native vegetation.
- Vehicle interactions resulting in injury or death of native fauna.
- Introduction and/or spread of weed species and pathogens leading to reduced flora species and ecological diversity.
- Wind erosion generated from construction activities has the potential to impact on local flora and fauna, impact local air quality and affect dune stability.
- Noise generated outside of hours without prior approval can cause local nuisance.
- Site activities have the potential to cause bushfires in the reserve, leading to damage or death of local flora, fauna, and/or communities, following by potential land degradation and dune instability. In addition, there is a risk to assets, the community and nearby buildings.
- Uncontrolled waste may result in risk of injury, pollution to groundwater, harm to native fauna and attract feral animals.

Where construction is proposed in sensitive environments such as this it is imperative that a series of construction controls are developed well in advance of construction occurring to mitigate the risks posed by the above impacts. Often these controls are required to be documented as a condition on the relevant approvals. This documentation is often referred to as a Construction Environmental Management Plan (CEMP). CEMPs are also often recommended to be prepared in advance and in support of the assessment of the proposed development.

Any CEMP should be prepared in accordance with the EPA's *Instructions: How to prepare EP Act Part IV Environmental Management Plans* (EPA, 2024). Management actions should also be developed according to the SMART principal, in that they are:

- Specific
- Measurable
- Attainable
- Relevant
- Timebound.

Some construction controls that are likely to be included in the future CEMP for this site include:

- Measures to avoid and mitigate impacts to conservation significant vegetation, flora, and fauna, including:
  - Hygiene requirements to prevent the introduction or spread of weeds and disease
  - Clearing and access control measures (such as demarcation and temporary fencing of clearing boundaries)
  - Erosion and sediment control
  - Topsoil management
  - Demarcation of site laydown, materials and equipment storage areas
- Waste and fire management
- Pre-clearing fauna inspections/relocation
- Performance indicators that measure the effectiveness of avoidance and mitigation measures
- Contingency measures that will be undertaken if performance targets are not met
- Monitoring and reporting
- Roles and responsibilities of personnel associated with implementing mitigation measures.

5.2.4 Post-Construction Controls

Following the establishment of the infrastructure there will be a requirement for ongoing management and maintenance within the site to ensure that biological diversity and landform stability are maintained. For this site it is recommended that a Foreshore Management Plan (FMP) be prepared to document these ongoing commitments. The FMP could identify:

- The key environmental features of the reserve and foreshore zone.
- How access to the coastline can be maintained in a controlled and sensitive manner.
- How integration of passive recreational opportunities can be achieved without detrimental environmental impacts within the foreshore zone.
- Areas requiring native vegetation planting or revegetation, and outline components of this program including site stabilisation, weed control, planting and maintenance/monitoring programs.
- Identify how rubbish/litter accumulation will be managed.
- Fire prevention on-ground maintenance and management practices.
- Community education and awareness strategies.

5.2.5 Community Considerations

Other items which the City may wish to consider with regard to community matters include:

- Passive surveillance of the area such as CCTV
- Education opportunities such as informative signage to promote public awareness of the sensitive environment around the boardwalk

It is noted that these items should be considered at later stages and do not necessarily form part of the preliminary environmental feasibility studies, however, should still be noted as a likely future consideration.

5.3 Relevant Example Projects

To inform this report, Coterra undertook a review of project with similar constraints or proposed outcomes and summarised key points relevant to the boardwalks implementation. An overview of these projects is presented below (Table 5-1).

Table 5-1: Boardwalk Project Examples with Environmental Relevance

Project	Project Overview	Relevant Environmental Considerations/ Outcomes
Kalbarri Sky Walk (Plate 5-1)	Two cantilevered viewing platforms which extend over the Kalbarri National Park, constructed as tourist attraction, elevated 100 m over a Murchison River gorge.	• Excavated sandstone was reused around the project to enhance landscape • Structures were pre-assembled in a workshop to reduce on-site assembly • Erosion concerns were at the forefront of design considerations • Skywalk was developed to be fully accessible • Primary purpose was construction of a tourist attraction
Yanchep Coastal Boardwalk (Plate 5-2)	A boardwalk/ walking trail spanning 4 km one-way, encompassing several viewpoints overlooking the ocean.	• Within an ESA and coastal location • NVCP received for the site which facilitated the construction of the boardwalk and pedestrian access ways • Management controls required through the DWER NVCP process such as ongoing weed control • Offsets adjacent to the clearing area boundary (either side of boardwalk)
Valley of the Giants Treetop Walk (Plate 5-3(	A treetop walk extending up to 40 m high through the Valley of the Giants in Western Australia's South-west. Lower level boardwalks installed along forest floor.	• Well known tourist attraction that required management actions to ensure its longevity and protection of the natural environment • Parts of skywalk were fabricated and partially assembled off-site to reduce environmental damage • Through environmental investigations the path of least damage was able to be determined, and areas which required restoration were established • Enhanced experience of the already existing tourist attraction that provided better environmental outcomes
Terrigal Coastal Boardwalk (Plate 5-4)	A 220 m long raised coastal boardwalk walking platform, including viewing and rest points in Terrigal, New South Wales.	• Main purpose was to provide public access along foreshore • Was designed to be accessible and safe for all users • Main objective was to avoid and minimise potential environmental impacts • Community Engagement Plan included consultation sessions

Project	Project Overview	Relevant Environmental Considerations/ Outcomes
		• Construction works were tailored to be environmentally sensitive • Boardwalk was prefabricated and fixtures were installed on site • Implementation of a Construction Environmental Management Plan
City Beach to Floreat coastal boardwalk (Plate 5-5)	A boardwalk through coastal sand dunes which links City Beach and Floreat Beach	• Similar coastal environment • Similar purpose of construction • Incorporated viewing platforms • Boardwalk panels were designed to allow off-site fabrication • Elevated platform with recycled timber power poles to reduce environmental impacts • Galvanised steel and salvaged recycled jarrah to reduce ongoing maintenance

Plate 5-1: Kalbarri Sky Walk

Source: https://exploreparks.dbca.wa.gov.au/site/kalbarri-skywalk

Plate 5-2: Yanchep Coastal Boardwalk

Source: https://perthpeelcoastalwalk.com/yanchep

Plate 5-3: Walpole Treetop Walk

Source: https://exploreparks.dbca.wa.gov.au/site/valley-giants-tree-top-walk

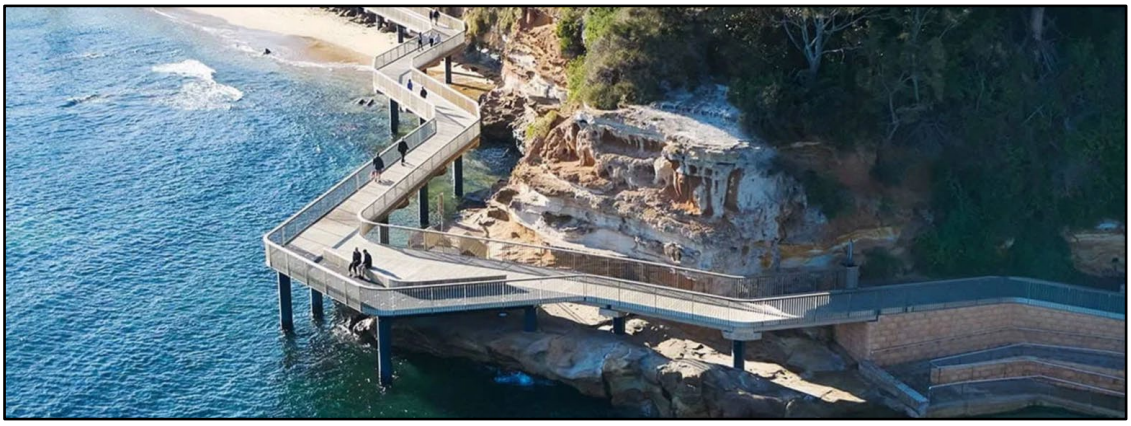

Plate 5-4: Terrigal Coastal Boardwalk

Source: https://www.arup.com/projects/terrigal-boardwalk/

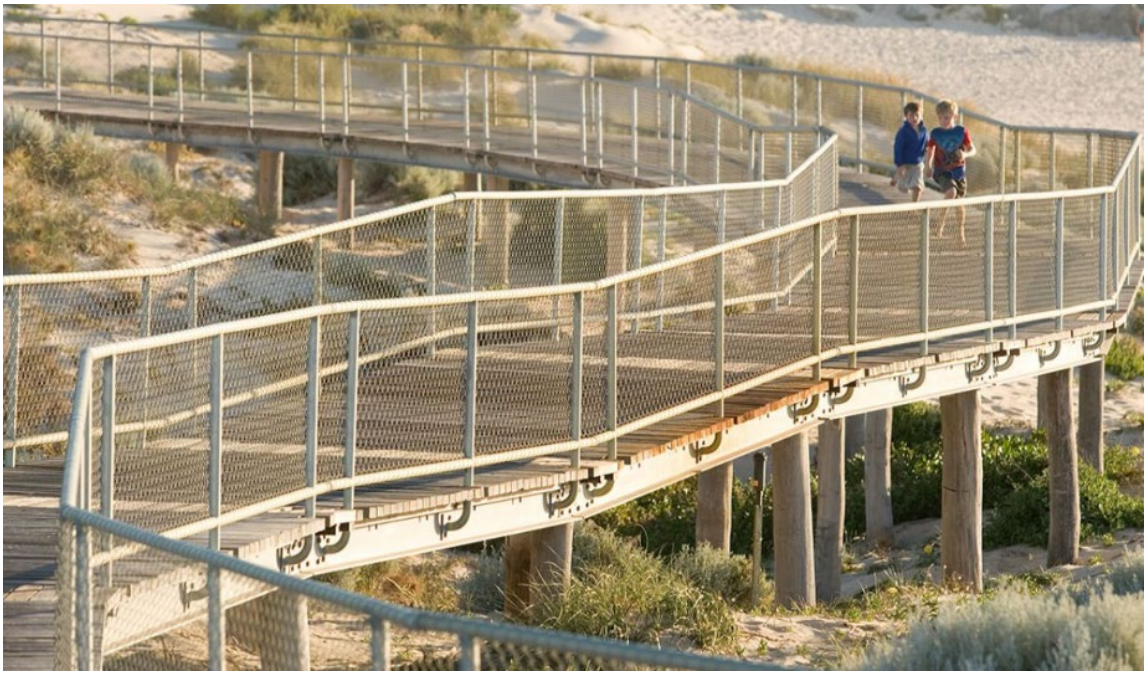

Plate 5-5: City Beach to Floreat Coastal Boardwalk

Source: https://www.pfeng.com.au/gallery/ports-marine/feature-projects-8/beach-dune-boardwalk/

6 Gap Analysis

This report is proposed to be utilised to identify the potential environmental impacts, and preliminary environmental opportunities and constraints of the proposed coastal boardwalk. A gap analysis has also been completed identifying further studies and technical reports recommended to be undertaken to inform the future design and alignment of the boardwalk. This information would also be valuable to include within this opportunities and constraints report to bolster the technical details, prior to it being made publicly available.

6.1 Flora and Vegetation Survey

In summer 2014, Natural Areas Consulting (NAC) undertook a flora and vegetation assessment of the site as part of a broader project. Due to a number of factors the vegetation in a particular area can change over time particularly in regard to vegetation condition and flora composition. Ten year old flora and vegetation survey results are unlikely to be acceptable to the Environmental Protection Authority (EPA) or the Department of Water and Environmental Regulation (DWER) when submitting a Section 38 EP Act referral (described in Section 7) or an application to clear native vegetation within a Bush Forever site and A Class Nature Reserve (Section 7). As such it is recommended an updated flora and vegetation survey be undertaken in Spring 2025. If desired, an out of season component of the survey could be completed prior to spring to provide earlier initial information to support the design, with the spring survey component then completed at the appropriate time to finalise the technical input.

6.2 Fauna Survey

Previous fauna and habitat surveys were undertaken for the BF 308 site, as well as in 2015 by NAC across part of the site, however there has not been a survey undertaken with specific focus on the proposed boardwalk site. As such, the City may wish to consider undertaking a Level 1 ('Basic') fauna and habitat assessment, which could provide information on:

- Any conservation significant fauna which may utilise the area, and how the proposed development may impact these species
- Context for specific design considerations (e.g., if snakes are recorded to be present, the boardwalk design may wish to be raised to not allow snakes to use it as an overpass, or provide information on size of expected fauna which may need to use the underpass of the boardwalk so habitat isolation does not occur)
- Feral fauna species which may require management
- Specific construction fauna management requirements.

6.3 Land Quality Assessment

During the site inspection on 7 October 2024, Coterra Environment observed rubbish which may potentially contain asbestos containing material (ACM). As a first step a review of historical land uses within and adjacent to the site could be undertaken to establish the likely source and relative risk of ACM or other material of potential concern being present, or if these surface fragment were isolated occurrences only.

Depending on the outcomes of the initial review, the City may wish to consider a preliminary site investigation to assess the potential presence and extent of materials of concern with reference to the investigation recommendations presented in the DWER (2021) *Assessment and Management of Contaminated Sites*, National Environment Protection Council (NEPC, 2013) *National Environment Protection (Assessment of Site Contamination) Measure 1999* (ASC NEPM) and Department of Health (DoH, 2021) *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia*.

6.4 Future Documentation for Environmental Approvals

6.4.1 Construction Environmental Management Plan

Where construction is proposed in sensitive environments such as this site, it is imperative that a series of construction controls are developed well in advance of construction occurring to mitigate the risks posed by the above impacts. Often these controls are required to be documented as a condition on the relevant approvals. This documentation is often referred to as a Construction Environmental Management Plan (CEMP). CEMPs are also often recommended to be prepared in advance and in support of the assessment of the proposed development under the EP Act.

Any CEMP should be prepared in accordance with the EPA's *Instructions: How to prepare EP Act Part IV Environmental Management Plans* (EPA, 2024).

6.4.2 Foreshore Management Plan

Following the establishment of the infrastructure there will be a requirement for ongoing management and maintenance within the site to ensure that biological diversity and landform stability are maintained. For this site it is recommended that a Foreshore Management Plan (FMP) be prepared to document these ongoing commitments.

6.4.3 CHRMAP Assessment

Depending on the proposed location of the boardwalk SPP 2.6 requires that all development applications likely to be impacted by coastal hazards during the 100-year planning timeframe should be accompanied by a CHRMAP.

The CHRMAP is to be in accordance with the CHRMAP Guidelines, indicating the risk management measures to be implemented to reduce coastal hazard risk to tolerable levels for the development. If a CHRMAP already exists and covers the development site (for example the one completed and adopted by the City of Stirling), then the existing CHRMAP should be included with detail of how the development is consistent with it (WAPC, 2020).

6.5 Future Expert Input

It is recommended that specialist advice from a Landscape Architect be obtained to assist with boardwalk design and alignment considerations. In addition specialist engineering is also recommended regarding boardwalk construction and associated options for consideration to address potential environmental impacts.

7 Potential Environmental Approval Requirements

In Western Australia, environmental impacts are regulated through the EP Act. Part IV of the EP Act provides for the assessment of significant proposals and planning schemes, whereas Part V provides for the issuing of permits, works approvals and licenses, such as permits to clear native vegetation.

At the federal level, proposals which may significantly impact Matters of National Environmental Significance (MNES) require referral under the EPBC Act. MNES include (but are not limited to) species and ecological communities listed as threatened under the Act.

7.1 Part V of the *Environmental Protection Act 1986*

7.1.1 Native Vegetation Clearing Permit

DWER assesses and determines application for approval to clear native vegetation through a Native Vegetation Clearing Permit (NVCP) application process. Regard is given to the clearing principles contained in Schedule 5 of the EP Act and to any planning instrument or other matters DWER considers relevant. It is worthwhile to note that in accordance with Regulation 5 Item 1 of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004,* clearing undertaken to construct a building or structure is exempt from requiring a native vegetation clearing permit; however, the exemption does not apply to riparian vegetation and areas mapped as Environmentally Sensitive Areas, which includes this site.

An assessment and approvals process via a NVCP is considered to have the following advantages for suitable projects over a formal assessment under Part IV of the EP Act:

- Timeframes for approval are substantially less (considered in terms of months, rather than years)
- There is one assessment pathway only, giving certainty on process prior to application
- Clearing permits attract a smaller, fixed, and predictable government fee, as opposed to the complex and significant cost recovery requirements under Part IV.

The above notwithstanding, the EP Act requires proposals which may have a significant impact on the environment to be assessed under Part IV of the Act.

7.1.2 Environmental Offsets

It should be noted that provision of environmental offsets is likely to be a requirement of a NVCP approval and the preference is generally that these offsets be located as close to the clearing area as possible. As such, onsite rehabilitation in the coastal reserve within the surrounding the site may be a good option to explore given the success of the City's current revegetation projects. Updated flora and vegetation survey information would provide a better guide to any areas within the site which may benefit from rehabilitation works.

7.2 Part IV of the *Environmental Protection Act 1986* – S38 Referral

While the nature and extent of impacts these project components may have on the environment is currently unknown, should it become apparent that the residual impacts will trigger significance thresholds under the EP Act, then it is likely that a s38 referral under Part IV of the EP Act may be required.

Given the level of public scrutiny that this project may be subject to, and that the location of the development within a site that is designated Bush Forever and an A Class Reserve, there may be an expectation for the City to refer this development to the EPA for its consideration under Part IV of the EP Act regardless of whether the residual impacts trigger the significance thresholds under the EP Act.

It is worthwhile to note that section 38(1) of the EP Act provides third party referral rights, which would give any concerned community member or organisation to refer the proposed development to the EPA for its

consideration. Going forward, and once the residual impacts are known and understood, it is recommended further analysis is undertaken to determine the likely risks and whether there is merit in progressing a section 38 referral.

7.3 Environment Protection and Biodiversity Conservation Act 1999

Although currently it is not expected that there will be impacts to MNES, once the proposed technical studies have been undertaken and the design concept is prepared, it is recommended that a review is undertaken to determine if there any impacts to MNES which may require approval under the EPBC Act.

8 Conclusion

A pathway along the coastline is an important, highly utilised community asset. There are many considerations to balance when locating and designing such an asset as described in the previous sections. Some of the key considerations and recommendations for this proposal are:

- Ensure that the location and design of the boardwalk minimises potential impacts to coastal processes and landform stability, taking into account predicted coastal hazards such as coastal erosion and climate change.
- To minimise risk to the proposed coastal boardwalk from coastal erosion, the proposed boardwalk should in the most part be situated to the east of the 2070 coastal erosion hazard extent detailed in the City's CHRMAP.
- Protect, enhance and minimise impact to coastal zone values, particularly in landscape, biodiversity and ecosystem integrity.
- Ensure design does not substantially alter existing natural drainage patterns.
- Disturbance of existing vegetation during construction should be minimised to the smallest footprint practicable. The loss of vegetation and flora within the site is a significant constraint to the proposed development and minimising the impact to this vegetation should be one of the highest priorities considered in the boardwalk design and construction techniques.
- If disturbance to vegetation is unavoidable, the area should be rehabilitated after disturbance with native species of local origin to stabilise landforms in and around the infrastructure.
- Places of unique landscape and scientific significance should be avoided during the design process including the *Callitris preissii* (or *Melaleuca lanceolata*) Forests and Woodlands of the Swan Coastal Plain TEC, which is listed as Critically Endangered under the State *Biodiversity Conservation Act 2016*. This should be protected with a suitable buffer applied.
- Development should be designed and construction managed to minimise invasion by introduced species, disease and pests.
- Development should be designed to not occur on or adjacent to unstable or mobile dune landforms susceptible to erosion.
- Natural sediment processes, including lithification and wind or water transport should not be significantly or permanently altered by the development.
- Control public access either side of the accessway through fencing or balustrading. This type of access may be susceptible to erosion or require frequent or costly maintenance to preserve safety.
- The proposed boardwalk should be sustainably designed to minimise erosion, wind tunnelling and maintenance.
- Visual amenity is a significant factor requiring careful consideration during the design of the boardwalk.
- Siting and design of the infrastructure to minimise fire risk, and assist in quick response times when fires occur.
- Pedestrian access paths should be justified in terms of a coastal public access purpose and potential impacts described and managed through preparation of a Construction Environmental Management Plan and ongoing maintenance and management outlined within a Foreshore Management Plan.
- Specialist advice from a Landscape Architect be obtained to assist with boardwalk design and alignment considerations, with specialist engineering also recommended regarding boardwalk construction and associated options to address potential environmental impacts.

9 References

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Figures

Source: Cadastre - Landgate
Orthophoto - NearMaps, 14.09.24

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City of Stirling
COASTAL BOARDWALK OPPORTUNITIES AND CONSTRAINTS REPORT
WEST COAST HIGHWAY, SCARBOROUGH, CITY OF STIRLING

SITE LOCATION

Figure 1

C:\GIS\Jobs\CoTerra\COSBWK01 - CoS Coastal Boardwalk, Opp and Cons\Figures\COSBWK01_F01 Site Location_241025.mxd

LEGEND

- Site Boundary
- Cadastre
- Contour (mAHD)

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3

GDA2020 MGA Zone 50

INDIAN OCEAN

West Coast Hwy

West Coast Tce

Bournemouth Pde

Peet Cr

Harwood Ct

Abney Pl

Contacio Cove

Diego Ct

Pearl Pde

The Esplanade

Reserve St

Source: Contours - DPIRD
Cadastre - Landgate
Orthophoto - NearMaps, 14.09.24

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TOPOGRAPHY - CONTOURS

Figure 2a

C:\GIS\Jobs\CoTerra\COSBWK01 - CoS Coastal Boardwalk, Opp and Cons\Figures\COSBWK01_F02a Topography - Contours_241025.mxd

LEGEND

Site Boundary

Cadastre

Elevation (mAHD)

22.0

0.0

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3

GDA2020 MGA Zone 50

INDIAN OCEAN

West Coast Hwy

West Coast Hwy

West Coast Tce

Bournemouth Pde

Peet Cr

Abney Pl

Contacio Cove

Diego Ct

Pearl Pde

The Esplanade

Reserve St

Source: Contours - DPIRD
Cadastre - Landgate
Orthophoto - NearMaps, 14.09.24

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TOPOGRAPHY - DIGITAL ELEVATION MODEL

Figure 2b

C:\GIS\Jobs\CoTerra\COSBWK01 - CoS Coastal Boardwalk, Opp and Cons\Figures\COSBWK01_F02b Topography - DEM_241025.mxd

LEGEND

- Site Boundary
- Cadastre

Soil Landscape Mapping

- 211Qu__S1: EnvGeol S1 Phase
- 211Qu__S2: EnvGeol S2 Phase

Geology

- S1: CALCAREOUS SAND - white, fine to medium-grained, sub-rounded quartz and shell debris, of eolian origin.
- S2: CALCAREOUS SAND - as S1

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA2020 MGA Zone 50

INDIAN OCEAN

211Qu__S1

S1

211Qu__S2

S2

West Coast Hwy

West Coast Hwy

West Coast Tce

Bournemouth Pde

Peel Cr

Harwood Ct

Abbey Pl

Contacio Cove

Diego Ct

Pearl Pde

The Esplanade

Reserve St

Source: Cadastre - Landgate
Orthophoto - NearMaps, 14.09.24
Geology - DoIR: Geological Survey of W.A., 1999

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SOILS

Figure 3

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LEGEND

- Site Boundary
- Cadastre
- Coastal Waterline
- Water Pipe
- Drainage Pipe
- Drainage Pit

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA2020 MGA Zone 50

Source: Cadastre - Landgate
Drainage and Pipes - WCORP
Orthophoto - NearMaps, 14.09.24

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HYDROLOGY

Figure 4

C:\GIS\Jobs\CoTerra\COSBWK01 - CoS Coastal Boardwalk, Opp and Cons\Figures\COSBWK01_F04 Hydrology_241125.mxd

LEGEND

- Site Boundary
- Cadastre
- Native Vegetation Extent
- SPP 2.8 Bush Forever Area
- Threatened Ecological Community

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA2020 MGA Zone 50

Source: Cadastre - Landgate
Orthophoto - NearMaps, 14.09.24 | TEC - CoS
Bush Forever - DPLH | Native Veg Extent - DPIRD

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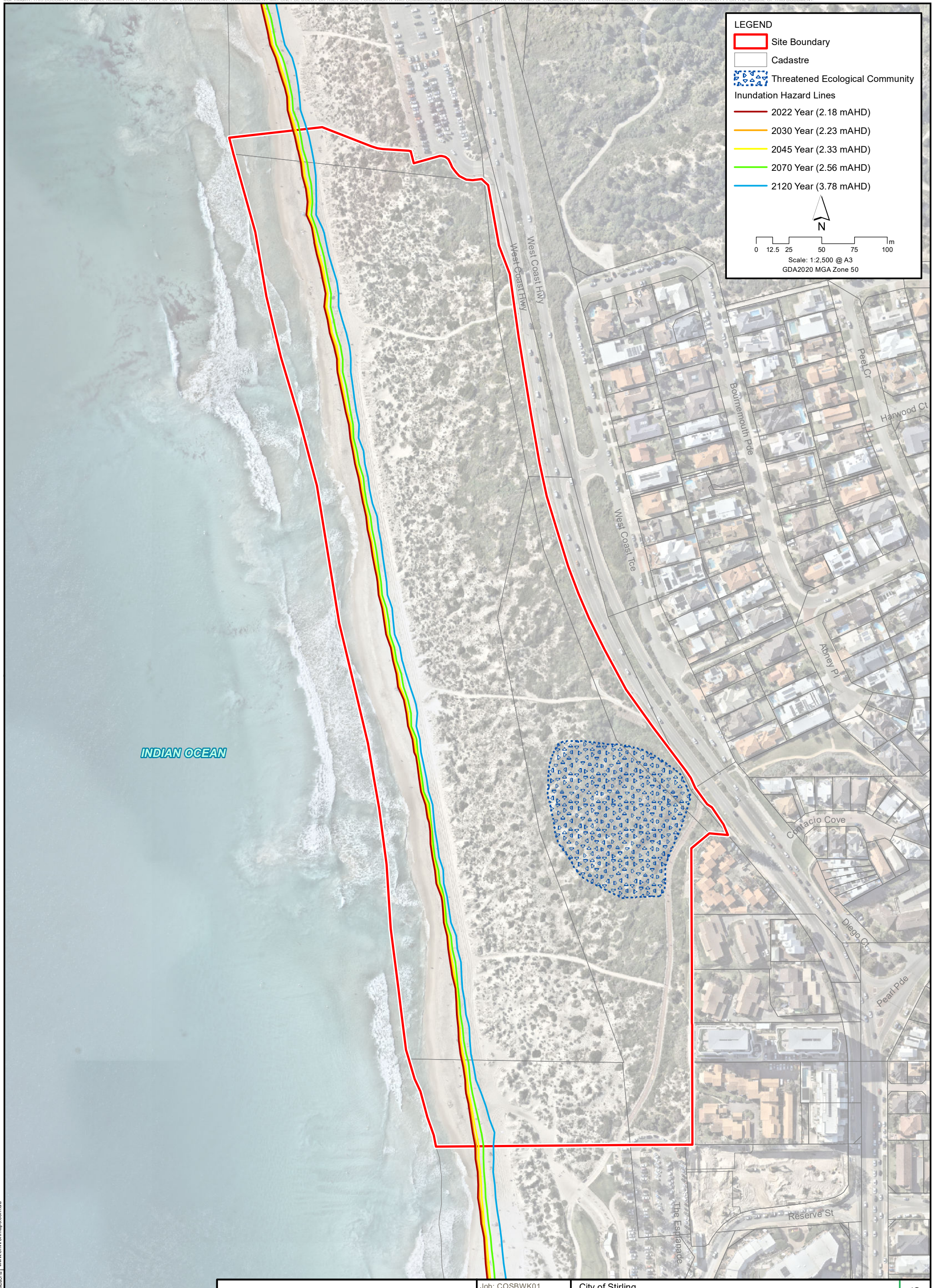
VEGETATION AND CONSERVATION AREAS

Figure 5

C:\GIS\Jobs\CoTerra\COSBWK01 - CoS Coastal Boardwalk, Opp and Cons\Figures\COSBWK01_F07 Vegetation and Conservation Areas_241125.mxd



Source: Contours - DPIRD
Cadastre - Landgate | TEC - CoS
Orthophoto - NearMaps, 14.09.24

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INUNDATION HAZARD LINES

Figure 6

LEGEND

- Site Boundary
- Cadastre
- Threatened Ecological Community

Erosion Hazard Lines - Limestone

- 2030
- 2045
- 2070
- 2120

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA2020 MGA Zone 50

INDIAN OCEAN

West Coast Hwy
West Coast Hwy
West Coast Tce
Bournemouth Pde
Peel Cr
Hanwood Ct
Abney Pl
Contacio Cove
Diego Ct
Pearl Pde
The Esplanade
Reserve St

Source: Contours - DPIRD
Cadastre - Landgate | TEC - CoS
Orthophoto - NearMaps, 14.09.24

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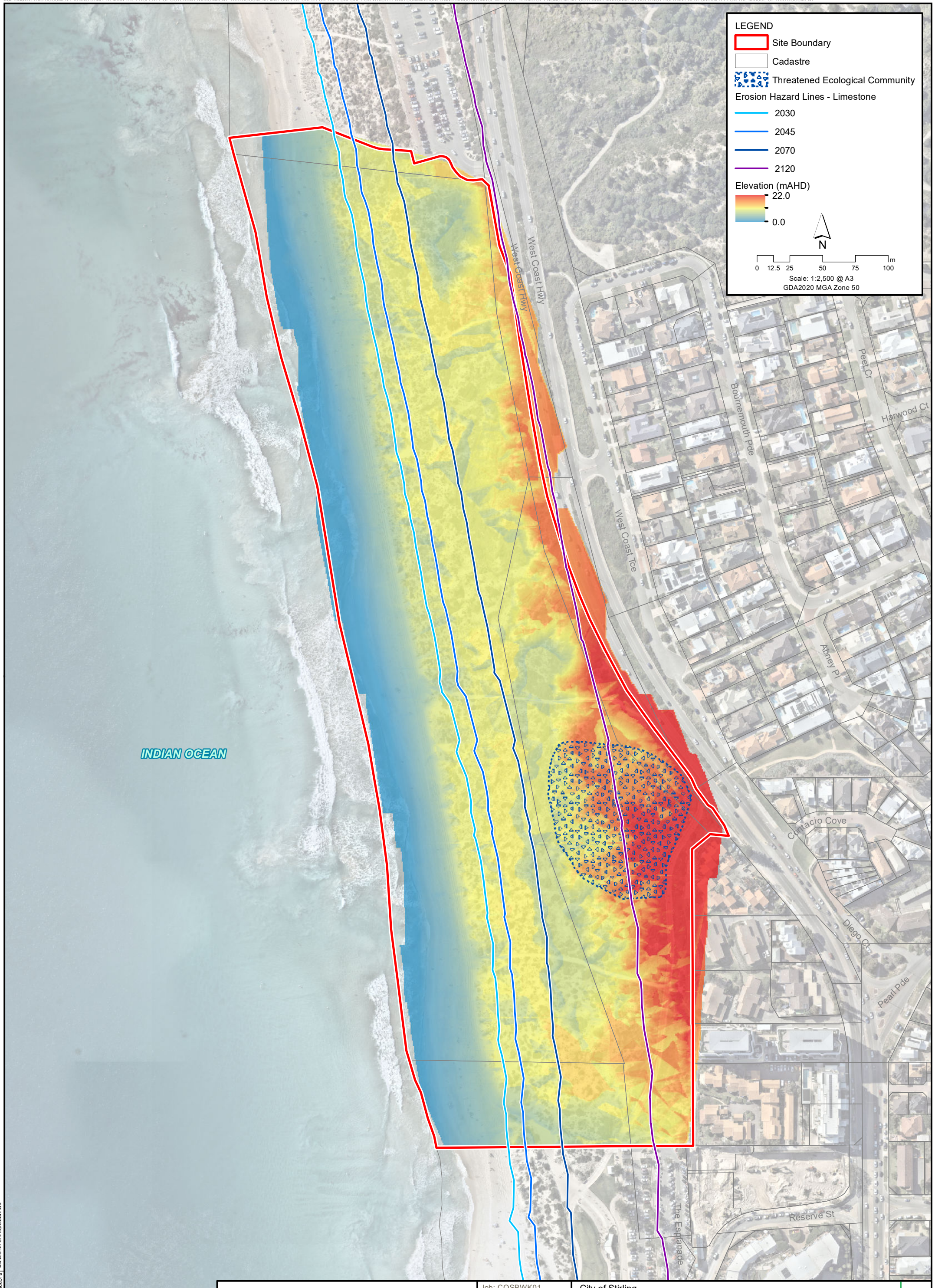
EROSION COASTAL LINES

Figure 7

C:\GIS\Jobs\CoTerra\COSBWK01 - CoS Coastal Boardwalk, Opp and Cons\Figures\COSBWK01_F05 Erosion Coastal Lines_241125.mxd



Source: Contours - DPIRD
Cadastre - Landgate | TEC - CoS
Orthophoto - NearMaps, 14.09.24

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OPPORTUNITIES AND CONSTRAINTS

Figure 8

C:\GIS\Jobs\CoTerra\COSBWK01 - CoS Coastal Boardwalk, Opp and Cons\Figures\COSBWK01_F08 Opps and Cons_241125.mxd

Appendix 1 Weed Mapping

Weedcover 2014

1 0 - 20%
2 21 - 40%
3 41 - 60%
4 61 - 80%
5 81 - 100%

Labelling

Weedcover Value 2011
3
111 ** CS
Polygon Number
* = Weed control
** = Restoration

carried out by:
Stirling Natural Environment Coastcare (SNEC), Westcoast (W) or City of Stirling (CS)

City of Stirling - Remap of 2011 SNEC Weed Mapping

Date: 26/06/2015	Prepared by Matze Riedel for Fisher Research Pty Ltd
Page 20 of 38	Map number: T1
Photomap by nearmap.com (15/2/2011)	
Scale: 1:1000	
Coordinate System: GDA 1994 MGA Zone 50	

0 10 20 30 40 50 m

Stirling Natural Environment Coastcare
Coastwest
City of Stirling
Perth Region NRM

Weedcover 2014

1 0 - 20%
2 21 - 40%
3 41 - 60%
4 61 - 80%
5 81 - 100%

Labelling

Weedcover Value 2011
3
111 ** CS
Polygon Number
* = Weed control
** = Restoration

carried out by:
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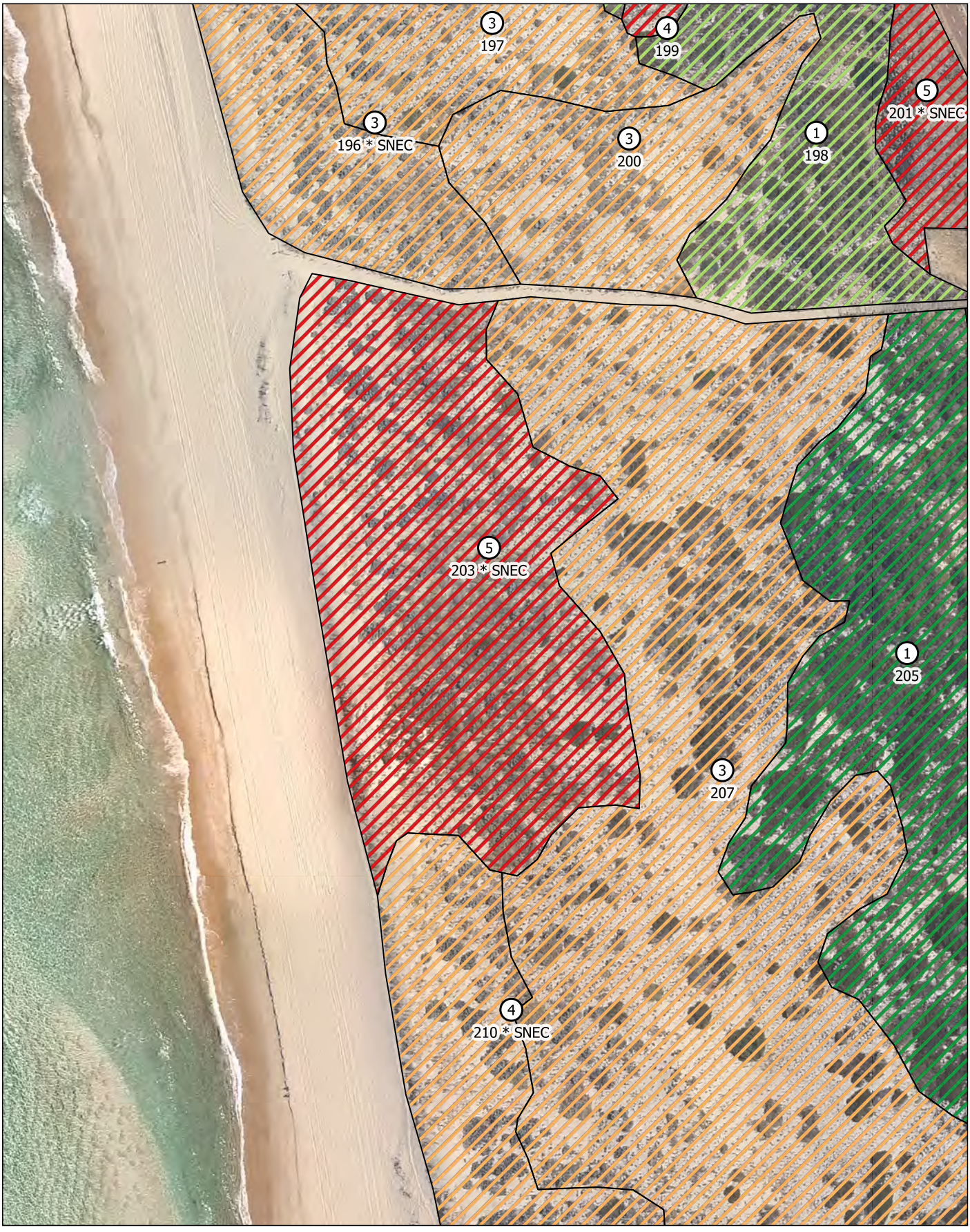
City of Stirling - Remap of 2011 SNEC Weed Mapping

Date: 26/06/2015	Prepared by Matze Riedel for Fisher Research Pty Ltd
Page 21 of 38	Map number: U1
Photomap by nearmap.com (15/2/2011)	
Scale: 1:1000	
Coordinate System: GDA 1994 MGA Zone 50	

0 10 20 30 40 50 m

Stirling Natural Environment Coastcare
Coastwest
City of Stirling
Perth Region NRM



Weedcover 2014

1 0 - 20%
2 21 - 40%
3 41 - 60%
4 61 - 80%
5 81 - 100%

Labelling

Weedcover Value 2011 → 3

111 ** CS

Polygon Number

* = Weed control
** = Restoration

carried out by:
Stirling Natural Environment Coastcare (SNEC), Westcoast (W) or City of Stirling (CS)

City of Stirling - Remap of 2011 SNEC Weed Mapping

Date: 26/06/2015	Prepared by Matze Riedel for Fisher Research Pty Ltd
Page 22 of 38	Map number: V1
Photomap by nearmap.com (15/2/2011)	
Scale: 1:1000	
Coordinate System: GDA 1994 MGA Zone 50	

0 10 20 30 40 50 m

Stirling Natural Environment Coastcare
Coastwest
City of Stirling
Perth Region NRM

Weedcover 2014

1		0 - 20%
2		21 - 40%
3		41 - 60%
4		61 - 80%
5		81 - 100%

Labelling

Weedcover Value 2011

3

111 ** CS

Polygon Number

* = Weed control
** = Restoration

carried out by:
Stirling Natural Environment Coastcare (SNEC), Westcoast (W) or City of Stirling (CS)

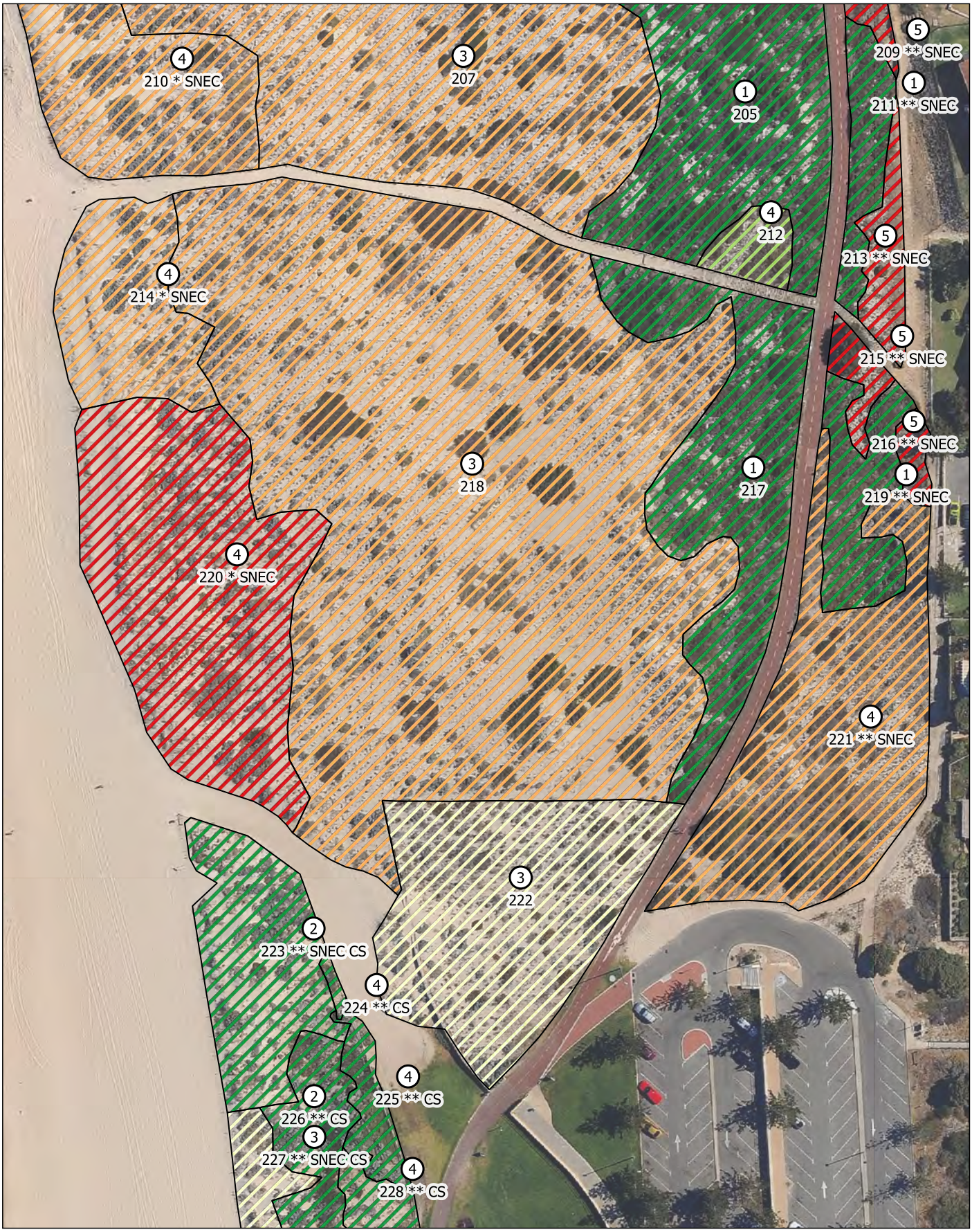
City of Stirling - Remap of 2011 SNEC Weed Mapping

Date: 26/06/2015	Prepared by Matze Riedel for Fisher Research Pty Ltd
Page 23 of 38	Map number: V2
Photomap by nearmap.com (15/2/2011)	
Scale: 1:1000	
Coordinate System: GDA 1994 MGA Zone 50	

0 10 20 30 40 50 m

Stirling Natural Environment Coastcare

Coastwest City of Stirling Perth Region NRM



Weedcover 2014

1 0 - 20%
2 21 - 40%
3 41 - 60%
4 61 - 80%
5 81 - 100%

Labelling

Weedcover Value 2011

3

111 ** CS

Polygon Number

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carried out by:
Stirling Natural Environment Coastcare (SNEC), Westcoast (W) or City of Stirling (CS)

City of Stirling - Remap of 2011 SNEC Weed Mapping

Date: 26/06/2015	Prepared by Matze Riedel for Fisher Research Pty Ltd
Page 24 of 38	Map number: W1
Photomap by nearmap.com (15/2/2011)	
Scale: 1:1000	
Coordinate System: GDA 1994 MGA Zone 50	

0 10 20 30 40 50 m

Stirling Natural Environment Coastcare

Coastwest City of Stirling Perth Region NRM

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