Ordinary Meeting of Council

Paraburdoo

Attachments – Public Document
Part Two
21 November 2017

Ashburton Hall
Ashburton Avenue
Paraburdoo
1.00pm

The Shire of Ashburton 10 year Community Strategic Plan (2012-2022) provides focus, direction and represents the hopes and aspirations of the Shire.

Our Vision

The Shire of Ashburton will be a vibrant and prosperous place for work, leisure and living

Our Mission

Working together, enhancing lifestyle and economic vitality

Absent – Cr Glen Dellar

The Shire of Ashburton respectfully acknowledges the traditional custodians of this land.

Community Goals

- Vibrant and Active Communities
- Economic Prosperity
- Unique Heritage and Environment
- Distinctive and Well-services Places
- Inspiring Governance

Future Focus

The next four years will see a strong focus on:

1. Community inclusion and participation
2. Provision of infrastructure that enables economic strength
3. Economic strength
4. Organisation stability
5. Staying ahead of the game
6. Development of our governance

BEACH RECREATION

COASTAL RECREATION

ACCESS TO MONTE BELLO ISLANDS, DIRECTION & THEVENARD ISLANDS

BACK BEACH RD

SIMPSON ST

SECOND AV

MCGRATH AV

BEADON CREEK RD

EAGLENEST RD

McAULLAY RD

ONSLOW ROAD

45 L_{A10} db

50 L_{A10} db

40 L_{A10} db

35 L_{A10} db

500m buffer

100m buffer

LEGEND

- ONSLOW TOWNSITE BOUNDARY
- A Ocean View Caravan Park
- B Onslow Police Station
- C New Entry Road (Onslow Road)
- D Onslow Primary + High School
- E Onslow Sporting Oval
- F Onslow District Hospital
- G Jetty (Onslow Salt)
- H Onslow Salt
- I Onslow landfill site (closed)
- J Water Corp. Waste Water Treatment Plant
- K Onslow Wharf / Beadon Creek boat harbour
- L Onslow Airport
- M Old Onslow (off plan)
- N ANSIA (off plan)
- O Four Mile Creek Recreation Area (off plan)
- P Bindi Bindi Town Reserve
- Q Discovery Holiday Park and Service Worker Accommodation
- R Onslow Marine Supply Base

OPPORTUNITIES

- Potential development area subject to further investigation
- Opportunity for future housing development beyond existing urban areas
- Existing Industry/Mixed Business
- Opportunity for future Industry/Mixed Business
- Existing Tourism and Short-Stay accommodation with opportunity for expansion
- Opportunity for future Tourism and Short-Stay accommodation
- Expansion and upgrades to Beadon Creek boat harbour including opportunity for community boating precinct
- Access to Monte Bello Islands, Direction & Thevenard Islands
- Road links for improved connectivity and legibility
- Potential reserve for equine agistment
- E Proposed future Primary and District High School
- 1 Potential expansion of hospital/medical precinct
- 2 Onslow Swimming Pool
- 3 Potential new road link
- 4 Proposed Airport Expansion
- 5 New Onslow Landfill (off plan)

ISSUES / CONSTRAINTS

- 2110 Modelled Coastal Setback (Cardno 2017)
- Potential Flooding Consideration of a 100 year ARI storm event 2110 Estimated Inundation Extents (MP Rogers)
- Area to be preserved as Conservation & Natural Landscape
- Potentially contaminated sites may require remediation prior to redevelopment
- Drainage flow to run toward creek and avoid strategic infrastructure
- Onslow WWTP Buffer
- Future Onslow Airport Obstacle Limitation Surface
- Noise impacts from Onslow Salt - may constrain future urban development within close proximity to facility
- 6 Closed Onslow Landfill site. New facility identified outside of townsite
- Waste Transfer Site Buffer
- Bushfire Prone Areas (DFES 2016)

ONSLOW ISSUES AND OPPORTUNITIES

Local Planning Strategy

A Shire of Ashburton Project

0m 100 200m

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figure 53

LEGEND

PARABURDOO TOWN SITE BOUNDARY

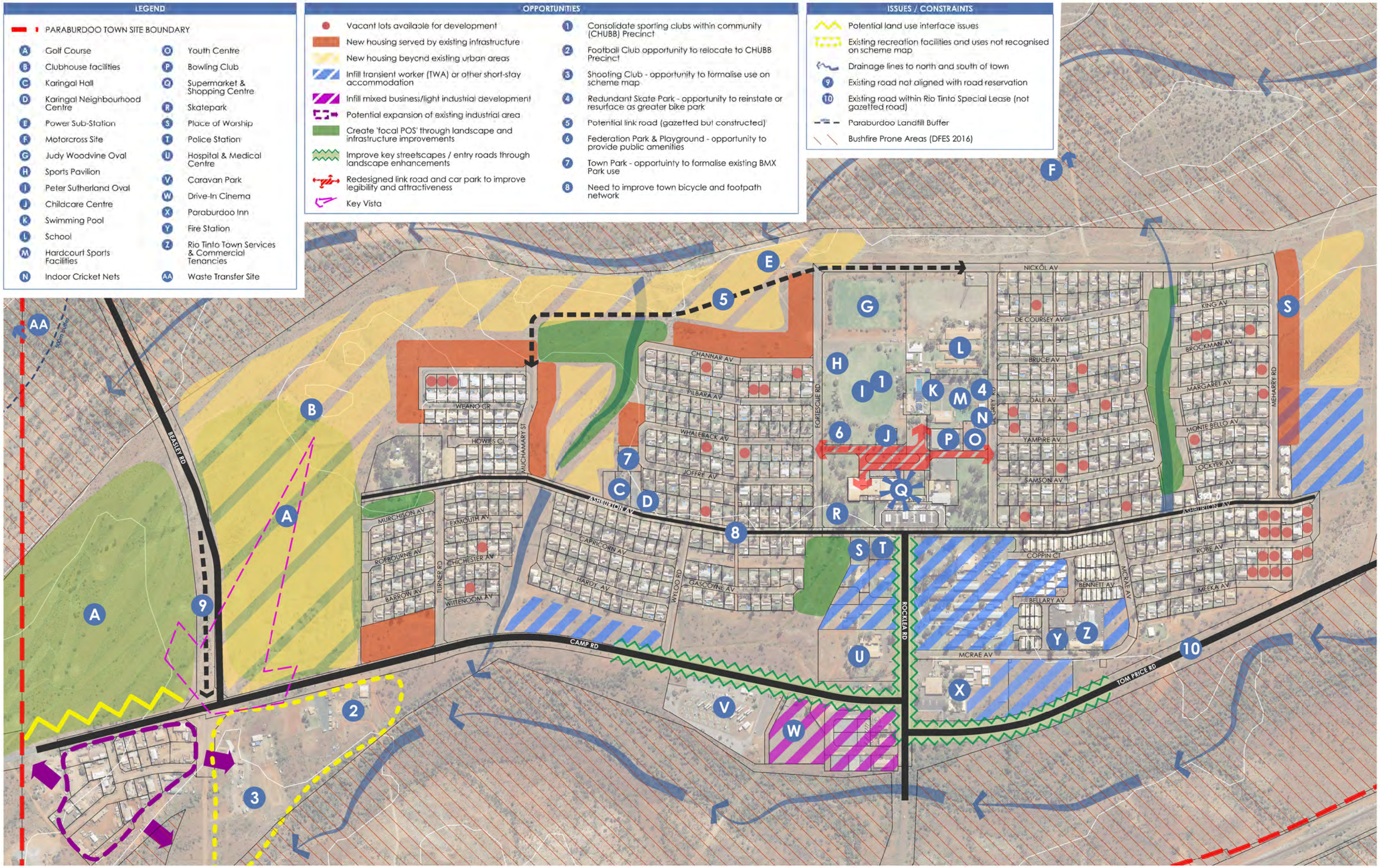
- A Golf Course
- B Clubhouse facilities
- C Karingal Hall
- D Karingal Neighbourhood Centre
- E Power Sub-Station
- F Motorcross Site
- G Judy Woodvine Oval
- H Sports Pavilion
- I Peter Sutherland Oval
- J Childcare Centre
- K Swimming Pool
- L School
- M Hardcourt Sports Facilities
- N Indoor Cricket Nets
- O Youth Centre
- P Bowling Club
- Q Supermarket & Shopping Centre
- R Skatepark
- S Place of Worship
- T Police Station
- U Hospital & Medical Centre
- V Caravan Park
- W Drive-In Cinema
- X Paraburdoo Inn
- Y Fire Station
- Z Rio Tinto Town Services & Commercial Tenancies
- AA Waste Transfer Site

OPPORTUNITIES

- Vacant lots available for development
- New housing served by existing infrastructure
- New housing beyond existing urban areas
- Infill transient worker (TWA) or other short-stay accommodation
- Infill mixed business/light industrial development
- Potential expansion of existing industrial area
- Create 'focal POS' through landscape and infrastructure improvements
- Improve key streetscapes / entry roads through landscape enhancements
- Redesigned link road and car park to improve legibility and attractiveness
- Key Vista
- 1 Consolidate sporting clubs within community (CHUBB) Precinct
- 2 Football Club opportunity to relocate to CHUBB Precinct
- 3 Shooting Club - opportunity to formalise use on scheme map
- 4 Redundant Skate Park - opportunity to reinstate or resurface as greater bike park
- 5 Potential link road (gazetted but constructed)
- 6 Federation Park & Playground - opportunity to provide public amenities
- 7 Town Park - opportuinty to formalise existing BMX Park use
- 8 Need to improve town bicycle and footpath network

ISSUES / CONSTRAINTS

- Potential land use interface issues
- Existing recreation facilities and uses not recognised on scheme map
- Drainage lines to north and south of town
- 9 Existing road not aligned with road reservation
- 10 Existing road within Rio Tinto Special Lease (not gazetted road)
- Paraburdoo Landfill Buffer
- Bushfire Prone Areas (DFES 2016)



PARABURDOO ISSUES AND OPPORTUNITIES
Local Planning Strategy
A Shire of Ashburton Project

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figure **54**

LEGEND

- TOM PRICE TOWNSITE BOUNDARY
- A Sporting club
- B North Tom Price Primary School
- C Tom Price Senior High School
- D Shopping Centre/Supermarket
- E Tom Price Medical Centre
- F Tom Price Hospital
- G Police Station
- H Shire of Ashburton
- I Sporting Club

ISSUES / CONSTRAINTS

- Steep terrain to be considered in future design
- Steep terrain provides constraint to future townsite expansion
- Drainage path
- 4 Railway track forms physical barrier and limits contiguous future urban development
- 5 Cul de sac as key vehicle access to school/community facility constrains access opportunities
- 500m Tom Price Landfill Buffer
- Bushfire Prone Areas (DFES 2016)

OPPORTUNITIES

- Aging Housing Stock suitable for investigating as infill
- Opportunity for future housing development beyond existing urban areas
- Existing residential grouped housing with additional development potential
- Existing TWA. Consider future desirable mix and/or transition of use.
- Existing Industrial with opportunity for expansion
- Opportunity for future Industrial uses
- Potential future short stay accommodation or residential expansion area
- 1 Possible future road link
- 2 Potential road realignment to increase legibility
- 3 Opportunity to explore improvements to pedestrian connectivity, noting existing disconnected street network

INDUSTRIAL LAND SOUTH OF TOM PRICE

TOM PRICE ISSUES AND OPPORTUNITIES

Local Planning Strategy

A Shire of Ashburton Project

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figure 55

Coastal Hazard Risk Management & Adaption Plan

CHRMAP For the Onslow Coast

59916801

Prepared for
Shire of Ashburton

21 July 2017

Cardno
Shaping the Future

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V1	4/12/2015	DRAFT	JGW	
VA	2/12/2016	Preliminary DRAFT	JRB	DvS
VB	24/02/2017	Revised Draft	JB	DvS
VC	21/07/2017	Final Draft	DvS	CH

Executive Summary

Like a number of coastal communities in the north west, the town of Onslow is preparing for the threats of climate change and sea level rise to property, infrastructure, the environment and ultimately the viability of the town itself. Historically Onslow was established to service agricultural activities, primarily sheep and cattle grazing within the hinterland, then supported fishing and salt production and more recently mining and oil and gas activities. The town was originally sited in 1885 near the mouth of the Ashburton River, about 20 km southwest of its current location. Following cyclone damage to the critical jetty infrastructure in the early 1920's it was decided to relocate the town to its current location near the mouth of Beadon Creek. This Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) has been prepared to provide a long term view of the possible strategies to adapt to the changing future conditions that will impact the current town.

A key aspect for the future of the town is the threat of steadily rising sea levels, combined with storm events - ocean storm surge, local rainfall-induced flooding and rising water tables – that will affect the viability of low lying areas of the town. In addition, coastal erosion is likely to threaten some infrastructure in the lee of the present Town Beach, including the Bindi Bindi community area. Strategies that might be adopted to respond to these threats at significant future turning points are articulated in this plan.

Development of the Onslow CHRMAP has followed the requirements of WA State Planning Policy 2.6: Coastal Policy (SPP2.6) and supporting guideline documents. A series of 37 recommendations for implementation is tabulated in Chapter 7 Conclusions and Recommendations of this Plan. The key strategies and actions to plan for future adaptation in the immediate (< 5 years) and short term (5-10 years) may be summarised as:

Avoid

Implement changes to the land zonings that are currently covering undeveloped land within the designated 2110 coastal erosion hazard zones.

Update Special Control Area (SCA)

Retreat

Immediate action - Develop an integrated coastal and water management plan to guide stormwater management strategies and planned retreat from the town's flood-prone areas.

Short term - Monitor sea level, coastal vegetation boundaries and storm erosion movements and review the hazard line estimates and strategies for retreat of public and private assets (including the Onslow Salt infrastructure) in the current foreshore zone. Review the foreshore land zone boundaries and adjust, where appropriate, to facilitate retreat of assets within the future foreshore zones.

Accommodate

Immediate action – Establish database of assets in the 2110 flood-prone area including present day value and projected end of life cycle. Identify options for mitigating the impacts of increased flooding, undertake a detailed cost benefit analysis and communicate with the community and stakeholders to agree on preferred options and communicate the significance of residual risks.

Review and adjust local government Planning Controls to ensure proposed developments in the flood prone areas accommodate the future threats and minimise liabilities.

Incorporate coastal erosion and flooding risks into emergency response plans.

Short term – monitor flood levels and extents and review boundaries and water level implications for the Hazard Control Area and planning controls

Protect

Immediate action – Collect data on the geology of the Front Beach hinterland (including the possible sea wall extension to the northeast of the existing seawall) to assess whether the current hazard line estimates can be revised. Liaise with the stakeholders to assess future protect or retreat options at the end of life of houses in the housing estate.

Short term – monitor beach profiles at Front Beach to assist considerations of future beach nourishment options.

Abbreviations and Acronyms

Abbreviation	Description
AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
ANSIA	Ashburton North Strategic Industrial Area
AS	Australian Standard
CHRMAP	Coastal Hazard Risk Mitigation and Adaption Plan
FFL	Finished Floor Level
HSD	Horizontal Shoreline Datum
MCA	Multi-criteria analysis
GIS	Geographical information Systems
MS	Microsoft
SCA	Special Control Area
SPP2.6	State Planning Policy No 2.6
the Shire	Shire of Ashburton
WAPC	Western Australian Planning Commission

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1 INTRODUCTION

1.1 Purpose/ Objectives

Climate change, including sea-level rise, is expected to bring changes to the West Australian coastline over coming decades. To plan for this, all levels of government are putting in place planning processes to ensure that communities understand the risks to values and assets on the coast, and plan to adapt over time.

To demonstrate the change in mean sea level at Onslow water level data collected at Beadon Point tide gauge is shown in **Figure 1-1** along with the projected sea level rise for WA as adopted by the State (DoT, 2010).

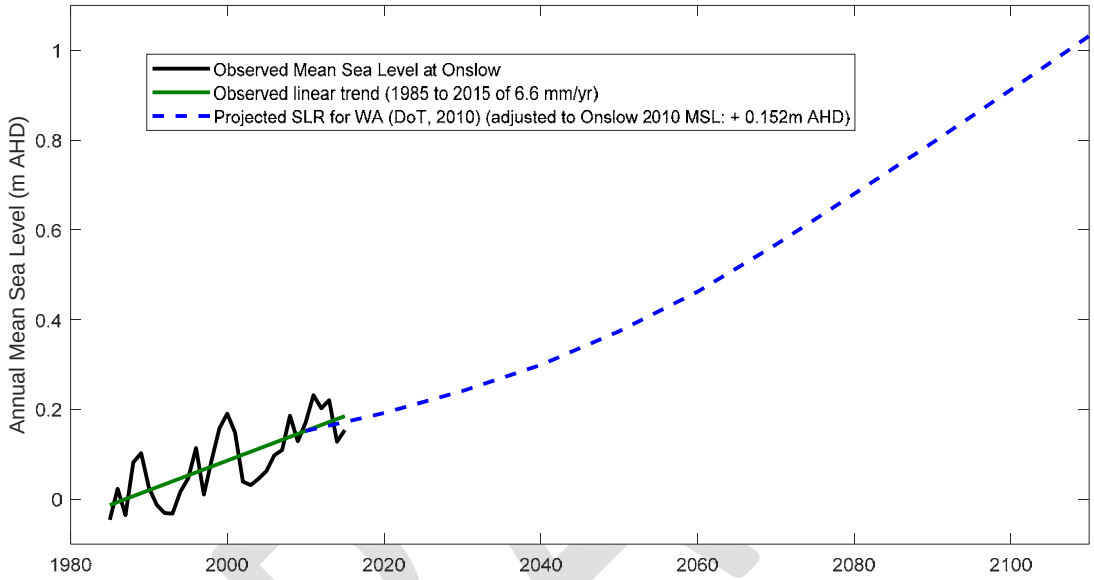

Figure 1-1 Graph showing annual mean sea level at Onslow over the past 3 decades (1985 to 2015), its annual trend and projected sea level increase to 2110 (DoT 2010)

This Coastal Hazard Risk Management and Adaption Plan (CHRMAP) has been undertaken by Cardno on behalf of the Shire of Ashburton (hereafter called 'the Shire') to identify risks and plan responses to climate change impacts for the Onslow coastline.

The purpose of the CHRMAP is to:

- Ensure that development and 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; and
- protect, conserve and enhance coastal zone values, particularly in areas of landscape, biodiversity and ecosystem integrity, indigenous and cultural significance.

An example of the possible scenario of future maximum annual still water levels is provided below in **Figure 1-2.** Rising sea levels at Onslow will affect:

- the town stormwater drainage efficiency;
- increase the frequency of flooding of current low lying flood-prone areas;
- rate of erosion of the shoreline;
- overtopping of sea defence structures; and
- increase the groundwater table leading to longer ponding times in the town drainage basins and low lying swales.

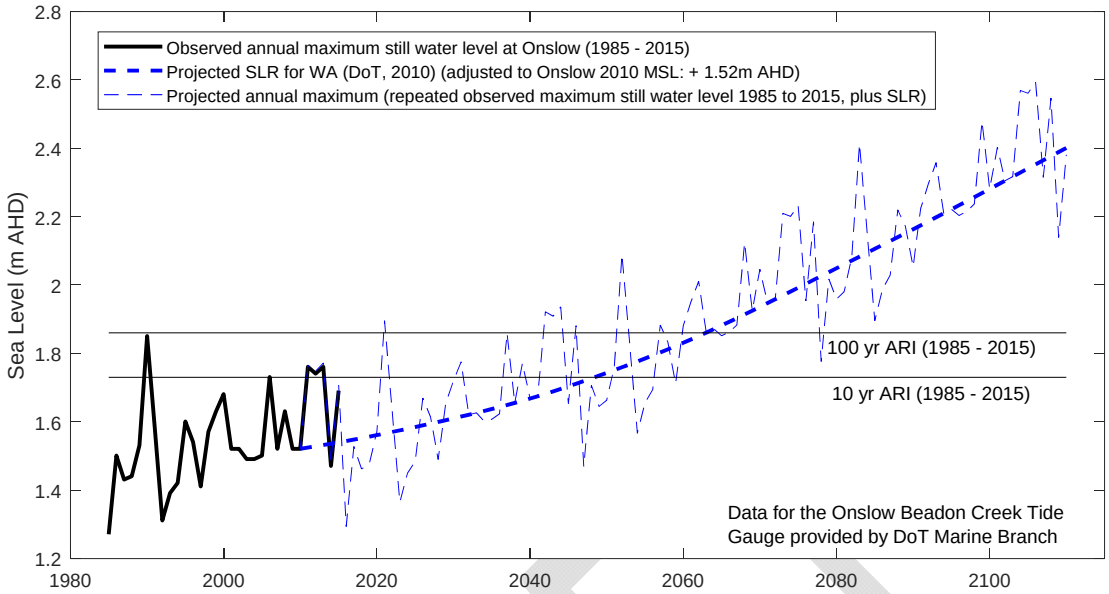

Figure 1-2 Observed maximum annual water level from 1985 to 2015. The observed sequence (1985-2015) has been projected into the future to highlight a possible scenario of future events.

1.2 Overview of CHRMAP Process

The key policy governing coastal planning in Western Australia is the State Planning Policy 2.6: Coastal Planning (2006, herein referred to as 'SPP2.6'), which recommends that management authorities develop a CHRMAP using a risk mitigation approach to planning that identifies the hazards associated with existing and future development in the coastal zone. SPP2.6 (WAPC 2013a) and the SPP2.6 Guidelines (WAPC 2013b) contain prescriptive details, for example in relation to scales of assessment, storm event types and sea-level rise allowances.

The Western Australian Planning Commission (WAPC) has also developed CHRMAP Guidelines which are less prescriptive, but are aimed to ensure that planning is carried out using a risk based approach with due regard for stakeholder engagement, community consultation and education, and that a full range of adaptation options is considered. An overview of the CHRMAP process is shown in **Figure 1-3.**

Coastal planning in accordance with SPP2.6 also needs to take into consideration the requirements of other planning policies, including State Planning Policy No. 2 Environment and Natural Resources Policy and State Planning Policy No. 3 Urban Growth and Settlement. State Planning Policy 2.9 Water Resources also require consideration in relation to the implementation of total water cycle management planning for urban growth and settlement.

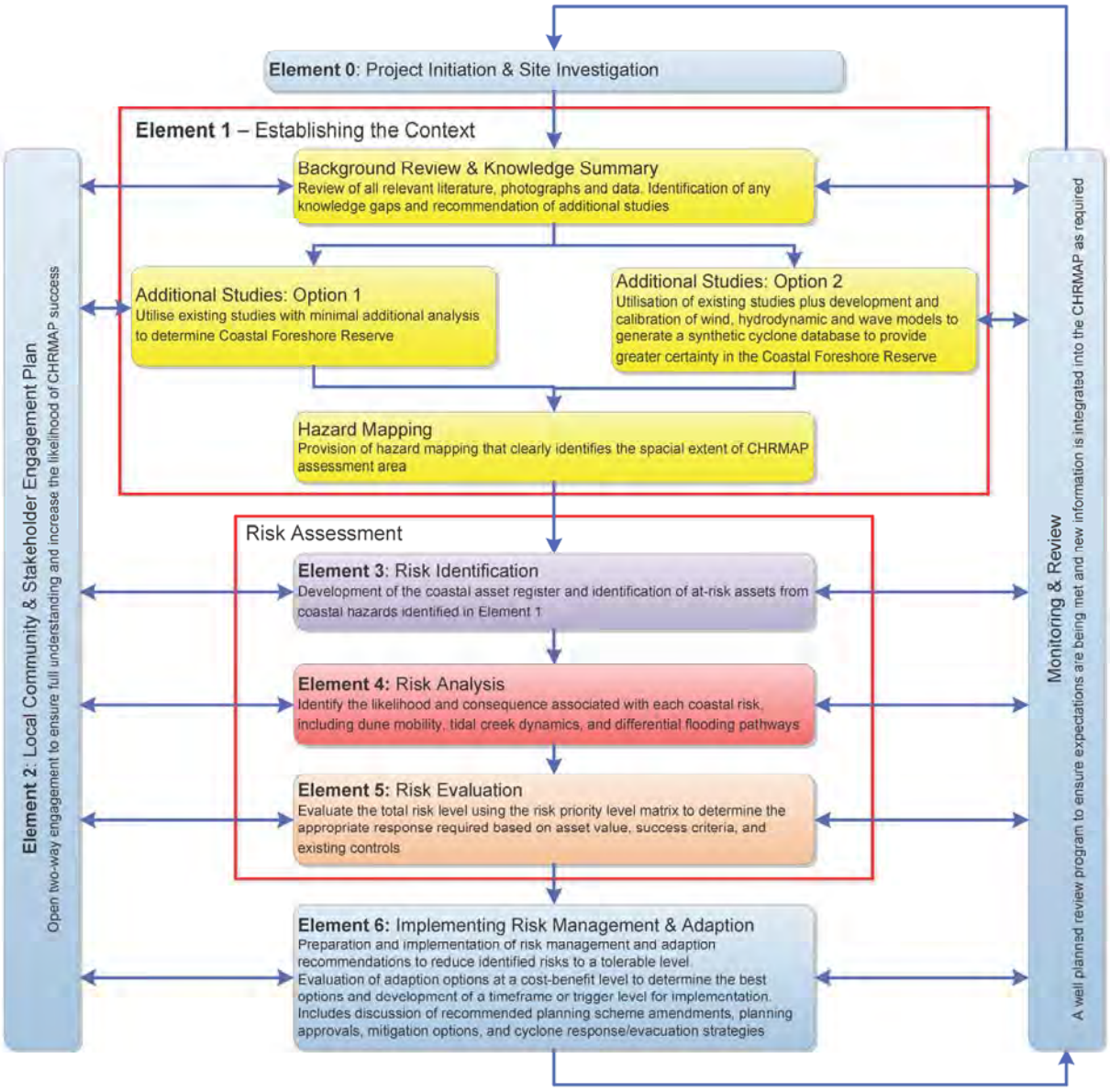

Figure 1-3 CHRMAP methodology flow chart (adapted from WAPC CHRMAP Guidelines)

1.3 Guiding Principles and Concepts

Underlying the CHRMAP process are a number of guiding principles and concepts which are fundamental to understanding the purpose and outcomes of the process.

1.3.1 Equity

Equity is a concept that is central to the purpose of the CHRMAP process. Australia's coastline is highly valued by the community as a public asset, and stakeholders range from individual property owners adjacent to the coast, to all levels of government, and users both within and outside jurisdictional boundaries.

Responsibility for coastal planning lies with both State and Local Government, and in making decisions these authorities need to consider equity of access, equity of enjoyment and equity of public good in terms of budget allocation for coastal protection over and above other community needs.

Equity is also relevant to considerations about how a protection structure (for example a Groyne) might impact on coastal processes. Protection structures may exacerbate erosion immediately adjacent to the structure,

and limit sediment availability for maintaining beaches and community values some distance from the protected area. Coastal protection creates beneficiaries (those who are protected from hazards) and potentially creates disadvantage to others who may be considered to be injured parties. In this regard coastal management has similarities to the management of water rights, if one user takes all the water upstream and leaves none for downstream users then this is clearly not fair and equitable. In a future of eroding coastlines due to sea-level rise, sand for maintaining beaches and former protection buffers for coastal assets is likely to become a valuable commodity. Under the user pays principle it is expected that the beneficiaries of coastal works will bare the costs of such works, both capital and ongoing maintenance. Determining the key beneficiaries and apportioning costs in an equitable and appropriate manner will require further investigation. The challenge is to ensure that planning and management is as transparent and equitable as possible.

1.3.2 Coastal Foreshore Reserve

The coastal foreshore provides beach access, recreation and conservation, is a tourist attraction and provides habitat for native flora and fauna. Importantly, it also provides a buffer to mitigate risks to high value assets such as buildings and infrastructure.

SPP2.6 provides guidance for calculating the component of the coastal foreshore reserve required to allow for coastal processes, based on the 100-year hazard line determined in accordance with SPP2.6, to be contained in an appropriate coastal foreshore reserve (determined in accordance with clause 5.9 of SPP2.6) of greater width to ensure that at the end of the planning timeframe a coastal foreshore reserve is provided which is not exposed to the adverse impacts of coastal erosion and inundation. Development is able to be considered behind this point. In addition to the allowance for physical processes such as erosion, the coastal foreshore reserve includes land allocation for maintaining the values, functions and equitable use of the coast over the 100 year planning horizon (WAPC 2013b). SPP2.6 (clause 7), however, outlines specific instances where certain types of developments may be considered appropriate to locate within a coastal foreshore reserve regardless of the allowance for coastal physical processes.

Permanent and easy public access to the beach and coastal recreation (foreshore) reserves is a fundamental coastal planning objective. The coast and coastal recreation reserves are a public asset which should not, now or in the future, become the de facto exclusive domain of private landowners by virtue of the erosion of coastal reserves or other coastal processes. Coastal reserves should be wide enough that they can still perform recreation and/or conservation functions (according to the reasons for their initial designation) even if they are affected by coastal erosion or diminution due to sea level rise.

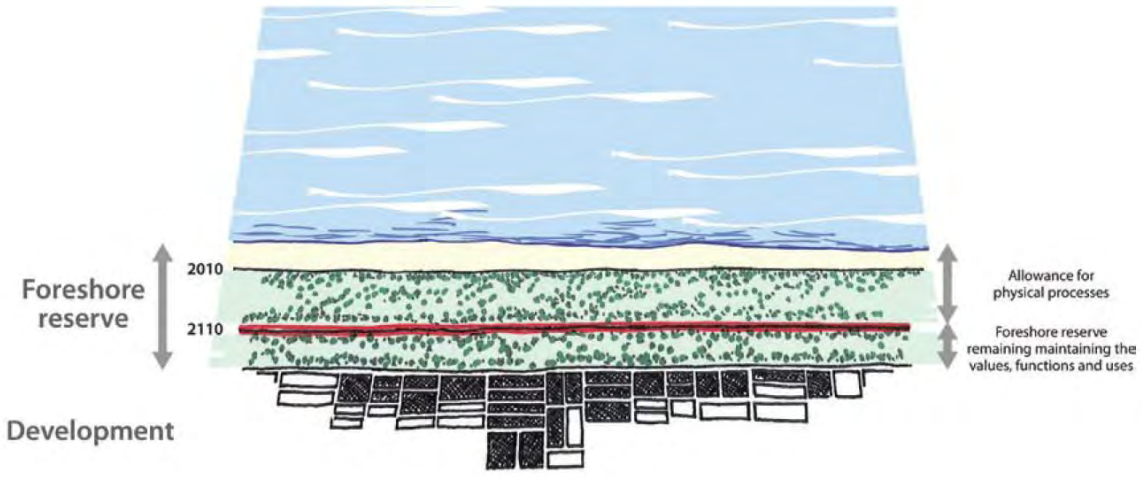

Figure 1-4 Coastal foreshore reserve – sandy coast example (WAPC 2013b)

1.3.3 Rights and Responsibilities

There is no law requiring the government (at any level) to provide protection of private property from natural hazards nor compensation when land is lost to the sea. There are, however, several laws which allow the intervention of governments to enforce eviction if private property becomes uninhabitable or removal of

property if it constitutes a public risk. In the event of coastal erosion causing a property to "fall into the sea", and the land to disappear below the high water mark, the loss is to be borne by the property owner.

Nonetheless, it is the aim of all levels of government to protect the interests of all Australians, and the CHRMAP process ultimately intends to minimise risks and maximize beneficial use of the coast from an economic, social and environmental perspective. In reality, mechanisms for managed retreat are likely to be aided by public monies, and in some instances where public good can also be demonstrated, protection may also be funded. Where the benefits of a particular coastal protection measure is limited to private beneficiaries, there is an expectation that the cost will be borne by those beneficiaries under the "user pays" principle. Again, identifying the key beneficiaries of any coastal works required for future hazard mitigation and apportioning costs in an equitable manner will require further investigation.

1.3.4 Hazards

Sea-level rise is predicted to result in both erosion and inundation of the Onslow area due to seawater encroaching on the land. In this report inundation due to seawater ingress is called "coastal inundation". Erosion and coastal inundation hazards are modelled using oceanographic models.

In Onslow, a secondary hazard exists from freshwater inundation during high rainfall events (such as cyclones). This is related to the issue of sea-level rise due to constraints on drainage at high tide and higher groundwater table levels due to increased sea-level. In this report, inundation from rainfall has been modelled in addition to the modelling of coastal processes, and is called "pluvial inundation".

Details of the hazard assessment are provided in the Coastal Hazard Assessment Report (Cardno 2016a), and key outcomes are summarised in **Section 2.7.1**.

1.3.5 Assets

An asset is defined a useful or valuable thing. As defined by AS 5334-2013, value can be tangible or intangible, financial or non-financial; examples of assets include financial assets, human resource assets, physical assets, and organization reputation. Value includes consideration of risks and liabilities, and can be positive or negative at different stages of the asset's life.

In the current CHRMAP, assets include:

- Natural features such as beaches and native vegetation;
- Buildings and other structures (sheds, shade structures);
- Infrastructure such as fences, lighting, water and sewerage;
- Roads, paths and walkways; and
- Existing protection structures, such as the seawall.

1.3.6 Risk

Risk is defined as a hazardous event or circumstance and the consequences that may flow from it. Risk is measured in terms of a combination of the likelihood of a hazard occurring and the consequence of that hazard occurring. (likelihood and consequence).

1.3.7 Adaptive Capacity

Adaptation is defined by SPP2.6 as:

> "*an adjustment in natural or human systems in response to actual or expected stimuli or their effects, which moderates harm or exploits beneficial opportunities. Adaptation is the means for maximising the gains and minimising the losses associated with coastal hazards over the planning timeframe."*

WAPC (2014) further defines adaptive capacity as reflecting the ability of an asset to change in a way that makes it better equipped to deal with external influences (e.g. coastal climate change impacts).

In this report, adaptive capacity has been assessed in relation to the ability of an asset to be modified to reduce risk (for example raising the height of the seawall) or relocated (for example moving a wooden walkway inland).

1.3.8 Vulnerability

Vulnerability has a specific meaning in the context of risk based approaches to climate change adaptations, in accordance with Australian Standards (AS 5334-2013) and SPP2.6, which defines vulnerability as:

> *"the means the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. Systems that are highly exposed, sensitive and less able to adapt are vulnerable"*

This report uses vulnerability as the final outcome of the risk assessment process, combining likelihood and consequence of hazards with the adaptive capacity of assets in a stepwise process as summarised in **Section 3.1** and fully described in the risk assessment report (Cardno 2016b).

1.3.9 Temporal scales

Coastal hazard assessment and planning needs consider a number of different timeframes (**Figure 1-5**). SPP2.6 specifies the need for identifying risks and extending planning considerations out to a one hundred year planning horizon, whereas practical planning from the Shire's point of view needs to consider the current planning period (5 year horizon), short (5 - 10 years) and medium term (10 - 25 years). Planning for more than 25 years into the future is considered to be long term.

The need for identifying potential long term risks is important for ensuring these risks are taken into consideration in Onslow's asset management strategy and statutory planning framework. The long term perspective is also important for management of community expectations and gives potentially impacted stakeholders ample time to appropriately manage assets potentially at risk.

This CHRMAP includes predictions of current to long-term risks associated with climate change and predicted "planning pathways" to guide management approaches for vulnerable assets. The planning pathways result from the risk and adaptation options assessment, taking into account the timing of likely impacts, the lifecycle of the asset and any other relevant timing constraints and opportunities.

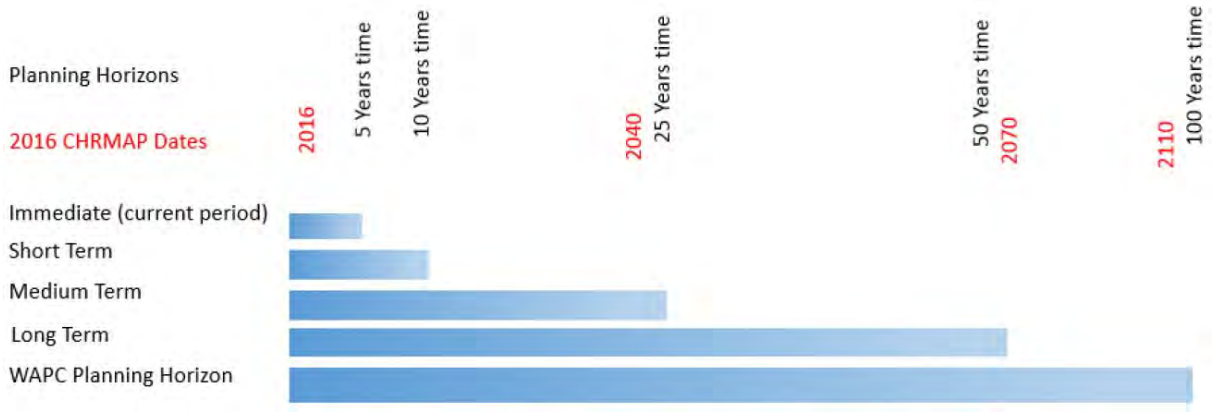

Figure 1-5 Coastal planning timeframes used in this report

1.3.10 Spatial scales

The CHRMAP process also considers a range of spatial scales, from the individual asset scale to groups of assets that belong to the same functional coastal management unit. SPP2.6 requires that hazard assessment is carried out at the "coastal compartment" scale, to reflect the reality that modifying one part of a coastline will have impacts beyond the immediate area of the works.

The prescribed methods for predicting future shoreline position (or hazard lines) incorporate a number of assumptions that need to be tested in time to review the predicted hazard lines. Interpretation of hazard lines needs to be approached carefully, since the underlying assumptions used to predict erosion allowances (see **Section 2.7.1.1**), leads to hazard line estimates with considerable variability in scale.

1.3.11 Reactive Management

Reactive (or adaptive) management is the term given to a structured, iterative process of robust decision making in the face of uncertainty (Allan & Stankey 2009). In the CHRMAP context it allows for predictions of

potential impacts and long term planning pathways to mitigate against risks, while at the same time acknowledging that things will change over time. It is certain there will be changes in context (for example population pressures), risk profile (for example occurrence of storm events) and implementation of controls (for example extension of the seawall) that will require adjustments to the type and timing of management response.

The CHRMAP therefore also includes directions for the monitoring and review process and defines triggers for implementation of management actions to manage risk and achieve adaptation objectives in the event of "things not going according to plan".

1.4 CHRMAP Format

This document has been designed to inform the community and provide direction to the Shire for planning for climate change risks facing the Town of Onslow. The structure of the document also allow for the planning context of individual assets or groups of assets to be separated from the main document with Appendices formatted as separate sheets provided for each of the coastal assets.

2 ESTABLISHING THE CONTEXT

2.1 Overview of CHRMAP Area

Onslow is located on the Shire's coastline in the Pilbara Region of northwest WA, approximately 100 km east-northeast of Exmouth and 200 km southwest of Karratha. The Ashburton North Strategic Industrial Area (ANSIA) is located around 13 km to the west of the town; together these areas are two of the Shire's important coastal developments (refer inset in Figure 2-1 for study area and locality plan). The tertiary coastal cell boundaries indicate areas of similar coastal geomorphology. The focus of this study is the town and foreshore defined by the four coastal units (sections 1 to 4 in Figure 2-1) that delineate particular shoreline characteristics.

2.2 Relevant Socio-economic Aspects

Onslow has traditionally been a small town supporting fishing, pastoral and tourism industries as well as a significant salt production facility. Due to the development of the ANSIA and Chevron's Wheatstone Project, the town is expecting significant population growth; LandCorp have recently developed and released a 220 lot subdivision as a first step towards accommodating this growth.

Primarily a service town, the prosperity of Onslow is highly dependent on the commodities market, and the population has a large proportion of transient residents.

It is significant in the context of coastal planning that the Onslow town site was moved in 1923. Old Onslow was situated 18 kilometres to the south-west of the current site. The decision to move the town was made due to repeated cyclone damage and the silting up of the river caused increasing problems with the loading and unloading of visiting ships. The new town-site was gazetted on 10 January 1924, and the residents of Old Onslow moved across in 1925. The new location for Onslow's jetty was better protected from storm damage with the townsite more conveniently located on the coast (http://www.ashburton.wa.gov.au/visit-ashburton/onslow/history).

To adequately plan for the future, and accommodate the increased pressure on the coastal zone from increased development, the Shire has investigated and redefined the 'Onslow Coastal Hazard Area – Special Control Area' which covers a significant portion of the town site, including low-lying coastal areas deemed at risk by previous studies. A key outcome of this CHRMAP is to investigate the extent of this coastal hazard area so that sustainable development of the coastline can occur for the long term and the Shire can maximise its use of the coastal foreshore area.

The area has a long and rich aboriginal heritage of the Thalanyji people and the coastal area was accessed by a number of tribes who inhabited the hinterland areas of the West Pilbara. Native title of lands surrounding the town site is vested in the Buurabalayji Thalanyji Aboriginal Corporation who administer a number of services and local businesses in Onslow. A number of culturally significant sites are located around the Beadon Bay foreshores.

2.3 Relevant Environmental Aspects

The study area coastline is a diverse and, at times, challenging environment that experiences seasonal cyclones with potentially dangerous storm surges. The tidal range at Onslow is approximately 3 m but the extreme meteorological and oceanographic conditions generated in a cyclone have the potential to raise the sea level several metres higher than normal, as was the case during Tropical Cyclone Vance in 1999 (BoM, 2000), and a number of other cyclones (**Figure 2-2**). Flooding is relatively common and the coastal zone can be hazardous, and extreme events such as TC Vance can result in significant ocean inundation and coastal erosion. In addition to ocean storm surge cyclones also dump torrential rains leading to local catchment flooding of the local drainage infrastructure, also known as pluvial inundation.

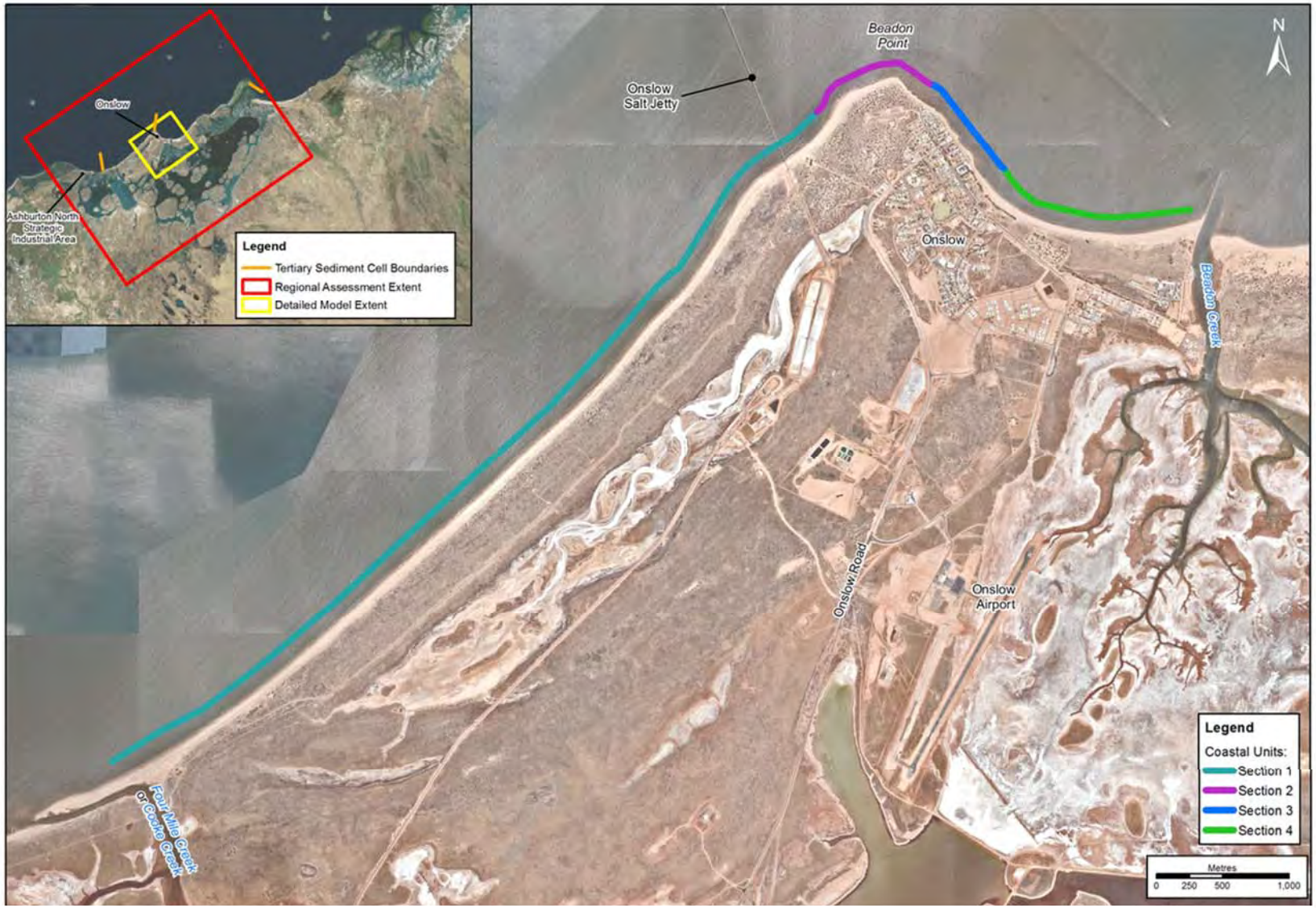

Figure 2-1 The CHRMAP study area extents shown in yellow (detailed model extent) and red (regional assessment extent); tertiary sediment cell boundaries indicated by the red crosses.

a)

b)

Figure 2-2 Photographs of historical of Onslow town site flooding in a) 1963 and b) 2015

The Shire of Ashburton have been undertaking modifications to roads and stormwater drainage infrastructure to mitigate flooding impacts associated with the threats of the 1 in 10 year Average Recurrence Interval rainfall events. These works are also attempting to keep pace with the effects of rising sea level that is gradually increasing the frequency of flooding in low lying areas. For example, the 1 in 10 year flood event in 2010 is likely to occur more frequently, say 1 in 5 years, in 2030 due to the increase in the sea level that inhibits stormwater drainage. Rising sea level is also gradually increasing the annual mean level of the water table that can influence flooding characteristics and the type of vegetation.

Surface levels at the northwest end of Onslow derived from LIDAR data collected in 2012 and a land surface cross section adjacent Simpson St are shown in **Figure 2-3**. The cross section highlights the low lying area at Third Ave that forms the main drainage conduit for the northwest end of the town.

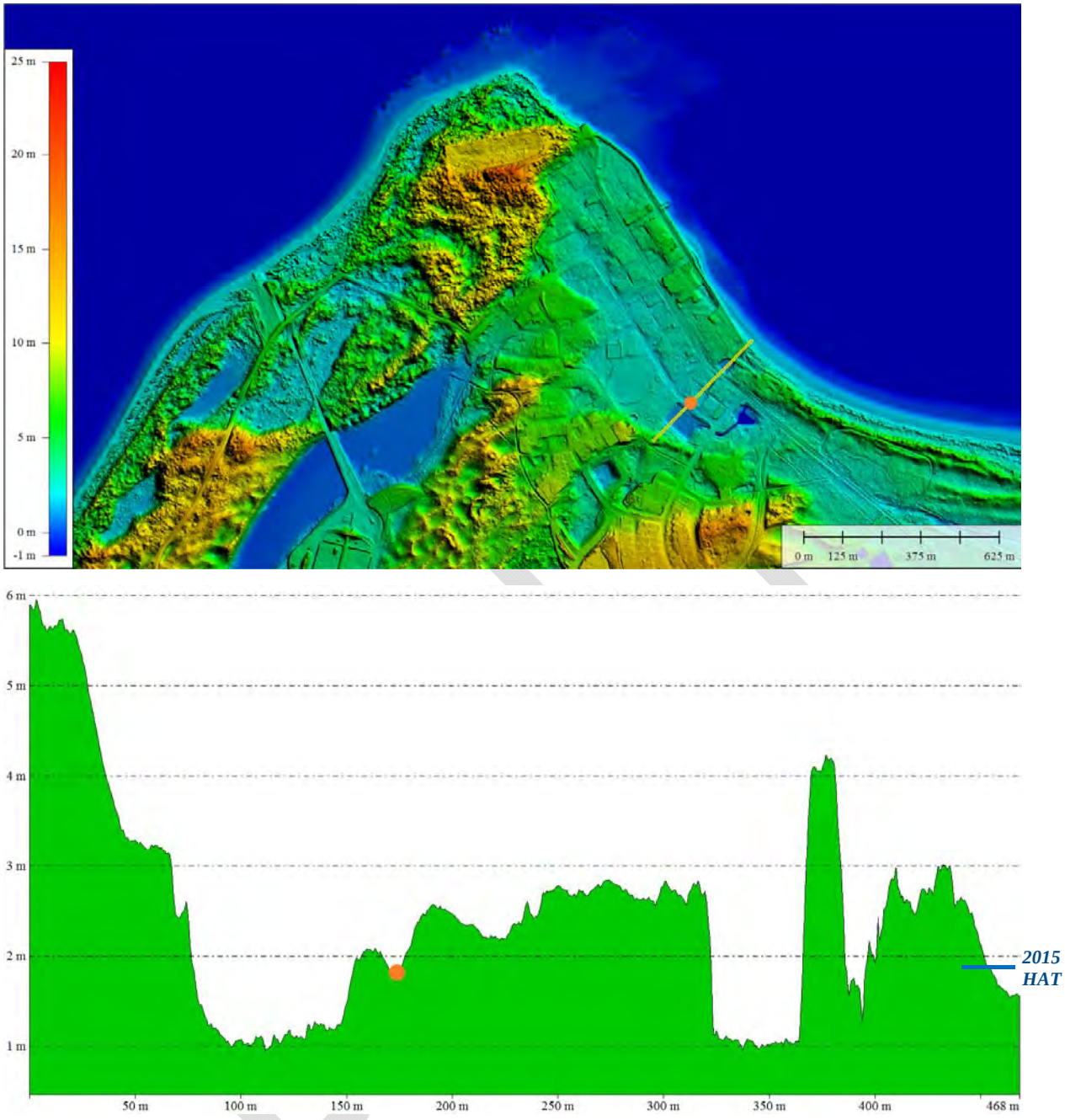

Figure 2-3 LIDAR Surface levels in north west Onslow and a land surface cross section along the section A-B adjacent Simpson St (Vertical Datum is AHD)

Erosion of the beaches and damage to coastal infrastructure is also driven by extreme ocean water levels and wave events that typically occur under tropical low pressure and cyclone weather systems. Examples of the impact of coastal erosion are presented in **Figure 2-4** that shows the loss of beach sands and the erosion escarpment produced by the combined effects of storm surge inundation and large waves associated with Tropical Cyclone Vance in March 1999. With rising sea levels these effects will effectively move the coastline landward threatening coastal habitats and infrastructure.

Figure 2-4 Image showing the erosion escarpment at beach west of Onslow after TC Vance in March, 1999.

2.4 Planning Context and Existing Controls

The key statutory planning document is the Shire of Ashburton Town Planning Scheme No. 7 (TPS 7). This applies zones and reserves to land within the Shire, and outlines the permissibility of land uses, the requirements for development, and the processes for seeking approval for proposed development. Of particular significance to the CHRMAP is the delineation on the Scheme Map of a Special Control Area (SCA); the Onslow Coastal Hazard Area SCA (Onslow SCA). TPS 7 was gazetted in 2004. Amendment 24 to TPS 7 was gazetted on 1 August 2014 with relevant text around the SCA reprinted here:

> Under the Shire of Ashburton Local Planning Scheme No. 7 ('Scheme'), much of the land within the Onslow townsite is included with the *Onslow Coastal Hazard Area – Scheme Control Area (SCA).*
>
> The SCA applies to all land up to 4m Australian Height Datum (AHD) in the coastal zone and 5m AHD in the frontal dune areas of the townsite, between Four Mile Creek in the south-west and Beadon Creek in the north-east.
>
> The Shire is aware that some modification to the minimum AHD is likely due to a review undertaken by LandCorp and other State Agencies. This review is still to be finalised however the Shire is becoming increasingly aware of numerous proposals looming with the SCA.

In areas outside this SCA (Figure 2-5**)**, if the Shire considers that a proposed development could potentially be incompatible with TPS 7 and prone to flood and storm surge events it may still have regard to information about these events when determining applications for planning approval. A considerable part of the Onslow townsite is affected by the Onslow SCA, including all of the town centre, Bindi Bindi Aboriginal Community,

much of the older residential part of town on both sides of Third Avenue, both caravan parks, the primary school, hospital site, and most of the oval.

These existing statutory planning and physical controls (discussed below) form the key tools available to mitigate the risks of the identified future hazards. The potential social and economic consequences associated with implementing such changes will require additional analyses to optimise proposed options. The risk analysis considers these tools when assigning risk levels, vulnerability scales and the subsequent mitigation options. For the development of the future strategy options (Appendix B and C) the proposed introduction of planning controls that can minimise exposure to future liability are deemed preferred to physical or structural controls that may currently exist. The future pathway options identified and discussed in Appendix C are then subject to reanalysis of the risk assuming that the option is implemented in the future. This process then leads to an estimate of the residual risk that may remain after implementation of the particular option. Note that each option aims to reduce the risk to some degree that then needs to be assessed in terms of the acceptability of the residual risk. This process includes a number of steps that all include a level of uncertainty that will require refinement in future reviews and investigations. This CHRMAP (2017) documents the first attempt to articulate each component of the risk assessment and proposed mitigation options process to assist Council and the community understand the potential costs of the threat of rising sea level and the complexities of managing these future risks in a viable and equitable manner.

The adaptation process involves an integrated plan to monitor, investigate, implement and review the consequences of particular options as the threat intensifies in the future. The ongoing process then repeats these steps nominally each 5 years to revise the plan and optimise future responses. This approach is therefore a continuous process of adapting to the changing conditions in a measured and proactive way that ultimately aims to reduce the liability of today's decisions.

2.5 Existing Structural Controls

The key existing structural controls protecting the Onslow coastline are the seawall and the Beadon Creek Groyne. In addition to being an existing structural control for protection of the town site against coastal hazards, the seawall is also considered in this assessment as an asset.

The seawall extends from the western end of the town beach to the main drain discharge point near the end of Cameron Ave. The main flood storage basins in the town ultimately discharge through this drain. During extreme rainfall and potentially storm surge events in future, the drain is critical to the stormwater drainage from the western end of the town. Most of the time it is used as a beach access route across the beach berm. To the east of the drain it is appears there is some rock buried beneath the beach berm. It is not clear how far this material extends and its integrity as a protection structure could not be confirmed. Hence, hazard line estimates east of the seawall assumed this area is sand and subject to future erosion. The seawall is a rubble mound structure and as sea level rises may be subject to larger wave attack and failure modes such as slumping of the wall due to undercutting by extreme waves. As these events occur in the future it is likely the seawall will require more frequent repairs and maintenance.

The actual design specifications for the seawall (presumably reported prior to the commencement of the seawall construction in 2002, completed in 2003) were not available at the time of preparing this report. The following typical specifications have been assumed. The seawall design life is assumed to be 50 years and hence the future adaptation pathway will need to address the end of life of the asset in 2053. In addition, the design crest level (assumed to be 3.5 m) was based on wave conditions most likely derived from pre-2000 data sets. The rising sea level will effectively mean that the present day seawall is under-designed for the future conditions and hence more frequent maintenance and refurbishment is likely to be required. This is also likely to require consideration of beach amenity and mechanisms to facilitate retention of beaches for future community such as sand nourishment to maintain an accessible beach.

Figure 2-5 Onslow Coastal Hazard Area Special Control Area

2.6 Existing Hydrology and Stormwater Management

The township of Onslow is situated on a peninsula, with a ridge running north-south on the western edge of the town. The town does not have any significant creek or river systems running through it. Drainage in the township is through a stormwater network consisting of drainage pits and pipes, some open channels and a number of detention basins (**Figure 2-6**). The western end of the town drains through 3 detention basins and ultimately to the town beach through the drain at the end of Cameron Ave.

The release of water from the retarding basins via the drainage network to the ocean is impacted once tide levels rise above approximately 1 m Australian Height Datum (AHD). Typical one-way flap valves (**Figure 2-7**) are installed on pipes discharging to the ocean to prevent ocean waters flowing into the town during times of storm surge sea level.

Figure 2-6 Key drainage catchments and drainage paths in Onslow. The existing 10 year ARI pluvial flood extent is shown

a)

b)

c)

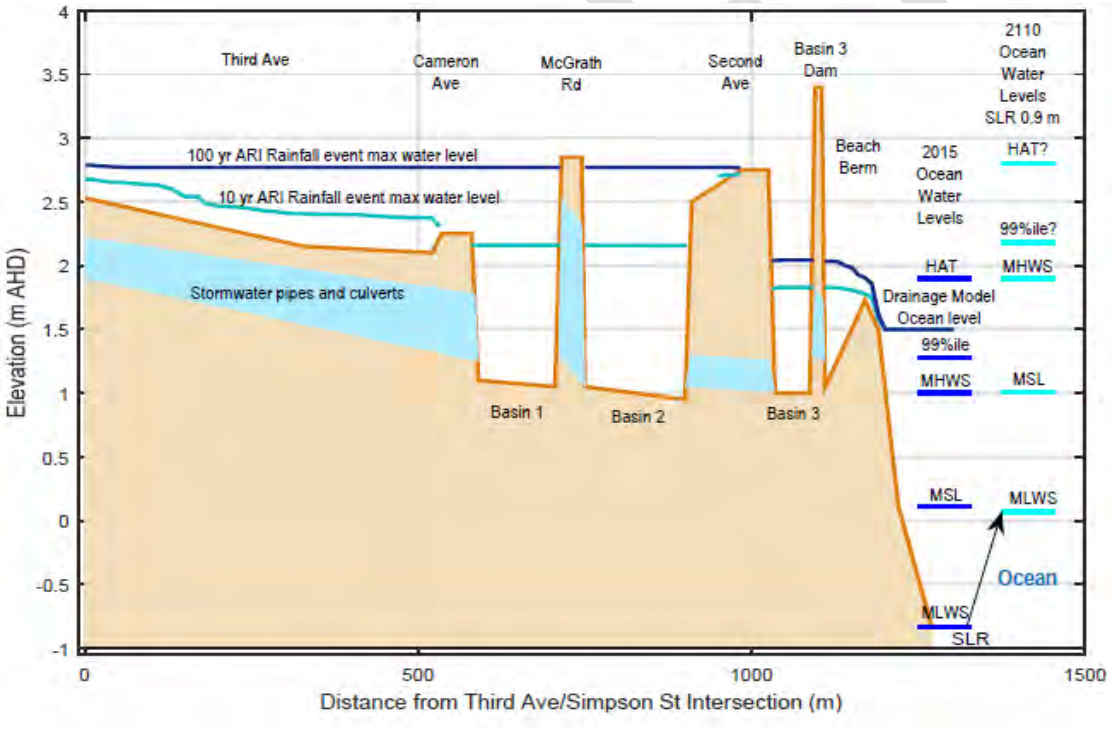

Figure 2-7 Key stormwater management features a) map of detention basin system and ocean discharge, b) photograph of stormwater discharge pipe on Front Beach and c) schematic representation of drainage network

2.7 Key CHRMAP Inputs

To effectively assess the risks and plan for the future management of the coastal zone, information is needed on:

- present and future erosion and inundation hazards;
- current assets, current worth and lifecycles; and
- community and stakeholder values.

As illustrated in **Figure 2-8,** over time it is the interrelationship between these which defines the priorities for adaptation planning.

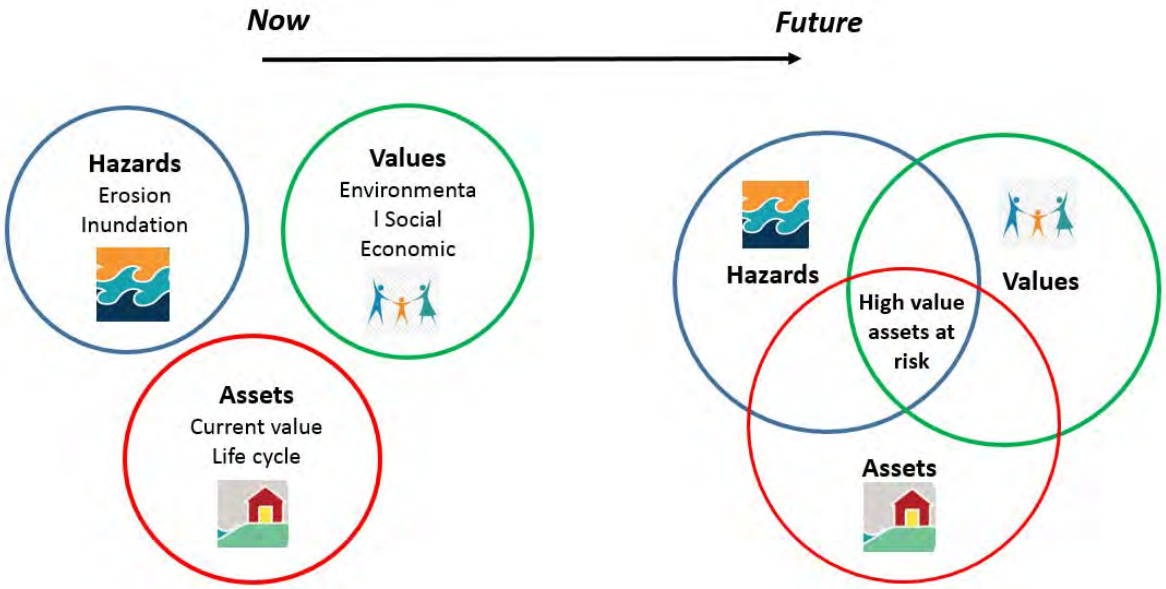

Figure 2-8 Conceptual relationship between key inputs to the coastal risk assessment process

2.7.1 Hazards

2.7.1.1 Erosion and Coastal Inundation

The study area was grouped into four sections by location and morphology as part of the shoreline stability assessment in Cardno (2016a) (**Figure 2-9**). A horizontal shoreline datum (HSD) was defined on the basis of the type of coastline being assessed to define the active limit of the shoreline under storm activity. Based on the levels calculated in the Storm Surge Inundation Assessment (Cardno 2016a), the HSD corresponds to 2.71 m AHD. This value represents the 100-year Average Recurrence Interval (ARI) water level plus an allowance for wave setup.

The hazard maps for the storm surge inundation assessment and the shoreline stability assessment are presented in the Coastal Hazard Assessment Report (Cardno 2016a). They provide the predicted extents for inundation and erosion under present day conditions, as well as the 2040, 2070 and 2110 planning horizons. The erosion allowances are presented in **Table 2-1** for each section of the coastline.

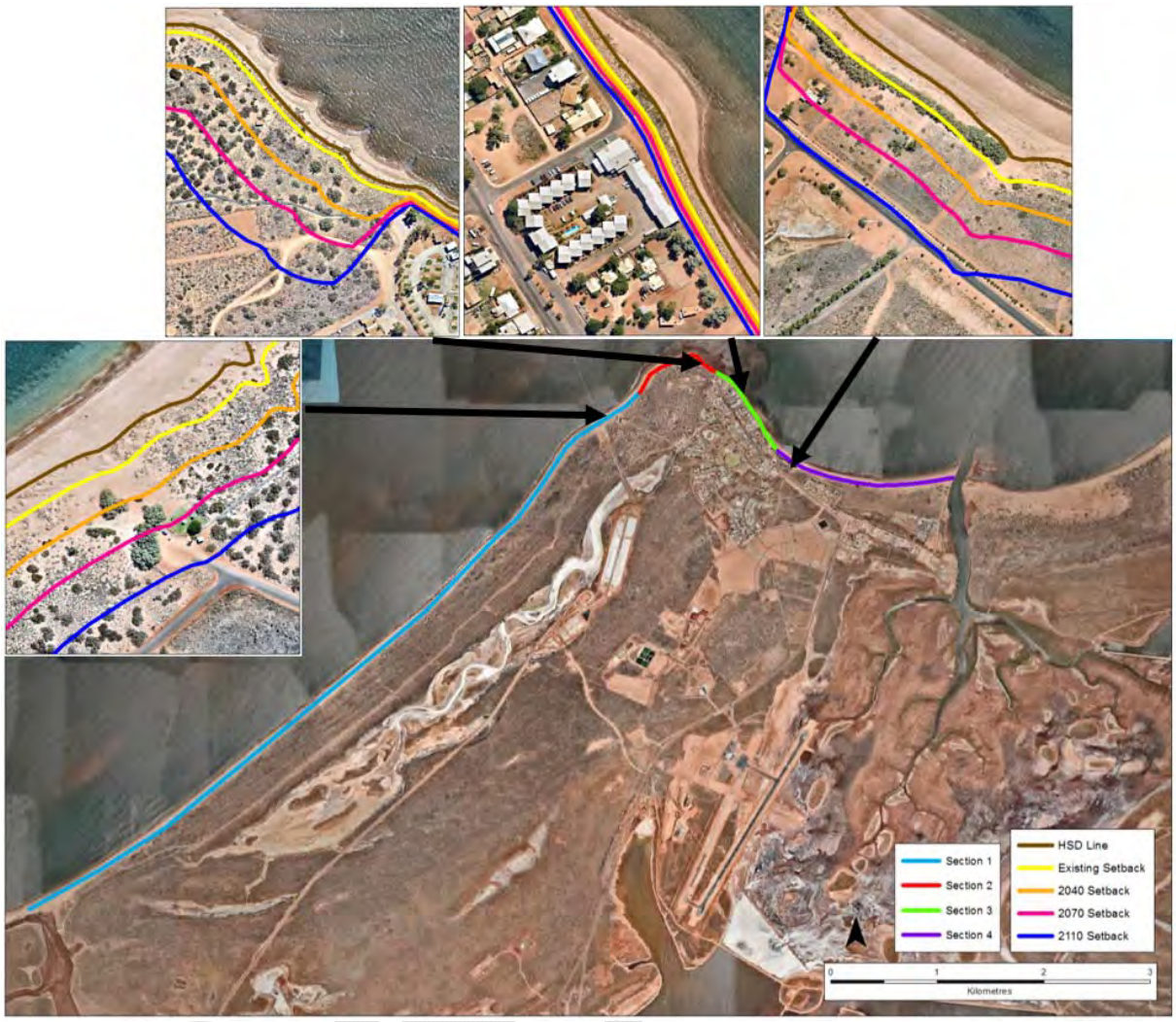

Figure 2-9 Shoreline stability assessment study sections (1 to 4) (aerial image source: NearMap)

Table 2-1 Coastal processes erosion allowance for present day and predicted conditions

Section	Total Erosion Allowance (m)			
	Present-day (2016)	2040	2070	2110
1	19	49	79	119
2	7	41	75	120
3	10	13	16	20
4	25	55	85	125

2.7.1.2 Pluvial Inundation

Pluvial assessment has adopted a direct rainfall approach for assessing the catchment inflows. This approach was selected due to the contained nature of the catchments that drain through Onslow and that the pluvial inundation assessment is for the township areas only (**Figure 2-10**). The results of storm surge inundation assessment indicate that for the township of Onslow:

> Township flooding is primarily from pluvial sources up to 2110. The increasing sea levels and rainfall intensity as a result of climate change will exacerbate the existing flooding that occurs in low-lying areas of the township.

> In the 2110 0.2% Annual Exceedance Probability (AEP) event, the township is significantly impacted by coastal inundation. Dunes and protection structures are overtopped and the township area floods to a level equivalent to the tidal level (approximately 4.55 m AHD).

> In the 2110 1% AEP event, although some overtopping of the dune occurs, it does not significantly impact the township, although access along Onslow Road is cut as a result of the storm surge water level.

For a full suite of inundation maps at a range of scales, see Cardno (2016a).

Figure 2-10 Example of predicted present day pluvial inundation extent for a 100-year ARI event overlain on asset map of Onslow light industrial area

2.7.2 Assets

Key assets were identified using a variety of methods, including community and stakeholder consultation, examination of the Shire's asset register and a detailed asset survey. For details of the community consultation and asset survey methods and outcomes see the Key Issues Paper (Cardno 2016c).

Assets at risk from inundation were categorised as commercial, public, tourism related and residential to assist in the assessment of values and consequences, and further categorised for management planning purposes as:

> Houses, buildings and property;

> Parks and recreation grounds;

> Public Infrastructure;

> Car parks;

> Roads and footpaths; and

> Sheds.

Table 2-2 presents the property and infrastructure that are predicted to be affected within the coastal foreshore reserve allowance for coastal processes, and **Table 2-3** presents the total count of assets affected by inundation hazards under 100 and 500 year ARI scenarios.

Additional information for each asset or asset type is provided in **Appendix A**.

Table 2-2 Assets at risk from coastal process hazards

Timeframe	Assets At Risk
Present Day	▪ On-ground infrastructure at Onslow Salt Jetty ▪ Onslow Back Beach picnic area (low risk) ▪ Front Beach / Sunrise Beach ▪ Town Seawall will need to be maintained for full planning timeframe to limit the risks to assets. Coastal erosion hazard extents allowed for in this section mainly consist of the uncertainty factor required as per SPP2.6. Present day: 1 bench is at risk
2040	▪ Seaview Drive near 12 Mile Creek / 4 Mile Beach ▪ Assets adjacent to crest of seawall (bins, shade structures, benches) ▪ Shire of Ashburton Offices (Business House) at the intersection of Second Ave and McGrath Rd (still Shire-owned) ▪ Aboriginal community on Second Ave ▪ Second Ave
2070	▪ Western half of Ian Donald Blair Memorial Walkway
2110	▪ Intersection of Seaview Drive and Back Beach Road ▪ Eastern end of Ian Donald Blair Memorial Walkway ▪ Lot 381 (top of hill at Beadon Point). Noting presence of underlying rock within Beadon Point hill may limit this erosion. In addition, elevation is not considered when applying methodology of SPP2.6. Hill crest is 10 to 15 m AHD. This additional volume of sediment means the 2110 hazard line is conservative ▪

Table 2-3 Assets at risk from pluvial inundation hazards

ARI Event	Affected Assets	Assets Not Affected	Total Assets	Percentage Affected
Present Day 100 Year	259	277	536	48%
Present Day 500 Year	327	208	536	61%
2040 100 Year	282	254	536	53%
2040 500 Year	352	182	536	66%
2070 100 Year	286	250	536	53%
2070 500 Year	395	117	536	74%
2110 100 Year	373	163	536	70%
2110 500 Year	447	84	536	83%

2.7.3 Values

Community and stakeholder engagement was undertaken to establish the spatial, social, and economic context of the CHRMAP, and develop the success criteria for the CHRMAP. Details of consultation methods and outcomes are provided by the Key Issues Paper (Cardno 2016c).

The stakeholder values were mapped according to the following categories:

> Recreational;

> Commercial;

> Environmental;

> Historic / heritage;

> Physical infrastructure;

> Aboriginal.

An example of recreational values identified is provided in **Figure 2-11**.

Figure 2-11 Example of values mapping showing recreational values for the study area

Success criteria were developed with the stakeholders and prioritised according to importance:

> Maintenance of the foreshore;

> Protection and enhancement of the local economy;

> Well maintained community structures;

> Year round accessibility to Onslow via Onslow Ring Road;

> Realistic and sustainable strategies;

> Sustaining and enhancing natural environmental values;

> Strategy not reliant on building heights;

> Not prohibitive of future development; and

> Year round accessibility of the foreshore (as was historically the case).

Whilst all of these success criteria will be considered during the CHRMAP process, it should be noted that not all may be realistically achievable.

3 RISK ASSESSMENT

3.1 Risk Assessment Framework

To provide a transparent and logical basis for determining adaptation planning priorities, a risk assessment was undertaken based on AS5334-2013, and the CHRMAP guidelines (WAPC 2014). As illustrated by **Figure 3-1**, risk was assessed in relation to likelihood, consequence and adaptive capacity. Likelihood was assigned using the results of the hazard assessment and consequence ratings were informed by public consultation. Risk is considered to be the combination of likelihood and consequence with consideration of adaptive capacity determining an assets overall vulnerability to climate change (as defined in **Section 1.3.6**).

The Risk Assessment Report (Cardno 2016b) provides a full description of the risk assessment process. A summary of the assigned likelihood, consequence and adaptive capacity for each asset is provided in **Appendix A**, and the resultant risk and vulnerability profile over time for each asset is provided in **Appendix B**.

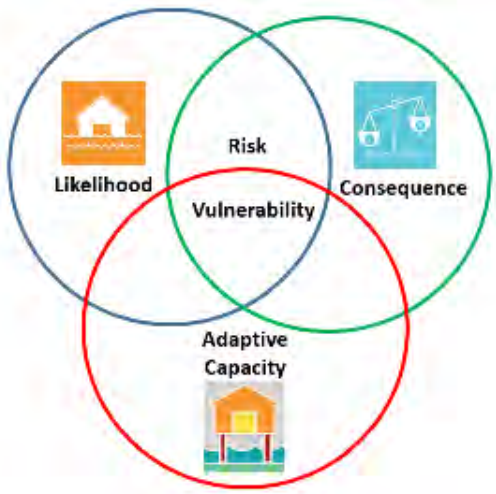

Figure 3-1 Conceptual relationship between risk assessment elements

3.2 Assets at Risk from Erosion and Coastal Inundation

Assets identified as being at risk of erosion and coastal inundation are shown in **Figure 3-2**. A brief description of the assessed risk and vulnerability profile for each of the assets is summarised below.

3.2.1 On-ground Infrastructure at Onslow Salt Jetty

The current hazard line is immediately adjacent to the seaward edge of on ground infrastructure at Onslow Salt jetty. These assets are therefore at risk of erosion before 2040, with likelihood increasing over time, and impacts considered to be almost certain by 2070 (**Appendix A**).

The current economic value of the assets and role of Onslow Salt as a significant local employer lead to a consequence rating of major being assigned to this group of assets. (**Appendix A**) However, since the assets include a number of relatively adaptable and relocatable elements, the adaptive capacity was deemed moderate and overall vulnerability was assessed as being high in 2070 and very high from 2110 (**Appendix B**).

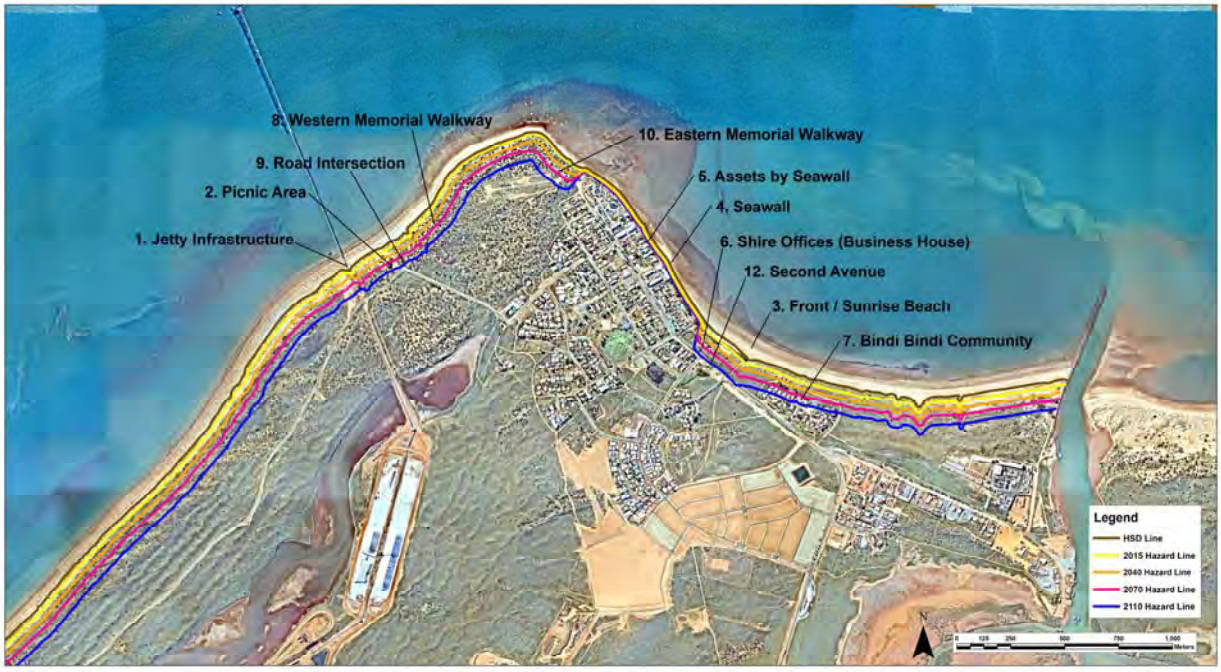

Figure 3-2 Map of assets at risk from coastal hazards

3.2.2 On-ground Infrastructure at Onslow Salt Jetty

The current hazard line is immediately adjacent to the seaward edge of on ground infrastructure at Onslow Back Beach Picnic Area

The picnic area assets are predicted to be at risk of erosion between 2070 and 2110. While having considerable value in terms of public recreational amenity, the economic value was estimated to be between $100 - $1M and therefore only a moderate consequence of loss (**Appendix A**). Furthermore the assets are considered to be relocatable so the adaptive capacity was deemed high and overall vulnerability was assessed as being low up to 2110 after which time it rises to medium vulnerability (**Appendix B**).

3.2.3 Front / Sunrise Beach

The front beach is highly valued by the community for recreation purposes, it has environmental value (including turtle nesting) aboriginal significance as a fishing area and commercial value in relation to tourism. The hazard assessment indicates that the beach will erode over time, intersecting with the Bindi Bindi community by 2040 and Second Avenue by 2070. Despite having being of high value, due to the inherently mobile nature of beaches - the consequences of the erosion are considered to be low initially, increasing over time as the space available reduces and there is conflict with other assets (**Appendix A**).

The results of the risk assessment show that the beach has a high vulnerability rating from 2070 and is considered very highly vulnerable from 2110 (**Appendix B**).

3.2.4 Existing Seawall

The risk assessment for the seawall is confounded by the fact that the seawall itself is a previously installed risk mitigation optoin. Firstly, the hazard lines show erosion landward of the wall, which is an artefact of the method prescribed in SPP2.6 that requires an allowance for sea-level rise even behind physical infrastructure. Secondly, the risk assessment was based on the assumption that the wall was not maintained and thirdly, in the CHRMAP context, its primary role is as a structural control influencing coastal processes. Nonetheless, in terms of public infrastructure and the Shire's operations it is a key asset and was assessed as such. The risk assessment was completed as if there were no mitigating factors (the seawall) and the likelihood, consequence and existing risk were assessed on this basis. The adaptive capacity and existing controls are then factored in to determine the vulnerability. The design life and future presence and functionality of the seawall need to be considered in long-term planning around both the seawall itself and adjacent assets which it presently protects.

It was considered possible that erosion will occur in the present day timeframe, consequences were considered to be moderate (assuming that the portion of wall that may be damaged has a value of $0.1M - $2M), but it is considered to have a high adaptive capacity (**Appendix A**).

The results of the risk assessment show that the seawall has a medium vulnerability at present up to 2070 at which time it has a high vulnerability rating through to the end of the planning horizon (**Appendix B**).

3.2.5 Assets adjacent to Seawall

As for the assets adjacent to the seawall, the erosion hazard lines landward of the seawall are an artefact of the way in which SPP2.6 requires that allowances are made for sea-level rise, and in reality if the seawall is maintained appropriately then these should not be at risk of erosion. Nonetheless the hazard assessment shows the assets adjacent to the seawall as possibly being impacted by 2070, with minor consequences increasing to moderate in 2110 (**Appendix A**). These assets are considered to have a moderate adaptive capacity because, although they are relocatable, the options for where to put them become limited if the reserve is eroded. Therefore the assets are considered to have a medium level of vulnerability by 2070 (**Appendix B**).

3.2.6 Shire of Ashburton Offices (Business House)

The Shire offices (Business House) are predicted to be impacted by erosion between 2040 and 2070, with major consequences (based on the assumed economic value of the property) (**Appendix A**). This assigned consequence rating along with a low adaptive capacity, results in the asset being assessed as having medium vulnerability by 2040 and increasing to high throughout the rest of the planning horizon.

The results of the risk assessment show that the Shire of Ashburton Offices (Business House) have a low vulnerability at present up to 2040, at which time it has a high vulnerability rating which increases again to very high in 2070 (**Appendix B**).

3.2.7 Bindi Bindi Community

The Bindi Bindi community has high cultural value and has the same risk and vulnerability profile as the shire offices (Business House) located approximately 300 m northwest (**Appendix A, Appendix B**). These two assets are ranked as having the highest priority for adaptation planning.

3.2.8 Western half of Ian Donald Blair Memorial Walkway

A portion of the Ian Donald Blair Memorial Walkway is predicted to be possibly impacted by erosion between 2040 and 2070, with a larger area becoming likely to be impacted between 2070 and 2110 (**Appendix A**). Although impact is almost certain by 2110, the consequence of this is thought to be minor due to the limited extent of the potential impact, and the highly adaptable nature of this asset results in a medium vulnerability rating by 2070 (**Appendix B**).

3.2.9 Intersection of Seaview Dr & Back Beach Rd

The road intersection is predicted to be at risk of erosion between 2070 and 2110 (**Appendix A**). Although it has considerable value providing beach access, consequence of erosion is thought to be minor. Furthermore, the asset is considered to be resilient so the adaptive capacity was deemed as high. The vulnerability was assessed as being low throughout the planning horizon (**Appendix B**).

3.2.10 Eastern half of Ian Donald Blair Memorial Walkway

The eastern portion of the Ian Donald Blair Memorial Walkway is located closer to the coast and therefore predicted to be at risk of erosion by 2040 (**Appendix A**). Similar to the western portion, impact is almost certain by 2110. However, due to minor consequences and the high adaptability of the walkway, the vulnerability rating is low until 2070 when it increases to medium (**Appendix B**).

3.2.11 Seaview Drive near 12 Mile Creek

The portion of Seaview Drive located near 12 Mile Creek is predicted to be at risk of erosion between 2040 and 2070 (**Appendix A**). Consequence of erosion to the road was considered to be minor. Due to its high adaptive capacity, vulnerability of the asset was assessed as being low until 2110 when it rises to medium (**Appendix B**).

3.2.12 Second Avenue

Second Avenue is considered to be a highly valuable asset, being one of the main roads in the Onslow Township. The road is considered to be at risk of erosion between 2070 and 2110 (**Appendix A**). Being of high value, any damages caused by erosion is thought to have moderate consequences. Combined with its moderate adaptive capacity, the road was assessed as having low vulnerability until 2070, when it increases to a medium level of vulnerability (**Appendix B**).

3.3 Assets at Risk from Pluvial Inundation

3.3.1 Housing, Buildings and Property

The asset survey identified approximately 530 houses and buildings. These included both privately and publically owned buildings and ranged considerably in economic value and ability to withstand flooding impacts (**Figure 3-3**). Additional information on this asset group is provided in **Appendix A**.

During the 100 year storm event, these assets are currently at risk of inundation, with likelihood increasing over time and impacts considered almost certain by 2110. Despite the variability in the state of each asset, all assets in this category were assessed as having moderate consequences to inundation, increasing to major in 2070. Due to the low adaptive capacity of these assets, overall vulnerability was assessed as being medium at present, increasing to high in 2070 and to very high in 2110 (**Appendix B**).

Figure 3-3 Examples of houses and buildings of varying value and existing ability to accommodate inundation risk

3.3.2 Parks & Recreation Grounds

Parks and recreation grounds include assets such as public open spaces and the public pool.

The risk of inundation for this set of assets was found to be low until 2070, where it increases to medium through to the end of the planning horizon. Consequence of erosion was considered as insignificant to minor by 2070. Due to the high adaptive capacity of assets in this category, vulnerability was only deemed to be medium from 2070 (**Appendix B**).

3.3.3 Public Infrastructure

Public infrastructure refers to amenities, such as gazebos, bins, light poles, water tanks. Overall, there are approximately 530 public assets identified by the asset survey. A more comprehensive list of items included in this category is provided in **Appendix A**.

The likelihood profiles for the public infrastructure follow that of the previous two categories. Many of the assets within this category do not have high economic value and are considered to be easily replaceable or relocatable. Hence, they were considered to have a moderate adaptive capacity throughout the planning horizon (**Appendix B**). These assets were determined to have minor consequences until 2070, where it increases to moderate.

The results of the assessment show that assets in the public infrastructure category have low vulnerability to pluvial inundation, increasing to medium by 2040, then again to high by 2110.

3.3.4 Car parks

Car parks were identified as privately owned and public parking. Any garages that are not connected to the house or are not buildings with utility services connected are categorised as car parks (**Appendix A**).

Car parks were found to be at risk of inundation before 2040, with likelihood increasing over time, and impacts considered to be almost certain by 2070 (**Appendix A**). The combination of having minor consequences and moderate adaptive capacity resulted in the assets having medium vulnerability from 2070 (**Appendix B**).

3.3.5 Roads and Footpaths

Roads and footpaths were found to have medium risk by 2040, with likelihood increasing over time, and impacts considered to be almost certain by 2070 (**Appendix A**). These assets were considered to have moderate adaptive capacity, considered to be resilient to flooding. The assessment found the assets as having medium vulnerability from 2040 and increasing to high in 2110 (**Appendix B**)

3.3.6 Sheds

Sheds include privately and commercially owned storage facilities. Any sea containers used for storage purposes were categorised as a shed. Sheds were found to have the same risk and vulnerability profile as public infrastructure (**Appendix B**).

3.4 Prioritisation of Assets based on Risk Assessment

Base on the outcomes of the risk assessment, the assets were given the priority rankings shown in **Table 3-1** and **Table 3-2**.

Table 3-1 Prioritisation Rankings for Onslow Assets at Risk of Coastal Erosion

Asset Code	Asset	Prioritisation Ranking
1	On-ground infrastructure at Onslow Salt Jetty	2
2	Onslow Back Beach picnic area	3
3	Front Beach / Sunrise Beach	2
4	Seawall	1
5	Assets adjacent to crest of seawall (bins, shade structures, benches)	3
6	Shire of Ashburton Offices (Business House) at the intersection of Second Ave and McGrath Rd	1
7	Aboriginal community on Second Ave	1
8	Western half of Ian Donald Blair Memorial Walkway	3
9	Intersection of Seaview Drive and Back Beach Road	4
10	Eastern end of Ian Donald Blair Memorial Walkway	3
11	Seaview Drive near 12 Mile Creek / 4 Mile Beach	3
12	Second Ave	3

Table 3-2 Prioritisation Rankings for Onslow Assets at Risk of Pluvial Inundation

Asset Code	Asset	Prioritisation Ranking
1	Housing, Buildings & Property	1
2	Parks & Recreation Grounds	3
3	Public Infrastructure (fencing, light poles, playgrounds etc)	2
4	Car parks	3
5	Roads/footpaths	2
6	Sheds	2

4 ADAPTATION OPTION ASSESSMENT

4.1 Overview

Planning for risk adaptation or risk treatment involves the identification and evaluation of several suitable adaption options to mitigate, reduce or eliminate risk and potentially change the consequences or at least the severity of the consequences.

Potential options were identified under the risk management categories of avoid, managed retreat, accommodate and protect in accordance with SPP2.6 and the CHRMAP guidelines (WAPC 2014). These guidelines stipulate a coastal hazard risk management and adaptation planning hierarchy on a sequential and preferential basis (**Figure 4-1**) in which protection is only to be considered where:

> *"sufficient justification can be provided for not avoiding the use or development of land that is at risk from coastal hazards and accommodation measures alone cannot adequately address the risks from coastal hazards, then coastal Protection works may be proposed for areas where there is a need to preserve the foreshore reserve, public access and public safety, property and infrastructure that is not expendable."*

Information gained from the stakeholder and community engagement was also considered in the development of the options.

Figure 4-1 Conceptual representation of adaptation option categories from Coastal Adapt (2016) modified to reflect the WAPC preferred planning hierarchy (WAPC 2014)

4.2 Option Assessment Framework

4.2.1 Potential Adaption Options

The suite of adaptation options considered were as per the CHRMAP guidelines. Adaption Options – Coastal Erosion Mitigation (**Table 4-1**).

Table 4-1 Adaptation options (WAPC 2014)

Option Category	Option Name		Description
Avoid	Avoid	AV1	Locating assets outside of hazard zone
	Re-zoning	AV2	Adjust town zoning/planning where hazard zone overlaps undeveloped parts of current zones/boundaries
Managed Retreat	Accept and repair losses	MR1	Assets are left unprotected and loss is accepted following hazard event. Repairs may be implemented for public safety, and asset is retreated outside hazard zone, or in the case of beaches/vegetation, as natural recession occurs.
	Relocate outside of hazard zone	MR2	Assets located in the hazard zone are relocated or destroyed. Applied to assets of low value where it is impractical to re-design to withstand hazard impacts.
	Prohibit further development	MR3	Allows continued use of the current infrastructure until such time that impacts arise, but prohibits the development of further infrastructure as the area/asset is known to be vulnerable
Accommodate	Notification on title	AC1	Indicates to current and future landholders that an asset is likely to be affected by coastal hazards over the planning timeframe. Helps owners to make informed decisions about level of risk they are/may be willing to accept and that risk management and adaptation is likely to be required at some stage.
	Emergency plans and controls	AC2	Implement plans for asset that are at risk of coastal erosion due to severe weather. Have procedures in place for before, during and after the events for safety. E.g. signage barrier to prevent access.
	Re-design to withstand impact	AC3	Where avoiding or relocating are not an option, re-design to withstand impacts.
Protect	Dune care program	PR1	Development of a long term program for revegetation and rehabilitation of the dune system.
	Beach Nourishment or Replenishment	PR2	Replacement of sand on upper beach face and dunes to re-establish the sandy beach and provide a sediment supply. Generally utilised in conjunction with other methods for sand retention.
	Seawall	PR3	Construct small seawall in front of asset or along length of coastline to protect it from coastal hazards. This may need to be accompanied by beach replenishment/renourishment.
	Groyne	PR4	Construct shore normal groynes along the beach to capture sediment and protect the shoreline and assets behind.
Do Nothing	No prohibitions or development regulations	DN	No limitations on development or controls on adaptation planning. Assumes all risks are accepted at their present level.

4.2.2 Stakeholder Preferred Options

A stakeholder workshop was held on the 15th August 2016 to present and seek feedback on possible adaptation options to the attendees. Maps were presented to the stakeholders to locate the assets at risk and the table of Adaptation Options presented for reference. Stakeholders then nominated their preferred option for each assets using a worksheet (see Umwelt Outcomes Report, 2016 for details). The majority preferred option for each asset is presented in **Table 4-2**. This information is incorporated in the Multi-Criteria Analysis through 'Community Acceptability' (**Table 4-3**).

Table 4-2 Stakeholder Preferred Adaptation Option (from Umwelt, 2016)

Asset Code	Asset at Risk	First Preferred Adaptation Option	Second Preferred Adaptation Option
1	On-ground infrastructure at Onslow Salt Jetty	MR3 (Prohibit Further Development)	AC2 (Emergency Plans & Controls)
2	Onslow Back Beach picnic area	MR1 (Accept Losses & Repair)	PR1 (Dune Care Program)
3	Front Beach / Sunrise Beach	MR1 (Accept Losses & Repair)	PR2 (Beach Renourishment etc)
4	Seawall (if not maintained)	AC3 (Redesign to Withstand Impact)	-
5	Assets adjacent to crest of seawall (bins, shade structures, benches)	PR1 (Dune Care Program)	PR2 (Beach Renourishment etc)
6	Shire of Ashburton Offices (Business House) at the intersection of Second Ave and McGrath Rd	AC1 (Notification on Title)	MR3 (Prohibit Further Development)
7	Bindi Bindi Aboriginal Community on Second Ave	AC1 (Notification on Title)	MR3 (Prohibit Further Development)
8	Western half of Ian Donald Blair Memorial Walkway	PR1 (Dune Care Program)	MR2 (Relocate Outside of Hazard Zone)
9	Intersection of Seaview Drive and Back Beach Road	MR3 (Prohibit Further Development)	AC2 (Emergency Plans & Controls)
10	Eastern end of Ian Donald Blair Memorial Walkway	MR1 (Accept Losses & Repair)	PR1 (Dune Care Program)
11	Seaview Drive near 12 Mile Creek / 4 Mile Beach	PR1 (Dune Care Program)	MR2 (Relocate Outside of Hazard Zone)
12	Second Ave	AC3 (Redesign to Withstand Impact)	PR1 (Dune Care Program)

4.2.3 Multi-criteria and Cost Benefit Analysis

The CHRMAP employed an overview evaluation system to identify practical adaption options for each identified risk. This evaluation method incorporates a qualitative multi-criteria analysis and a preliminary cost benefit analysis. It is designed to provide an overall indication of an option's suitability. Options are colour coded according to a traffic light method, displayed in **Table 4-3**. Red lights are not always intended to completely disregard the option, but more to provide an indication of when reassessment may be required.

4.3 Assessment Results

The results of the options assessment for each asset are provided in **Appendix B**. This presentation summarises the risk and vulnerability profile for each asset and provides a preliminary assessment of the acceptability of the options in accordance with the MCA criteria (**Table 4-3**).

A summary of recommendations arising from the assessment is provided in **Table 4-4 and 4-5**. Options are either recommended, not recommended or it is suggested that they be investigated further. Where options are rated as "recommended" or "further investigation, these are discussed in greater detail in **Section 6**.

Table 4-3 Multi-criteria assessment and qualitative cost benefit input ratings and assessment outcome categories

	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Outcome
	Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Financial Gain / Avoidance of Cost	Capital Cost	Ongoing Cost	Recommendation
Unlikely to be acceptable	Likely to be Ineffective	Not likely to be approved / likely to result in legal risk	Not likely to be reversible. Limits future options once implemented	Likely to have unacceptable negative impacts	Unlikely to meet most success criteria	No financial gain or avoidance of loss	Very expensive	Very expensive	Not Recommended
May be acceptable	May be effective	May not be approved / may present legal risk	Likely to be reversible / adaptable at high costs	Some impacts that can be managed to an acceptable level	Mixed response, may meet some success criteria but not others	Some financial gain / small number of benefactors	Moderately expensive	Moderately expensive	Investigate / detailed option assessment
"No regrets"	Likely to be effective	Likely to be approved / minimal legal risk	Easily reversible or adaptable for the future, no negative impacts in the future	Not likely to have negative impact, may have positive impacts	Likely to meet most acceptability criteria	Large financial gain / public benefit	Low cost	Low cost	Recommended
Not Applicable									

Table 4-4 Summary of outcomes from the preliminary MCA/CBA of adaptation options for coastal erosion . Recommended (R) options are in green, not recommended (NR) options in red and adaptation planning options which are further investigated (I) in yellow. Option descriptions are provided in Table 4-1.

Description	Avoid		Managed Retreat			Accommodate			Protect				Do Nothing	Preliminary long term pathway
	AV1	AV2	MR1	MR2	MR3	AC1	AC2	AC3	PR1	PR2	PR3	PR4	DN	
1: On-ground Infrastructure at Onslow Jetty	R	R	NR	R	R	R	R	R	R	NR	NR	NR	NR	Avoidence of additional development. Managed retreat with low-level protection (dune care program).
2: Onslow Back Beach Picnic Area	R	N/A	NR	R	R	N/A	R	I	NR	NR	NR	NR	NR	Avoidence of additional development.
3: Front Beach / Sunrise Beach	R	N/A	NR	N/A	R	N/A	R	N/A	I	I	I	I	NR	Avoidence of additional development. Managed retreat with possible protection.
4: Seawall (if not maintained)	N/A	N/A	NR	N/A	N/A	N/A	R	R	N/A	I	N/A	I	NR	Protection of asset.
5: Assets adjacent to crest of seawall (bins, shade structures, benches)	R	N/A	NR	N/A	R	N/A	R	R	N/A	I	I	I	NR	Avoidence of additional development. Managed retreat with possible protection.
6: Shire of Ashburton Offices at the intersection of Second Ave and McGrath Rd	R	R	NR	I	R	R	R	I	R	I	I	I	NR	Avoidence of additional development. Managed retreat with low-level protection (dune care program); possible construction of protection structures.
7: Bindi Bindi Aboriginal Community on Second Ave	R	R	NR	I	R	R	R	I	I	I	I	I	NR	Avoidence of additional development. Managed retreat with possible protection.
8: Western half of Ian Donald Blair Memorial Walkway	R	N/A	I	R	R	N/A	R	I	R	NR	NR	NR	I	Avoidence of additional development. Managed retreat with low-level protection (dune care program).
9: Intersection of Seaview Drive and Back Beach Road	R	N/A	R	R	R	N/A	R	I	R	NR	NR	NR	NR	Avoidence of additional development. Managed retreat with low-level protection (dune care program).
10: Eastern end of Ian Donald Blair Memorial Walkway	R	N/A	I	R	R	N/A	R	I	R	I	I	I	I	Avoidence of additional development. Managed retreat with low-level protection (dune care program); possible construction of protection structures.
11: Seaview Drive near 12 Mile Creek / 4 Mile Beach	R	N/A	R	R	R	N/A	R	I	R	I	I	I	NR	Avoidence of additional development. Managed retreat with low-level protection (dune care program); possible construction of protection structures.
12: Second Ave	R	N/A	NR	I	R	N/A	R	NR	R	I	I	I	NR	Avoidence of additional development. Managed retreat with low-level protection (dune care program); possible construction of protection structures.

AV1: Avoid
AV2: Re-zoning
MR1: Accept and repair losses
MR2: Relocate outside of hazard zone
MR3: Prohibit further development / redevelopment
AC1: Notification on title
AC2: Emergency plans ad controls
AC3: Re-design to withstand impact

PR1: Dune care program
PR2: Beach nourishment or replenishment
PR3: Seawall
PR4: Groyne
DN: No prohibitions or development regulations

Table 4-5 Summary of outcomes from the preliminary MCA/CBA of adaptation options for inundation. Recommended (R) options are in green, not recommended (NR) options in red and adaptation planning options which are further investigated (I) in yellow. Option descriptions are provided in Table 4-1.

Description	Avoid		Managed Retreat			Accommodate			Protect		Do Nothing	Preliminary long term pathway
	AV1	AV2	MR1	MR2	MR3	AC1	AC2	AC3	PR1	PR2	DN	
Housing, Buildings, Property	R	R	R	I	R	R	R	I	NR	NR	NR	Avoidence of additional development. Managed retreat.
Parks and Recreation Grounds	I	N/A	R	I	R	N/A	R	R	NR	NR	NR	Avoidence of additional development.
Public Infrastructure	R	N/A	R	R	R	N/A	R	R	NR	NR	I	Avoidence of additional development. Managed retreat.
Car Parks	R	R	R	I	R	R	R	I	NR	NR	NR	Avoidence of additional development. Managed retreat.
Roads / Footpaths	R	R	R	R	R	R	R	R	I	I	NR	Avoidence of additional development. Managed retreat with possible protection.
Sheds	R	R	R	R	R	R	R	I	NR	NR	NR	Avoidence of additional development. Managed retreat.

AV1: Avoid
AV2: Re-zoning
MR1: Accept and repair losses
MR2: Relocate outside of hazard zone
MR3: Prohibit further development / redevelopment
AC1: Notification on title
AC2: Emergency plans ad controls
AC3: Re-design to withstand impact

PR1: Levee
PR2: Levees and pump systems
DN: No prohibitions or development regulations

5 ADAPTATION MANAGEMENT PLAN

5.1 Predicted Planning Pathways

For each asset a predicted planning pathway has been developed based on the risk and vulnerability profile over time and the results of the options assessment (**Appendix C**). In general the pathway follows the hierarchy of avoid and accommodate where possible, with managed retreat and protect only being presented as alternative options in the planning pathway for some assets.

The planning time frames used incorporate the Shire's immediate and short term planning horizons as well as the longer term planning horizons required by the WAPC. The predicted planning pathway is the culmination best estimates of climate change (in particular sea level rise), community and stakeholder consultation, risk assessment results and the adaptation options assessment. The predicted pathway provides the current thinking in regard to how individual assets will be managed, thereby allowing stakeholders and community to prepare for these future threats.

One of the mechanisms assumed to be available to is prohibit further development within designated hazard areas. The actual planning or development control mechanism implemented to achieve a prohibition requires careful consideration of the legal status of the Planning instruments to ensure no unintended consequences, such as a triggering of injurious affection under the Act are to be dealt with. The recommendations below are framed around options for reducing the risks of coastal erosion and pluvial inundation. It will be imperative to successful and realistic implementation of such recommendations for not only the risk, but possible cost and sources of funds to pay such costs being investigated prior to being implemented. For the purpose of the discussion in the following chapters it is assumed that development can be prohibited but the actual mechanism by which this is achieved will require further investigation.

5.2 Reactive Management Framework

As introduced in **Section 1.3.11**, planning also needs to be responsive to changes in the risk profile over time. The predicted planning pathway will need to be updated following regular monitoring (for example monitoring of erosion or inundation levels) and review of other factors as per existing planning review requirements. If risks are increasing faster than expected, then management response needs to also be moved forwards, and conversely if risks are less than anticipated, then risks may remain tolerable for longer and management actions may be delayed. This approach is called a reactive management framework and is illustrated in **Figure 5-1**.

In addition to triggers associated with risks, other triggers may include the life cycle of an asset, and altered circumstances (for instance social pressures or economic climate).

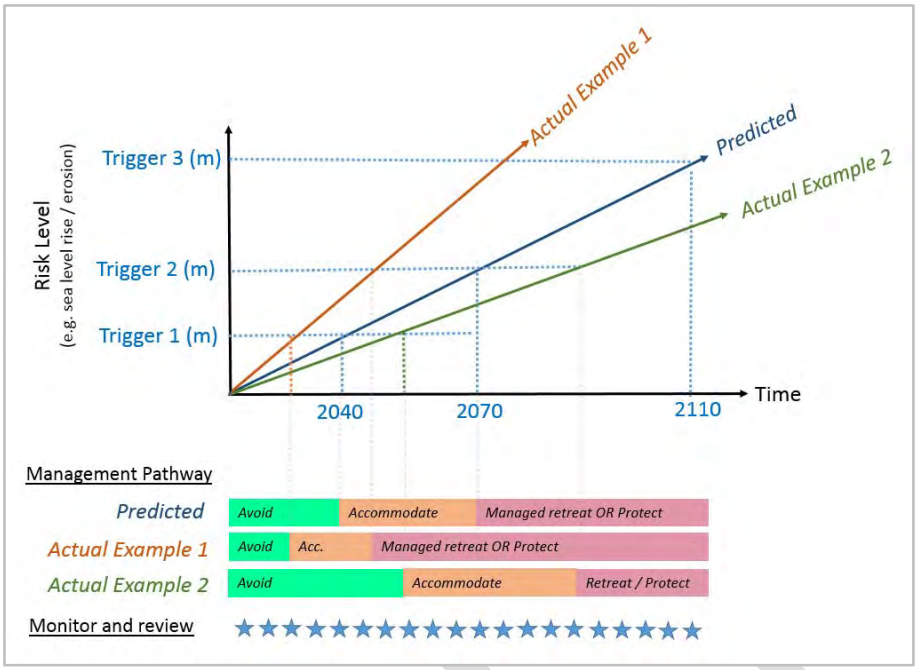

Figure 5-1 Representation of reactive management framework showing example of how triggers relate to the predicted and actual asset management pathways.

5.2.1 Existing Controls and Future Residual Risk Management

The residual risk identified in Appendix C is a direct outcome of inclusion of existing controls and the impact this has on the risk scale. The use of the existing controls and mechanisms that can be used to reduce the risk and the sequence of introducing controls or implementing strategies effectively means that future Adaptation options will be managed according to the residual risk levels. This is the assumption used Appendix C following the assumed implementation of a control at future time horizon. Note, however, that the CHRMAP review at each nominal 5 years will lead to a reassessment of the risk levels as new and more robust options are identified and assessed. For this 2017 CHRMAP the existing controls are assumed to continue into the future and hence have been incorporated into the risk levels for each asset as discussed the following sections 5.3 and 5.5. This approach flows on to the management and adaptation actions and recommendations.

5.3 Adaptation Management of Assets at Risk from Erosion

5.3.1 On-ground Infrastructure at Onslow Jetty

The vulnerability of the on-ground infrastructure at Onslow Jetty was assessed as being low until 2040, after which time it continually increases from medium to very high in 2110 (**Appendix B**). For the immediate term (5 years), adaptation management planning focuses on avoiding further development; and implementation of the "no regret" options: Emergency Plans and Dune Care Program (**Appendix C**).

In the short term (5-10 years), management aims to continue the existing management options, while at the same time commencing to plan for managed retreat or protection actions. During this period it is anticipated that some assets may be designed to withstand impacts and if damages do occur then short term repairs may enable continued functioning of the assets in their current location.

In the medium term (10-25 years) it is predicted that substantial re-design would be required to maintain functionality and relocation of assets is likely to be required. If the decision had been made to protect the assets in their current location, then this would need to be implemented.

Triggers for reactive management are based on the rate of erosion, occurrence of events causing damage to assets, asset lifecycle and potential for cessation of industry (**Appendix C**). Responsibility for management

of the salt export assets lies with Onslow Salt. If protection options are considered appropriate then as beneficiaries of the protection works, it is expected the company would contribute to the costs of protection and also show that any potential shifts in erosion hazards will not disadvantage other neighbouring stakeholders.

5.3.2 Back Beach Picnic Area

The picnic area assets were assessed as having low vulnerability until 2110 at which time they a medium vulnerability (**Appendix B**). For the immediate to short term (5-10 years), adaptation management planning focuses on avoiding and prohibiting further development; and implementation of Dune Care Program and Emergency Plans (**Appendix C**).

In the medium term (10-25 years), existing management options will remain, whilst commencing to plan for managed retreat actions. During this period it is anticipated that re-design of assets and potential protection options be investigated. Any damage to assets are to be repaired so that continued function in their current location can occur. Consideration should be given to any changes in zoning that may be required for creation of an alternative picnic area in the vicinity of Back Beach.

In the long term (50 -100 years) relocation of assets may be required. If the decision is made to protect the assets in their current location, then this would need to be implemented.

Triggers for reactive management are based on the rate of erosion, occurrence of events causing damage to assets and asset lifecycle. Responsibility for management of the assets lies with the Shire of Ashburton.

5.3.3 Front / Sunrise Beach

The results of the risk assessment show that the beach has a high level of vulnerability in 2070, increasing to very high by 2110 (**Appendix B**). For the immediate term (5 years), implementation of Emergency Plans and a Dune Care Program is recommended, as well as investigations into protection options (**Appendix C**).

In the short term (5-10 years), existing management options and investigations into protection options would continue. By the medium term (10-25 years) any protection options selected would need to be implemented.

The beach itself is not treated as an economic asset in this analysis, and it is deemed to have reasonable adaptive capacity in the medium term. However, if the decision is made to implement protective measures such as the extension of the seawall (**Section 6.4.2**), then earlier intervention will maintain more of the functionality of the beach and retain the natural dune buffers.

The main trigger for reactive management is based on the rate of erosion of the beach (**Appendix C**). Responsibility for management of the assets lies with the Shire of Ashburton.

5.3.4 Existing Seawall

The seawall has a medium vulnerability at present up to 2070 at which time it has a high vulnerability rating through to the end of the planning horizon (**Appendix B**). For the immediate to short term (5-10 years), implementation of Emergency Plans is necessary, while investigation into protection options should commence (**Appendix C**). Any damages to the seawall in any event are to be repaired to withstand future impacts.

In the medium term (10-25 years) continual improvements to the seawall would be required to maintain the integrity of the structure. During this time, any protection options selected would need to be implemented.

Triggers for reactive management (**Appendix C**) are based on the rate of erosion, occurrence of events causing damage to the seawall and adjacent properties. Responsibility for management of the assets lies with the Shire of Ashburton.

5.3.5 Assets adjacent to seawall

The assets adjacent to the crest of the seawall are considered to have low vulnerability to coastal erosion until 2110, when it increase to medium (**Appendix B**). For the immediate to short term (5-10 years), implementation of Emergency Plans is necessary and any further development in the area is to be prohibited (**Appendix C**).

In the medium term (10-25 years), management aims to continue the existing management options, while at the same time commencing to plan for managed retreat or protection actions in association with protection of the seawall described above. During this period it is anticipated that some assets may be designed to

withstand impacts and if they do occur then short term repairs may enable continued functioning of the assets in their current location.

In the long term (50-100 years) it is predicted relocation of assets is likely to be required unless maintenance of the seawall is sufficient to mitigate the erosion risk. If the decision is made to protect the assets in their current location, then this would need to be implemented.

Triggers for reactive management (**Appendix C**) are based on the occurrence of overtopping, erosion impacts to the seawall and events causing damage to property. Responsibility for management of the assets lies with the Shire of Ashburton.

5.3.6 Shire of Ashburton Offices

The Shire offices (Business House) become highly vulnerable in 2040 (**Appendix B**) and require immediate (5 years) implementation of "No regret" options: Emergency Plans and Dune Care Program (**Appendix C**). Further development is to be avoided until plans to implement managed retreat options are to be developed and agreed.

In the short term (5-10 years), re-design would be required to maintain functionality. If the decision had been made to protect the assets in their current location, then this would need to be implemented. In the medium term (10-25 years), relocation of assets is likely to be required and further development in the area be prohibited.

The risk profile of this asset is linked to other assets including the Front Beach, Bindi-Bindi Community and Second Avenue. Any protection measures implemented in this area will alter the hazard lines and therefore likelihood and consequences of erosion. If protection options are considered, investigations would need to commence in the immediate term.

Triggers for reactive management (**Appendix C**) are based on the rate of erosion, occurrence of events causing damage to property and asset lifecycle. Responsibility for management of the assets lies with the Shire of Ashburton.

5.3.7 Bindi Bindi Community

Similar to the adjacent Shire of Ashburton Offices (Business House), the results of the risk assessment show that the Bindi Bindi Community becomes highly vulnerable in 2040 (**Appendix B**) and require immediate (5 years) implementation of "No regret" options: Emergency Plans and Dune Care Program (**Appendix C**). Future development in its current location is to be avoided.

In the short term (5-10 years), re-design would be required to maintain functionality of assets. If the decision had been made to protect the assets in their current location, then this would need to be implemented. In the medium term (10-25 years), relocation of assets is likely to be required and further development in the area be prohibited.

The risk profile of this asset is linked to other assets including the Front Beach, Shire of Ashburton Offices (Business House) and Second Avenue. Any protection measures implemented in this area will alter the hazard lines and therefore likelihood and consequences of erosion. If protection options are considered for the collection of assets then investigations would need to commence in the immediate term.

Triggers for reactive management are based on the rate of erosion, occurrence of events causing damage to property and asset lifecycle (**Appendix C**). Responsibility for management of the assets lies with the community itself and the relevant state government authorities.

5.3.8 Western half of Ian Donald Blair Memorial Walkway

The western portion of the Ian Donald Blair Memorial Walkway was assessed as having medium vulnerability from 2070 (**Appendix B**). For the immediate to short term (5-10 years), implementation of Emergency Plans and Dune Care Program is recommended and any further development is to be prohibited (**Appendix C**).

In the medium term (10-25 years) it is anticipated that the walkway may be designed to withstand impacts and if damages do occur then short term repairs may enable continued functioning of the walkway in its current location.

In the long term (25-50 years) it is predicted that substantial re-design would be required to maintain functionality and relocation of the walkway is likely to be required.

Triggers for reactive management are based on the rate of erosion, occurrence of events causing damage to assets and asset lifecycle (**Appendix C**). Responsibility for management of the assets lies with the Shire of Ashburton.

5.3.9 Intersection of Seaview Dr & Back Beach Rd

The results of the risk assessment show that the intersection of Seaview Drive and Back Beach Road has a low level of vulnerability to coastal erosion throughout the planning horizon (**Appendix B**). Emergency Plans and Dune Care programs would be required in the immediate term (5 years) and further development is to be prohibited.

In the long term (25-50 years), any damages to the asset are to be repaired so that functionality is maintained. It is anticipated that re-design may be required withstand future impacts.

In the long term (50-100 years), relocation of the asset is likely to be required

Triggers for reactive management are based on the rate of erosion, occurrence of events causing damage to assets and asset lifecycle (**Appendix C**). Responsibility for management of the assets lies with the Shire of Ashburton.

5.3.10 Eastern half of Ian Donald Blair Memorial Walkway

The eastern portion of the Ian Donald Blair Memorial Walkway was assessed as having medium vulnerability from 2070 (**Appendix B**). For the immediate to short term (5-10 years), implementation of Emergency Plans and Dune Care Program is necessary and any further development is to be prohibited (**Appendix C**).

In the medium term (10-25 years), if damages occur then short term repairs may enable continued functioning of the walkway in its current location. However, investigation into re-design options would be required.

In the long term (25-50 years) it is predicted that re-design would be required to maintain functionality and relocation of the walkway is likely to be required.

Triggers for reactive management are based on the rate of erosion, occurrence of events causing damage to assets and asset lifecycle. Responsibility for management of the assets lies with the Shire of Ashburton.

5.3.11 Seaview Drive near 12 Mile Creek

The section of Seaview Drive near 12 Mile Creek was considered as having medium vulnerability by 2110 (**Appendix B**). Emergency Plans and Dune Care programs would be required in the immediate term (5 years) and further development is to be prohibited.

In the medium term (10-25 years), the road is anticipated to require a re-design to withstand impact. Any damages sustained could be repaired in the short term which will enable continued function in its current location.

In the long term (50-100 years) to maintain the road's function, substantial re-design and/or relocation may be required.

Triggers for reactive management are based on the rate of erosion and occurrence of events causing damage to assets (**Appendix C)**. Responsibility for management of the assets lies with the Shire of Ashburton.

5.3.12 Second Avenue

The vulnerability of Second Avenue was assessed as having low vulnerability until 2070 when it increases to medium for the rest of the planning horizon (**Appendix B**). For the immediate term (5 years), implementation of Emergency Plans and Dune Care Program is necessary (**Appendix C**). Further developments in the area would need to be prohibited.

In the short term (5-10 years), existing management options will continually be implemented, while at the same time commencing to investigate protection actions. During this period it is anticipated that the road may be designed to withstand impacts and if damages do occur then short term repairs may enable continued functioning of the road in its current location.

In the long term (25-50 years) it is predicted that substantial re-design would be required to maintain functionality and relocation is likely to be required. If the decision had been made to protect the road in its current location, then this would need to be implemented.

Triggers for reactive management are based on the rate of erosion and occurrence of events causing damage to property. Responsibility for management of Second Avenue lies with the Shire of Ashburton.

The risk profile of this asset is linked to other assets including the Front Beach, Shire of Ashburton Offices (Business House) and the Bindi Bindi Community. Any protection measures implemented in this area will alter the hazard lines and therefore likelihood and consequences of erosion. Potential protection options for this group of assets is discussed in **Section 6.4.2**.

5.4 Adaptation Management Plan of Assets at Risk from Inundation

5.4.1 Housing, Buildings and Property

The vulnerability of housing, buildings and properties to inundation was assessed was assessed as being high in the present day, increasing to extreme from 2040 for the rest of the planning horizon (**Appendix B**). For the immediate term (5 years), a range of adaptation options are indicated, including avoid, accommodate and protect actions (**Appendix C**). Adaptive management focuses on prohibiting of further development, zoning of land for acceptable use, design to withstand flooding, putting emergency plans in place, and undertaking further investigations to better understand and develop strategies to address drainage/ water management issues. Protective actions including maintenance (and possible extension of the seawall) and upgrade of drainage controls are recommended. Investigation of a levee system may be required as an alternative to managed retreat in the medium (10 years) to long term (25 – 50 years).

Due to the high level of current vulnerability of housing, buildings and property, the implementation plan focuses largely on the issue of risk of inundation to these assets and recommends a number of mitigation measures (Section 6).

Triggers for reactive management are based on the rate of occurrence of flood events causing damage to property. Responsibility for management of this asset group lies with asset owners and the Shire of Ashburton.

5.4.2 Parks & Recreation Grounds

Despite having a similar likelihood, consequences of inundation are considered to be lower and adaptive capacity higher for this asset group than for housing, buildings and properties (**Appendix A**). Therefore risk vulnerability are also considered to be lower (**Appendix B**). However, by 2070 vulnerability was assessed as having increased to a rating of medium, and recommended adaptation options are recommended which focus on accommodation (design to withstand impact) for the immediate to long term (<5 to 50 years) and managed retreat in the long term (50 – 100 years). Prohibiting further development is recommended. Protective actions and recommended investigations discussed above and detailed in **Section 6** will also result in mitigation of risks to this asset group.

Triggers for reactive management are based on the rate of occurrence of flood events causing damage to property. Responsibility for management of drainage lies with the Shire of Ashburton and adaptation planning aims to minimise risk, however ultimately responsibility for housing, buildings and property ultimately rests with asset owners.

5.4.3 Public Infrastructure

Vulnerability of public infrastructure to inundation is considered to be higher than for parks and recreation grounds but lower than for housing, buildings and properties (**Appendix B**). Present day vulnerability is considered medium and by 2070 these assets are predicted to be highly vulnerable. In the immediate to short term (<10 years) adaptation focuses on avoidance actions and accommodation by way of design to withstand inundation where possible. From 10 years on, managed retreat is recommended.

Protective actions and recommended investigations discussed above and detailed in **Section 6** will also result in mitigation of risks to this asset group.

Triggers for reactive management are based on the rate of occurrence of flood events causing damage to the assets. Responsibility for management of public infrastructure lies with the Shire of Ashburton and relevant State Government departments.

5.4.4 Car parks

The risk and vulnerability profile for carparks was assessed as being the same as for parks and recreation grounds (**Appendix B**). Functionality can largely be maintained despite inundation and this form f asset is considered to have a high adaptive capacity. However, by 2070 vulnerability was assessed as having increased to a rating of medium, and recommended adaptation options are recommended which focus on accommodation (design to withstand impact) for the immediate to long term (<5 to 50 years) and managed retreat in the long term (50 – 100 years). Prohibiting further development is recommended. Protective actions and recommended investigations discussed above and detailed in **Section 6** will also result in mitigation of risks to this asset group.

Triggers for reactive management are based on the rate of occurrence of flood events causing damage to property. Responsibility for management of this asset group lies with both the asset owners and the Shire of Ashburton.

5.4.5 Roads and footpaths

Vulnerability of roads and footpaths to inundation is considered similar to that of other types of public infrastructure (**Appendix B**). Present day vulnerability is considered medium and by 2070 these assets are predicted to be highly vulnerable. In the immediate to short term (<10 years) adaptation focuses on avoidance actions and accommodation by way of design to withstand inundation where possible. From 10 years on, managed retreat is recommended.

Protective actions and recommended investigations discussed above and detailed in **Section 6** will also result in mitigation of risks to this asset group.

Triggers for reactive management are based on the rate of occurrence of flood events causing damage to the assets. Responsibility for management of public infrastructure lies with the Shire of Ashburton and relevant State Government departments.

5.4.6 Sheds

Sheds are a type of property, but due to the nature of their construction and use they are considered to be less vulnerable to inundation (**Appendix B**). Present day vulnerability is considered medium and by 2070 these assets are predicted to be highly vulnerable. In the immediate to short term (<10 years) adaptation focuses on avoidance actions and accommodation by way of design to withstand inundation where possible. From 10 years on, managed retreat is recommended.

Protective actions and recommended investigations discussed above and detailed in **Section 6** will also result in mitigation of risks to this asset group.

Triggers for reactive management are based on the rate of occurrence of flood events causing damage to the assets. Responsibility for management of this asset group lies with both the asset owners and the Shire of Ashburton.

5.5 Residual Risk

A residual risk assessment for each asset group and time frame was undertaken based on the following assumptions:

- No protection measures are undertaken for coastal assets other than those behind front beach that may be implemented in the short term;
- The seawall is maintained and extended eastwards to at least beyond the Bindi Bindi community, and that the risk of erosion in this area becomes similar to that of the land currently behind the seawall;
- Houses and properties are protected by the presence and extension of the seawall;
- Accommodation actions reduce the consequences of inundation for all asset types;

> Managed retreat reduces the risk from both coastal erosion and inundation as it is assumed that the asset is no longer located in a hazard zone.

The results of the residual risk assessment are presented in **Appendix C** for each asset along with the assumed adaptation pathway.

6 IMPLEMENTATION PLAN

6.1 Overview

The information collated through the various stages of the CHRMAP process including outcomes of the risk assessment and subsequent analyses summarised in the preceding sections have been used to define priority actions for implementation by the Shire and other stakeholders. The proposed implementation actions are intended to reduce the risk posed by coastal hazards in the immediate to short term, with consideration of the 100 year planning horizon.

The implementation plan has been structured to group actions in accordance with the WAPC (2014) adaptation hierarchy. In addition, adaptation responses can be defined as being related to either, planning and development or to engineering as discussed by the Planning Institute of Australia's (PIA) National Land Use Planning Guidelines for Disaster Resilient Communities (2015) and show schematically in the **Table 6-1**.

Table 6-1 Effectiveness of land use planning and building responses in treating specific natural hazard risks relevant to coastal planning

Hazard	Detailed Action		
	Land use (spatial, zoning)	Built form (building form, lot layout)	Building (design, structural)
Flood	Strong	Strong	Strong
Storm Tide	Strong	Strong	Strong
Coastal Erosion	Strong	Strong	Strong
Sea Level Rise	Strong	Strong	Strong
Cyclonic Wind	Limited	Moderate	Strong
Storm (incl. hail)	Limited	Limited	Moderate

Table source: National Land Use Planning Guidelines for Disaster Resilient Communities (PIA 2015) p.31

6.1.1 Planning and Development Responses

Land use planning and development control responses may not always be appropriate to treat the risk borne by a particular hazard. Effective management for coastal hazards does not necessarily mean there can be no development in designated high risk areas. Part of the purpose of this CHRMAP is to help articulate the possible consequences of development in these areas so that the Onslow community may consider what risk it is prepared to accept in those areas – now, and in the future.

Land use planning and building regulations apply only to new properties and developments or significant modification to existing properties. They may have little or no influence in the short-term but a very significant long-term effect. It is, therefore, extremely important to make good decisions now, as the consequences of poor decisions may last for decades.

Spatial controls, like zoning, set limits on the type and extent of development that can happen in particular areas (or zones). The SCA is a form of spatial control, but the zones underlying the SCA are also important as these may still permit land uses that would be vulnerable to hazard impacts within the overall planning timeframe (100 years).

It is important to identify land uses that are strategically compatible with the risk, and to zone the land accordingly. Therefore, a review of current zoning and land use permissibility within these zones should be undertaken in light of the outcomes of the risk identification and assessment. Appropriate zoning is important to provide clarity for both the community and developers. Any ambiguity due to potential coastal hazards may stifle development and consideration of such hazards should not be left until the development assessment stage.

Once appropriate development has been confirmed, building controls may be helpful to address risks for that type of development. The links between planning and building processes must be clearly articulated, so that

building controls are appropriately applied in the right areas – planning and building are covered by different legislation and are (usually) managed by different personnel.

Responsive building design requirements may be introduced in planning controls – as is the case already in Appendix 12 of TPS 7, that don't exist in the building regulation. For example, planning provisions and policies may relate to the form and density of buildings, including lot size and layout, or to the design of buildings such as prescribed minimum FFL, elevation above anticipated flood levels, etc.

'Overlays' such as special control areas or precincts can articulate specific building siting requirements, densities, or other requirements that address and seek to reduce the impact of coastal hazards.

As a general rule, privatisation of coastal land at risk of erosion or long term inundation through freehold or long term leasehold subdivision should be avoided. Permanent structures including buildings should not be permitted on land at risk of erosion or long term inundation. Redevelopment of land at risk of erosion or long term inundation with permanent structures should not be permitted within the at-risk parts of the site.

R1. A detailed review of current zoning and land use permissibility within zones should be undertaken in light of the results of the risk assessment outcomes.

R2. Appendix 12 SCA in LPS 7 should be reviewed to reflect the outcomes of the CHRMAP process and, where relevant, include specific clauses to, for example, ensure that actions are enforceable

6.1.2 Engineering Responses

Engineering responses included in the implementation plan focus on:

- generalised adaptation engineering responses and design standards,
- specific concept designs for protective structures mitigating the risk of coastal erosion; and
- identifying drainage engineering issues and investigations required to reduce risks from pluvial inundation now and in the future.

6.1.3 Beneficiary pays principle and Equity Considerations

The beneficiary pays principle has been adopted policy of Australian governments for some time although its implementation and the identification of project beneficiaries and apportionment of costs has been a vexing issue in the coastal zone. SPP 2.6 aims to reduce the liability for future protection of privately owned coastal assets at risk of erosion or inundation by changing climate and sea level rise. Coastal projects (eg. protection and sand nourishment works) requiring significant capital and ongoing maintenance funding will be subject to an assessment of the beneficiary pays principle and a mechanism for equitable apportionment of costs to identified beneficiaries will be required. This mechanism will require further investigation to determine a fair and equitable process to mitigate the future threats to the coastal zone.

6.2 Avoid / Retreat Actions

6.2.1 Zoning

It is recommended that the existing Conservation, Recreation & Nature zoning is maintained / extended along coastline, seaward of 2110 hazard line. Where current zoning permits development that is incompatible with identified risk, rezoning may be required to prevent further inappropriate development. Two examples identified in this assessment are:

- Bring Strategic Industry zone near jetty inland of 2110 hazard line
- Prior to development of Lot 381 consider adjusting north east boundary to be inland of 2110 hazard line (or move the whole block to the south-west).

R3. The existing Conservation, Recreation & Nature zoning should be maintained / extended along the coastline, seaward of 2110 hazard line

R4. Move the Strategic Industry zone near jetty inland of 2110 hazard line

R5. Prior to development of Lot 381 consider adjusting north east boundary to be inland of 2110 hazard line.

6.2.2 Coastal Reserve Planning

The coastal foreshore reserve serves a number of functions and, as identified during preparation of this CHRMAP, it holds value in a variety of aspects. The coastal foreshore provides beach access, recreation and conservation, is a tourist attraction and provides habitat for native flora and fauna. Importantly, it also provides a buffer to mitigate risks to high value assets such as buildings and infrastructure.

An assessment has been made of the current function(s), use and assets present within the coastal foreshore reserve. The hazard mapping indicates that in some locations the existing coastal foreshore reserve could completely disappear, including in front of the existing sea wall **(Figure 6-1)**. If the loss of the foreshore reserve in any particular location would be unacceptable, consideration should be given to amending the scheme to extend the local scheme reserve for the foreshore area beyond the coastal hazard line a sufficient distance to accommodate relocation of foreshore assets. The exact distance would have to be calculated according the amount of land likely to be required to accommodate those assets (eg: beach access paths, public toilets, picnic facilities, car parking, boat ramps, ecosystem conservation, etc).

Extending the reservation in the scheme may only be necessary in the longer term to accommodate loss of the existing foreshore past an acceptable limit, however no new high value or permanent assets should be permitted inside the forecast 100 year hazard line.

Where extending the reserve or preventing new development or significant redevelopment would impact zoned private land there could be implications such as claims for injurious affection. However, this will have to be balanced with the potential public costs of funding asset protection measures for future development on private land, and the loss of public access to the foreshore.

R6. Consideration should be given to amending the scheme to extend the local scheme reserve for the foreshore area beyond the 2110 coastal hazard line a sufficient distance to accommodate relocation of foreshore assets. Where this may impact on private land, consideration should include risk of claims arising.

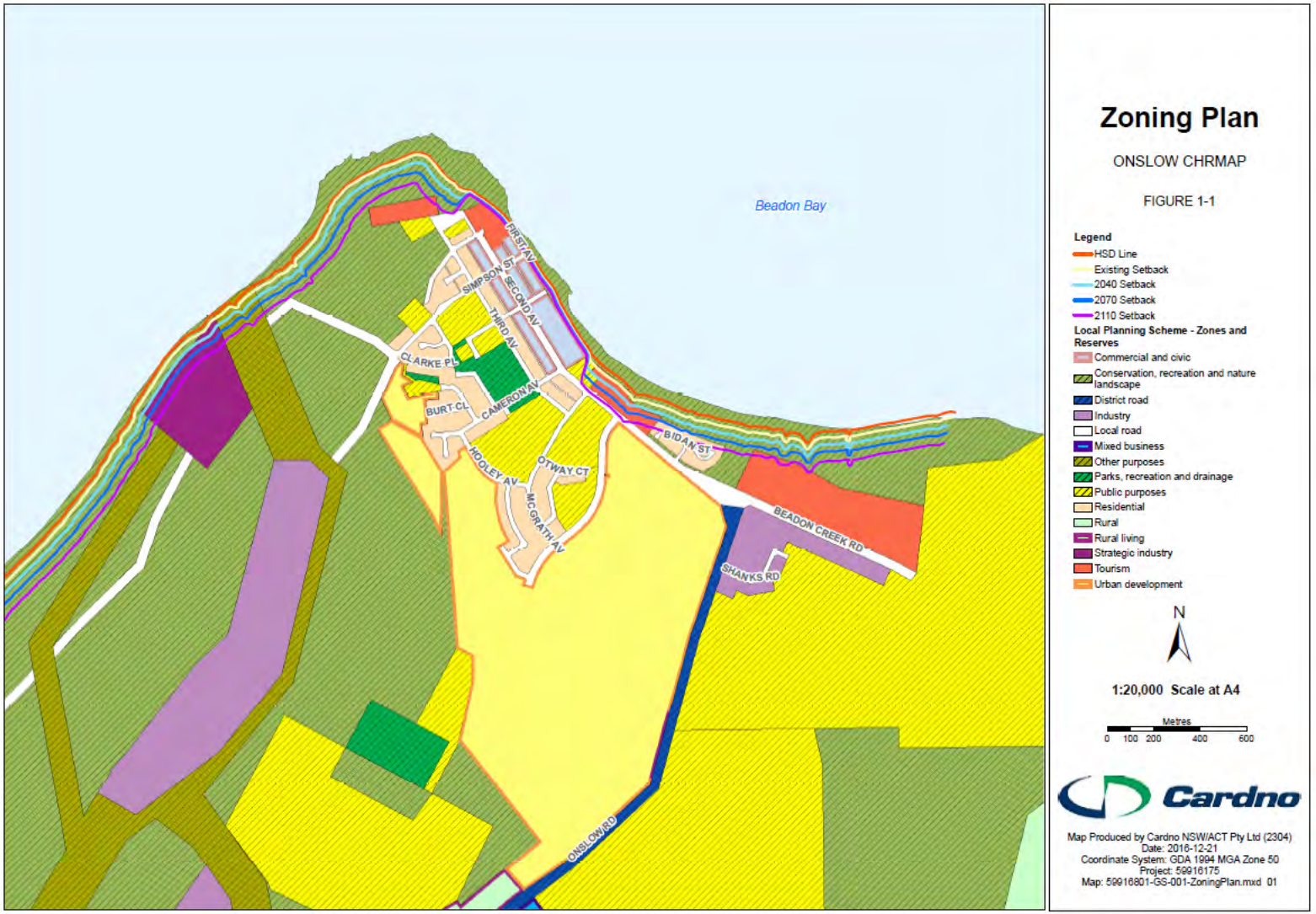

Figure 6-1 Coastal hazard lines in relation to town planning scheme zones

6.2.3 Special Control Area

The SCA currently applies to all land up to the 4m AHD contour in the coastal zone, and 5m AHD contour in frontal dune areas (Shire of Ashburton 2016) (see also **Section 2.4** of this report). The SCA also extends some way along the coast adjacent to Sunset Beach.

On the basis of the coastal hazard assessment, it is recommended that the SCA be extended inland to the 2110 coastal hazard line along the length of coastline, from the southern extent of the study area to Four Mile Creek.

In addition to coastal hazard allowances due to coastal erosion, SPP 2.6 could be interpreted such that it is appropriate for the extent of the SCA to reflect the modelling undertaken by the current study for the 1:500 year coastal inundation event. As described in **Section 2.7.2**, flooding in Onslow is dominated by pluvial (rainfall) inundation for all events except for the 1:500 year event in the year 2110. In this scenario, sea-level rise coupled with storm event metocean conditions results in the overtopping of the seawall, and extensive breaching of coastal dunes to the north and land to the east of the township towards Beadon Creek.

As presented in **Section 2.7.2**, the peak sea level for the 1:500 year event is approximately 4.55 m. Flood modelling is not as simple as assuming this level across the entire area as there are variations in peak water levels across the flooded footprint boundary, however, for the purposes of this study it is suggested that a level of 4.5 m AHD better represents the requirements of SPP2.6, and that this level is justified as the SCA for the current 100 year planning horizon. The coastal hazard assessment report (Cardno 2016a) provides additional technical detail about how the modelling was carried out and the results obtained. Figure 6-2shows the 4.5 m contour in relation to the SCA extent (as provided to Cardno – See **Figure 2-5**).

Every five years, when the local planning scheme is reviewed (as required by the *Local Government (Local Planning Schemes) Regulations*), the appropriateness of the SCA extent in the light of any studies undertaken by proponents in compliance with the provisions of Appendix 12 of the scheme can also be considered, and further adjustments made if appropriate. To aid this review, data relating to localised and general flooding in Onslow (not just the SCA) should be recorded in sufficient detail to identify trends over time, including any changes that may result from development that has taken place.

A Special Control Area is a mechanism that can be specifically used to assist facilitation of planned or managed retreat and is an adaptation option recommended for a number of areas of the Onslow Town site. In this instance the SCA classification can mandate that all development requires approval where ordinarily, development (e.g. single residential development) may otherwise be exempt from development control. The goal is to ensure any further development can only occur if the Shire considers it acceptable in light of the policy of planned or managed retreat. The existing Appendix 12 wording should be reviewed to ensure that it requires ALL development to obtain approval. This is not clear in the current wording as it only states that application for approval need to comply. Other issues should also be investigated for potential in facilitating planned or managed retreat through the SCA. Approval can be granted on a temporary basis (e.g. for 10 years) to permit the use for a limited time. This does not preclude a person from seeking further approval at the end of that timeframe. This permits or facilitates land to continue to be used in the immediate future whilst taking into account foreshadowed risks associated with rapid environmental changes in the medium to long term. This should be investigated further and included in the management and adaptation and implementation where relevant with regard to the planned or managed retreat recommendations.

CHRMAP guidelines also stipulate regular review of the CHRMAP. When this is done, the extent and level of the SCA should be reviewed in the light of monitoring results and updated hazard and risk assessments.

Updated survey data may be required if site works are carried out which change the ground level (for example the Berrada Estate) the fact that the SCA boundary will change over time, in response to changes in the risk profile due to uncertainty surrounding the prediction of future hazards, implementation of protective actions and adaptive responses such as raising the land level, as has been done at Berrada.

It would be appropriate to identify areas within the SCA and study area where avoidance of development altogether is the most advisable strategy. In these areas changes to zoning should be considered in order to prevent any inappropriate development. To assist in the Shire's planning in this regard, it is recommended that in addition to the updated SCA boundary, the 4.5 m contour, 1:10, 1:100 and 1:500 (for current, 2040,

2070 and 2110) flooding data layers be added to the Shires GIS to allow for cross referencing with other spatial data and enabling provision of advice and response to applications.

In accordance with existing policy, in areas not within the SCA, if the Shire considers that a proposed development could potentially be incompatible with and prone to flood and storm surge events, it may still have regard to information about these events when determining applications for planning approval.

It is recommended that intensification of development at the Bindi Bindi community should not be permitted. Renewal of existing infrastructure might be considered with flood-resistant building, such as houses raised on stilts (discussed in **Section 6.3.4**).

R7. The SCA should be extended inland to the 2110 coastal hazard line along the length of coastline, from the southern extent of the study area to 4 Mile Creek.

R8. For the current 100 year planning horizon the SCA extent should be defined by the 4.5 m AHD contour

R9. The SCA extent and provisions of Appendix 12 of the local planning scheme should be included in the five yearly local planning scheme review

R10. Review of the CHRMAP every five years is to include a review of the SCA extent and relevant provisions including Appendix 12 of TPS 7

R11. Data relating to localised and general flooding in Onslow (not just the SCA) should be recorded in sufficient detail to identify trends over time, including any changes that may result from development that has taken place

R12. Identify areas within the SCA and study area where avoidance of development altogether is the most advisable strategy

R13. Update of Shires GIS to include contours and flooding data from this study

R14. Intensification of development at the Bindi Bindi community should not be permitted. Renewal of existing infrastructure should only be considered with appropriate flood-resistant design

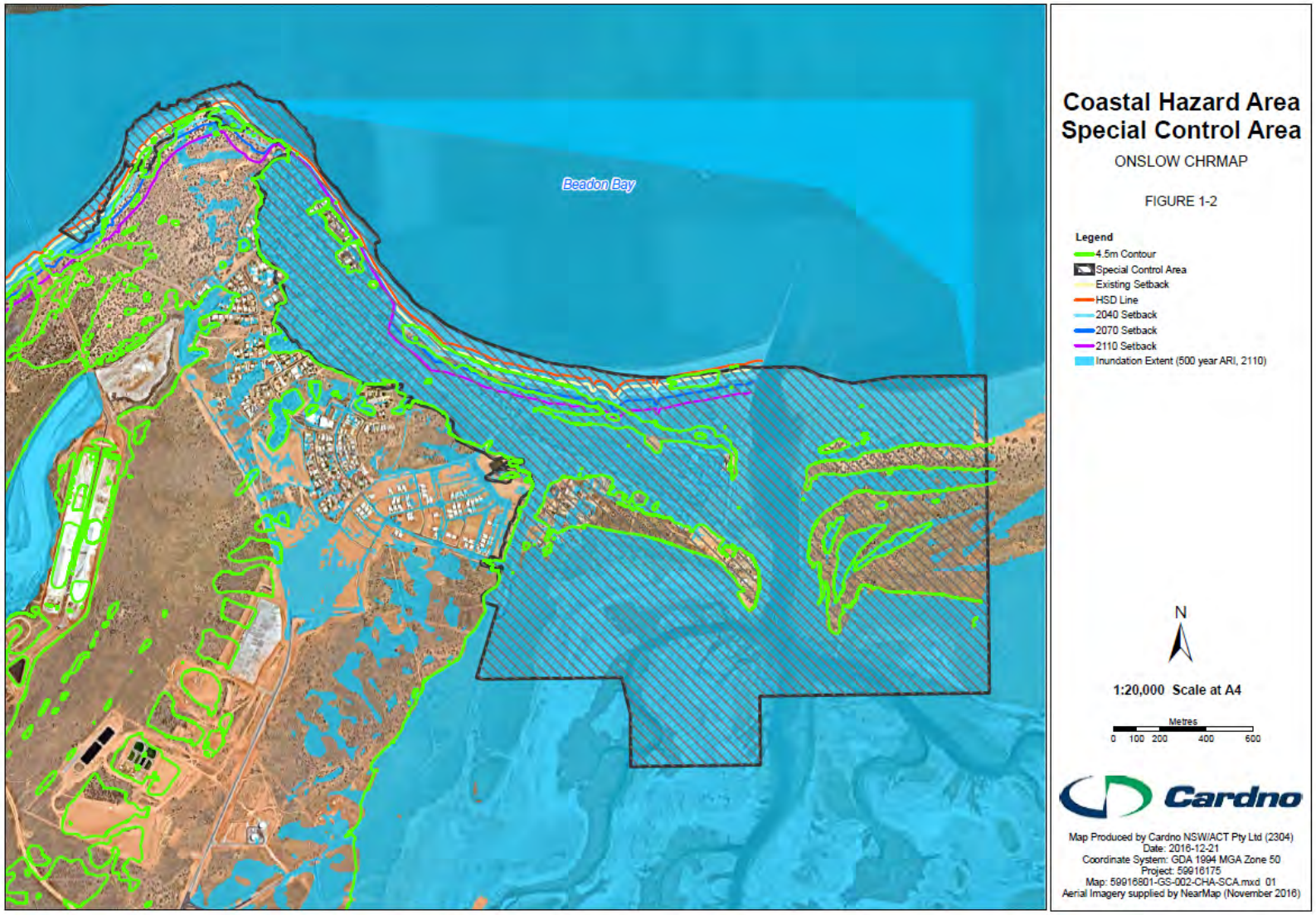

Figure 6-2 2004 Gazetted SCA overlaying current Onslow township zoning

6.2.4 Site Selection for Future Assets

Avoiding new development in hazard-prone areas and managed retreat requires the identification of alternative suitable sites for development. Where the risks of erosion or frequent inundation are high, new development should be avoided and strategies for retreat put in place as hazard event triggers that impact existing land uses are reached.

The predicted lifespan of the proposed development and its potential impact on other land during that lifetime, should be considerations for any application in areas identified as being at risk from coastal processes. Temporary land uses that can be removed before or when a nominated trigger is reached might be considered (for example, if the recurrence of flooding becomes unacceptably frequent and repair costs begin to exceed the retreat option costs). Appendix 12 to TPS 7 already contains provisions relating to temporary or transient development, requiring its removal by 31 December 2040.

No new development should be contemplated within the defined 2110 hazard line other than low impact, (relatively) low value and/or removable structures (such as beach shelters, access paths, fences, caravans, etc). No further subdivision of land within the 2110 hazard line should be contemplated, nor further intensification of existing development.

It has already been noted that the town of Onslow was completely relocated in the 1920's from its original location at the mouth of the Ashburton River, some 18 kilometres south-west of the current location. Whilst such a dramatic move is unlikely to be necessary again, it is nevertheless advisable to plan for the evolution of the town to achieve a gradual retreat of development in vulnerable areas to 'higher ground' (**Figure 6-3**). This recommendation should not cause alarm – dramatic and sudden changes should not be required if planning takes place early enough. All settlements evolve; this recommendation simply requires that improving the resilience of Onslow and its community to coastal erosion and inundation over time is a conscious inclusion in plan making.

A structure planning approach may be the best way of testing scenarios and producing a strategy that articulates a community vision for adapting Onslow iteratively over the long term to achieve an urban form that responds to storm tide and sea level rise risks. It would allow the establishment of a schedule or (more likely) milestones against which planning and development activity can be measured.

The endorsed structure plan for the expansion of the Onslow townsite already provides a direction for future development. Much of the plan is intended to cater for residential development. Structure plans are not statutory and some flexibility remains to identify sites suitable for the long term relocation of some land uses into the structure plan area if necessary. Thought could be given to keeping development on some sites relatively temporary to retain flexibility for the long term.

This CHRMAP looks 100 years ahead but also requires regular review to take into account new information and changing circumstances. A local planning strategy generally has a planning horizon of around 15 to 20 years, whereas a local planning scheme is reviewed every five years. Changes to planning controls, including the extent of the SCA and the development requirements that apply, are likely to be modest and incremental. As discussed in the previous section, 6.2.3, a SCA provides a mechanism to facilitate the implementation goal but a more detailed review needs to be undertaken to reduce the risks of unintended consequences of any proposed amendments.

R15. No new development should be contemplated within the defined 2110 hazard line other than low impact, (relatively) low value and/or removable structures

R16. Applications in areas identified as being at risk from coastal processes should consider the predicted lifespan of the proposed development and its potential impact on other land during that lifetime. Temporary land uses that can be removed before or when a nominated trigger is reached might be considered.

R17. No further subdivision of land within the 2110 hazard line should be contemplated, nor further intensification of existing development

R18. *Planning should guide the evolution of the town to less hazardous areas, from a flooding and coastal erosion perspective*

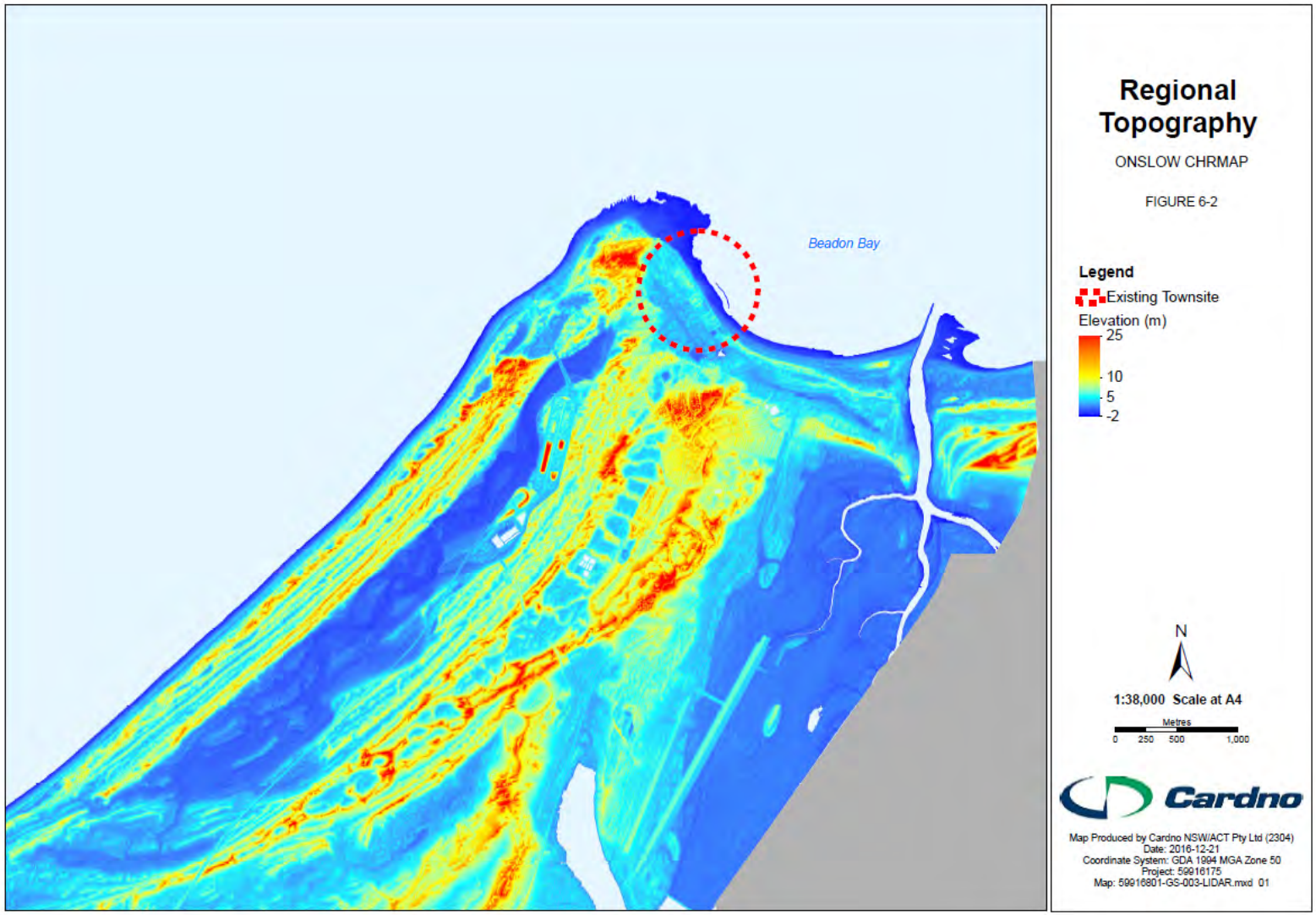

Figure 6-3 Topography of Onslow Region

6.2.5 Asset Relocation

This study has identified a number of public assets vulnerable to erosion for which the medium to long term pathway for adaptation is "managed retreat" (**Section 5.3**), including:

- Onslow salt infrastructure;
- Onslow Back Beach picnic area;
- Portions of the Ian Donald Blair Memorial Walkway; and
- Portions of Seaview Drive, Back Beach Road and Second Ave.

Ideally, the long-term preferred pathway for all assets in the SCA (i.e. at risk of inundation) is managed retreat, with some potential for accommodation in the form of changed land use and design to withstand impacts.

It is recommended that the Shire adopt a policy for relocation of public and Shire-owned assets from within the SCA at end of their lifecycle wherever possible. For some assets such as parks and recreations grounds and car parks these may be considered to be acceptable land uses and infrastructure should be designed to accommodate the risk as described in **Section 1.3**. It is recommended that the Shire's Asset Management Plan be updated to reflect the relocation policy.

Relocation of privately owned residential and commercial assets is a complex issue. As introduced in **Section 6.1**, it is important to identify land uses that are strategically compatible with the risk and zone the land accordingly, and a review of current zoning and land use permissibility with zones is recommended. Informing potential buyers of the long term risk is an important component as discussed in the following Section. Additional proactive strategies could include land buy back and land swap schemes (**Figure 6-4**).

Onslow salt infrastructure is vulnerable prior to 2040, and although there is scope for accommodation in the short term, the medium term adaptation pathway is for managed retreat (**Section 5.3.1**). It is recommended that the Shire convey the outcomes of this CHRMAP report and the expectation for long-term managed retreat to Onslow Salt management.

Consideration should also be given to the long term possibility of relocating the Bindi Bindi community to higher ground. This would obviously be something to be canvassed with the Bindi Bindi community given the tenure of the land and the cultural connections with the site, which was established as a 'native reserve' to house the many tribes forced off their country by the encroaching spread of pastoralism.

Alternative locations for all relocated assets would need to be identified as recommended in **Section 6.2.4** above.

R19. It is recommended that the Shire adopt a policy for relocation of public and Shire-owned assets from within the SCA at the end of their lifecycle wherever possible, and that the Shire's Asset Management Plan be updated to reflect the relocation policy

R20. The outcomes of this CHRMAP report and the expectation for long term management retreat should be conveyed to Onslow Salt management.

R21. Consideration should also be given to the long term possibility of relocating the Bindi Bindi community to higher ground.

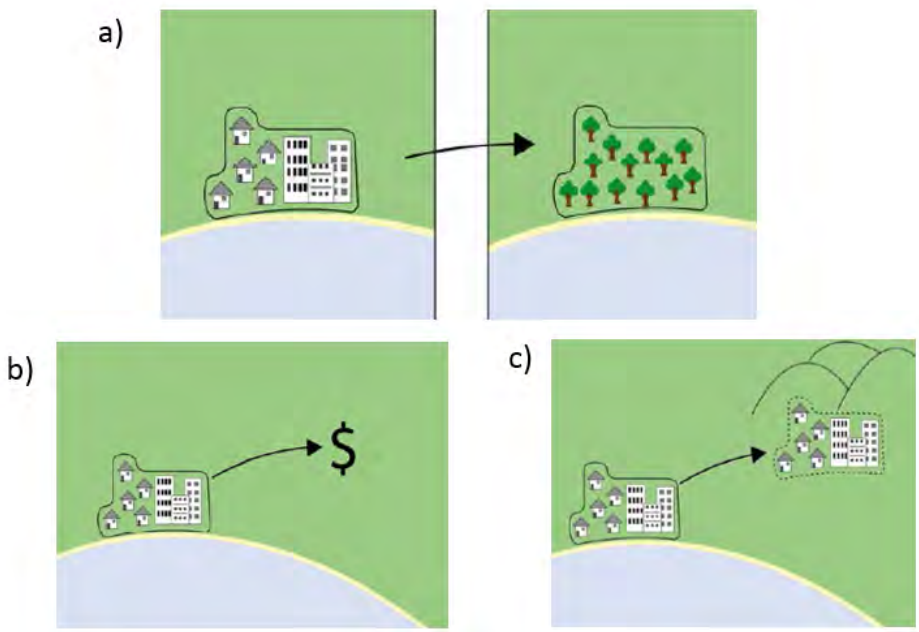

Figure 6-4 Relocation concepts a) changed land use within high risk coastal areas and strategies of b) land buy back and c) land swap (adapted from Griffith University Centre for Coastal Management, 2012)

6.2.6 Flood-prone Areas - Information for land buyers

Informing potential purchasers of land within the SCA and other flood prone land of the risk of flooding is important to allow people to make informed decisions about land they may look to purchase and develop. The Shire already has one mechanism for doing this, in some circumstances.

The provisions of Appendix 12 of TPS 7 include the requirement that any planning approval issued for development within the Onslow SCA shall include a condition requiring that a notification be placed on the certificate of title stating: "*VULNERABLE COASTAL AREA - This lot is located in an area likely to be subject to coastal erosion and/or inundation over the next 100 years."* This provision should remain.

Such a notification would take the form of a Notification under section 70A of the *Transfer of Land Act 1893*. A Section 70A Notice, as it is commonly known, advises prospective purchasers of a potential hazard or factor that might impact the enjoyment of the property. Typically it is only acceptable to place such a notice on a certificate of title if the factor is relatively permanent and would not be evident at all or would not necessarily be obvious on inspection of the land. Potential flooding is one such factor.

Except when the notification is required as a condition of development or subdivision approval, the land owner's acceptance is required before application to place a notice on a title can be lodged with the Registrar of Titles. Therefore whilst it is possible to apply to have a section 70A notice placed on the Title in other circumstances, it can only be with the agreement of the owner. Also, a fee is payable which might make the task cost prohibitive depending on the number of titles involved. Nevertheless it is something to consider and possibly negotiate with the State Government to remove the associated fees, in the public interest.

Information should also be given to prospective purchasers of flood-prone premises about the potential for inundation. This advice should be provided by the Shire in conjunction with the issue of zoning certificates and/or property enquiries. If it doesn't already, the information should be stored in the Shire's property data base where it can be accessed by Shire personnel responsible for responding to such enquiries. A GIS data base could also record incidences of flooding as they occur (along with a range of other site specific information), helping to build up a comprehensive picture that will aid future planning and investment decisions.

R22. Provision 6 of Appendix 12 of TPS 7 (requiring a notification be placed on the certificate of title) should remain

R23. Information on inundation risk should also be given to prospective purchasers of flood-prone premises by the Shire in conjunction with the issue of zoning certificates and/or property enquiries

6.3 Accommodate Actions

6.3.1 Sea Wall Maintenance

The seawall forms a protective structure not only in relation to coastal erosion, but also in the protection of the township from inundation. The maintenance of the seawall is assumed in the predicted risk profile of the assets protected by it (for example buildings in the township). For the assumed protective capacity of the seawall to be realised into the future, it must be adequately maintained. It is thus highly recommended that the seawall be maintained and current and future maintenance specifications should be developed. It is also recommended that consideration is given to extending the seawall as presented below (**Section 6.4.2**).

R24. It is highly recommended that the seawall be maintained, that detailed current and future maintenance specifications be developed and that beneficiaries and equitable apportionment of costs be investigated.

R25. Consideration should be given to extending the seawall to the east. This consideration should be informed by a Benefit Cost Analysis including options to equitably apportion costs to beneficiaries.

6.3.2 Land Use within the SCA

As introduced in **Section 6.1**, management for coastal hazards does not necessarily mean there can be no development in high risk areas. The SCA is a form of spatial control, but the zones underlying the SCA are also important as these may still permit land uses that would be vulnerable to hazard impacts within the planning timeframe (100 years). Zoning sets limits on the type and extent of development that can happen in particular areas. It is important to identify land uses that are strategically compatible with the risk and to zone the land accordingly. A review of current zoning and land use permissibility with zones is recommended.

Landuse within the SCA is considered in Appendix 12 of TPS 7 with specific reference to land use types: Health and Welfare and Community Services (Strategic and Non-strategic), Commercial (Strategic and Non-strategic), Residential, Temporary and or Transient; and Entertainment, Recreation and Culture (Appendix D).

In the context of adaptation planning, however it is recommended that land uses within the SCA be examined in greater details and consideration given to the formulation of guidelines on the preferred landuse within the SCA. In general, preference should be given to land uses which are by nature temporary or transient (for example caravan parks), and are readily relocatable in response to changes in the risk profile, or otherwise make the risk of erosion and inundation more tolerable. Extension of the conservation reserve may also be appropriate in some areas

R26. A detailed review of current zoning within the SCA and land use permissibility within zones is recommended.

R27. Consideration should be given to the formulation of guidelines on preferred landuses within the SCA. These guidelines may be incorporated into the update to the TPS.

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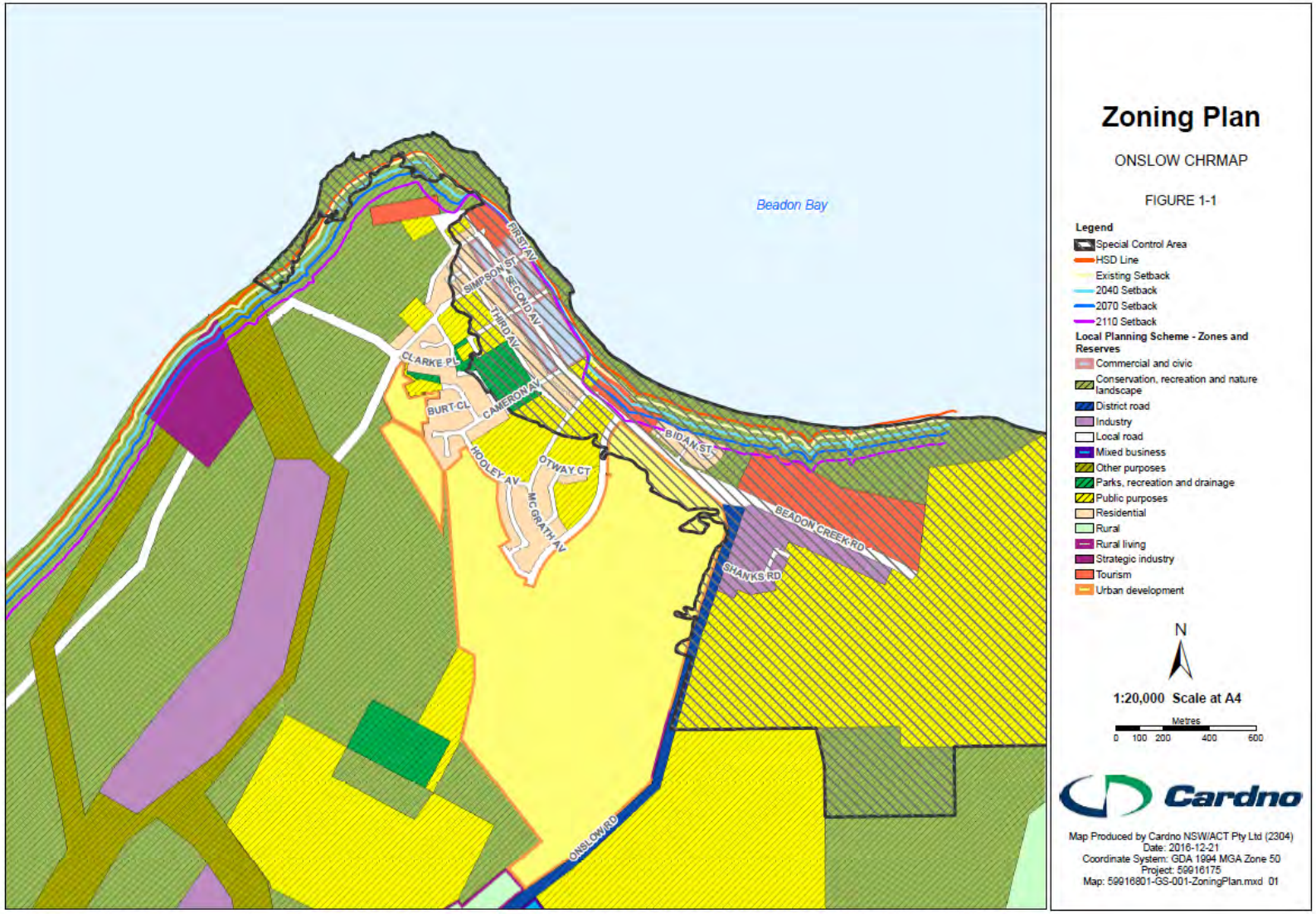


Figure 6-5 2004 Gazetted SCA overlaying current Onslow township zoning

6.3.3 Ground and Floor Levels

Inundation risks can also be managed through the application of planning and building controls, requiring elevated floor levels to reduce the impact of the expected flooding, especially under future conditions. This is usually implemented as a requirement to have a certain freeboard above a design flood level.

It is necessary to differentiate between finished ground level and finished floor level. All land that is the subject of a planning approval within the Onslow Coastal Hazard Area shall have minimum finished ground level of 2.5m AHD. However, fill to achieve a finished ground level of higher than 2.5m AHD is generally not supported, because increasing ground levels in one area can impact on other areas.

TPS 7 Appendix 12 currently specifies the minimum FFL for any building within the SCA as 2.5m AHD, with entertainment, cultural and recreation uses being permitted at this level. This minimum is specified to ensure that roads are less vulnerable to flooding. Other types of uses must have minimum floor levels of between 4m AHD and 6.4m AHD (Table 6-2), depending on their perceived vulnerability (refer to **Appendix D** of this document for the full text of Appendix 12 including a break-down of specific land uses included within each category).

On the basis of the results from coastal hazard assessment (Cardno 2016a), an appropriate level might be the 500-year ARI 2110 flood level of 4.5 m AHD with a 300mm or 600mm freeboard (i.e 4.8 -5.1 m AHD). This is in general agreement with the current FFLs (except for Temporary and/or Transient use and development). However, it is recommended that the Shire undertake a full review of FFL provided in Appendix 12 in relation to the flood levels provided in this document and existing precedents for land-use dependent freeboard allowances.

It is further recommended that this is reviewed again following review of the town drainage system as discussed in **Section 0.**

Table 6-2 TPS 7 Appendix 12 minimum Finished Floor Levels (FFL)

Land Use and Development	Minimum FFL (M AHD)
Health, Welfare and Community Services—Strategic use and development	6.4
Commercial—Strategic use and development	5.9
Residential use and development	5.9
Industry use and development shall be at a minimum finished floor level of	4.9
Commercial—non Strategic use and development	4.9
Health, Welfare and Community Services—non Strategic use and development	4.9
Temporary and/or Transient use and development*	4.0
Entertainment, Recreation and Culture use and development	2.5

* Where planning approval is issued, the use and development shall not remain beyond 31 December 2040.

R28. It is recommended that the Shire undertake a full review of FFL provided in TPS Appendix 12 in relation to the flood levels provided in this document

R29. FFL provided in TPS Appendix 12 should be reviewed again following review of the town drainage system

6.3.4 Design Guidelines

There are a range of adaptation approaches to inundation risk for property and building design as illustrated in **Figure 6-6**.

The Landcorp (2012) published document, *Pilbara Vernacular Handbook* already identifies a range of design considerations for building in the Pilbara, and includes a section on Onslow (Part 5). It describes elements of

the design vernacular typical of Onslow. This includes local typologies and use of materials and design elements to accommodate the climate, including heat, cyclones and inundation.

In terms of accommodating inundation, the most appropriate design element may be raising buildings on stumps or stilts so that water can flow beneath them (**Figure 6-6**). The height required in some locations may not make this a feasible response for retail and commercial buildings but it is a technique that has been employed for many years. Design guidelines might address the use of undercrofts, with habitable rooms raised above expected flood levels and other rooms and car parking permitted with lower FFLs.

Design guidelines are typically not statutory as writing specific design requirements into the planning scheme can limit innovative design responses. Only those design elements, such as FFL for habitable rooms, that are considered essential should be in the planning scheme. Beyond that, making design guidelines a local planning policy under the planning will provide them with sufficient status to require them to be given due regard, whilst maintaining flexibility to allow variations in specific circumstances.

It is recommended that design guidelines be developed to compliment those published by Landcorp to more specifically address measures for protection from inundation.

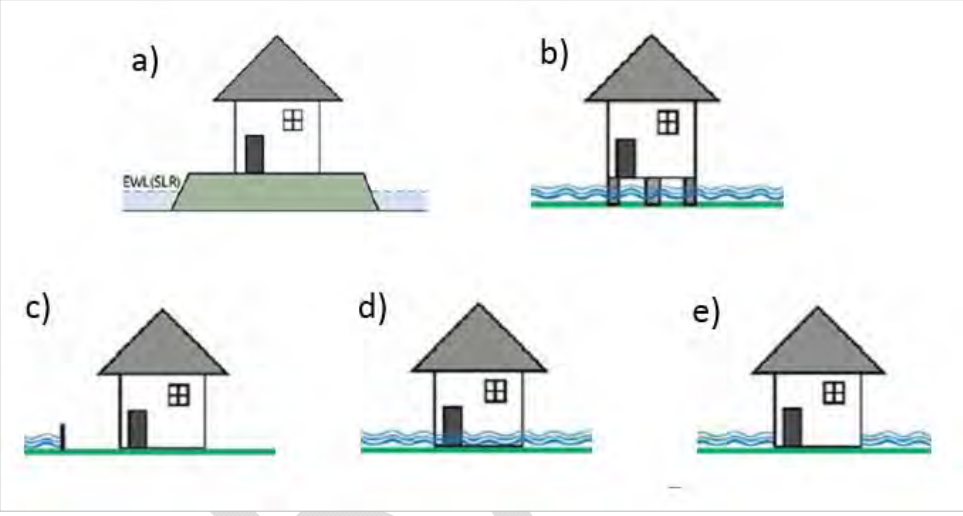


Figure 6-6 Property and building design adaptation responses a) raised ground levels, b) elevated buildings c) localised levees d) "wet" flood proofing and e) "dry" flood proofing (adapted from Griffith University Centre for Coastal Management, 2012)

R30. It is recommended that design guidelines be developed to specifically address measures for protection from inundation.

6.3.5 Drainage Design

Much of the town is relatively low and flat and the town's drainage relies on conveying runoff to stormwater detention basins prior to its discharge to the sea (see **Section 2.6**). This is particularly apparent for the drainage basins at the western end of the town. Over the 100 year planning horizon, the efficiency of the town drainage system is likely to be reduced (due to rising sea levels and the rising water table reducing the flood storage capacity of the drainage basins) leading to more frequent and prolonged flooding of low lying areas. Following significant future flood events the cost of repairs to any damaged infrastructure is likely to continue rising.

R31. It is recommended that prior to the next review of the CHRMAP the town drainage system be investigated and a strategy that meets the requirements of SPP2.6 and the CHRMAP Guidelines, the Water Management Plans, and other related State guidelines be developed.

6.3.6 Emergency Planning

It is recommended that the risks associated with emergency management and planning be considered through the implementation of cyclone and flood emergency response plans or similar. These plans map out the response to flood and coastal erosion emergencies prior to their occurrence and include the consideration of warnings, evacuation routes, trigger levels for response actions and the community recovery, post disaster.

R32. It is recommended that during the next phase of review Emergency Management plans incorporate the risks identified in this CHRMAP.

6.4 Protect Actions

6.4.1 Dune Care

On sandy shorelines, coastal dunes represent the last line of defence against erosion by providing a reservoir of sand for waves to utilise during storms (NSW Department of Land and Water Conservation 2001). In Onslow the dune system is low lying and generally sparsely vegetated (**Figure 6-7**). The current threats include uncontrolled vehicle and pedestrian access. These human impacts can also lead to excessive wind-blown erosion, above that expected naturally.

Figure 6-7 Track through the dunes near the Onslow Jetty

It is recommended that the Shire initiate a dune care program that includes at least the following elements:

- Restriction of vehicle and pedestrian access;
- Dune stabilisation works where required; and
- Planting of native species.

NSW Department of Land and Water Conservation (2001), Coastal Dune Management: A Manual of Coastal Dune Management and Rehabilitation Techniques is a recommended resource for developing this program.

R33. It is recommended that the Shire initiate a dune care program.

6.4.2 Seawall Extension

An option that may be considered to protect the town from coastal erosion and inundation if the dunes to the eastern end of the town beach are eroded would be to extend the existing seawall towards the east. This

option would provide a number of benefits to protect assets into the future but ultimately in the long-term the seawall is likely to be outflanked and/or overtopped.

The seawall could be extended to various distances and it may be appropriate to use a staged approach. These distances/stages might include:

1. Approximately 300 m extension, consistent with the span of the remnant seawall to protect infrastructure directly behind;
2. Approximately 700 m total extension (additional 400 m) to the eastern end of the Bindi Bindi community;
3. Approximately 1700 m total extension (additional 1 km) to the Beadon Creek groyne.

The cost for construction of such an extension is difficult to estimate due the variable nature of availability of construction plant and equipment, its mobilisation to Onslow, the source of appropriately sized rocks for the armour units and range of other factors. For comparison, a recent similar height and width seawall in the South west of WA, with a reasonably close source of amour rock, was estimated to cost about $500k per 100m length of seawall. Allowing an additional 50% for mobilising to Onslow and assuming a similar source of rock is reasonably close then the extension is likely to cost around $750k per 100 m length or approximately $5M for the 700m extension and approximately $7.5M for the 1000m extension. The total length of seawall is estimated to cost around $12.5M.

R34. It is recommended that the Shire initiate investigations into the availability of rock materials and undertake a more detailed costing of carrying out seawall extension using a staged approach. This consideration should be informed by a Benefit Cost Analysis including options to equitably apportion costs to beneficiaries.

6.4.3 Drainage Infrastructure

As discussed in **Section 0** the design of the stormwater drainage system will require consideration of a number of issues to remain effective into the future. Stormwater drainage infrastructure is critical to the functions of the town. In the absence of any changes to the system the flooding of low lying areas will continue to worsen into the medium term. The present program of maintaining the system to mitigate flood impacts at the 10 year ARI rainfall event and undertaking reactive works to improve elements of the system. The drainage maintenance and development strategy needs to be reviewed in the short term in the context of the medium to longer term sea level rise effects. Investigations of options to assist develop a more detailed Benefit Cost Analysis of the whole system asset base may be considered in the immediate term.

R35. It is recommended that the Shire initiate investigations of the drainage system and its performance/requirements in the longer term. The review to incorporate more detailed Benefit Cost Analyses to inform future decisions on adaptation of the stormwater drainage system.

6.5 Economic Aspects

6.5.1 Coastal Erosion

A strategic economic assessment was undertaken to assess the economic implications of the risk of coastal erosion and pluvial inundation (**Appendix E**). The costs over the 100 yr planning timeframe was assessed to be $0.6 to $3.7 million (present value, $2016) associated with coastal erosion. The assessment concluded that, based on the existing information, there are not enough costs associated with inaction to justify immediate relocation of assets to reduce risk. It is recommended to wait as long as possible before incurring replacement costs. A more detailed evaluation of costs and benefits of erosion specific management options is recommended.

In the medium term the costs associated with the seawall extension option (see **Section 6.4.2**) is likely to be less than the value of the assets that would be afforded protection from coastal erosion and inundation up to the 100 yr ARI ocean storm surge event. Ultimately in the long term the seawall would be outflanked and therefore a retreat strategy is recommended. These confounding factors require more detailed assessment and consideration of the longer term benefits to inform decisions on the future of these assets and at what time protect or retreat strategy may be implemented.

R36. A more detailed evaluation of costs, benefits and equitable apportionment of costs for erosion specific management options is recommended.

6.5.2 Pluvial Inundation

The strategic economic assessment also considered the damage repair costs of the 10 and 100 year ARI pluvial flooding events occurring at the present time and at the 2110 horizon. The method and assumptions used to produce relative costs are outlined in the Appendix E. Based on the number of buildings impacted and the damage cost per asset, the damage cost estimates for any one event is presented **Table 6-3**.

Table 6-3 Pluvial inundation damage cost per single event in 2016

Scenario	Damage Cost per Event
10 Year ARI (current)	$6.7M
100 Year ARI (current)	$9.9M
10 Year ARI (2110)	$9.9M
100 Year ARI (2110)	$14.5M

Table 6-4 presents the expected present value costs (expected value = probability x cost of damage / repair) of each scenario given their likelihood of occurrence over the 100 year period. The 10 Year ARI event is less intense but more frequent and as such is more costly than the 100 Year ARI event. The current value of the assets impacted by a 100 year event (should it occur today) is estimated at $110M.

Table 6-4 Pluvial inundation damage cost over 100 years

Scenario	Expected value of damage cost over 100 years	Present expected value of damage cost over 100 year assessment period
10 Year ARI	$78.6M	$10.8M
100 Year ARI	$11.6M	$1.6M

As for erosion, the inundation economic assessment concluded that, based on the existing information, there are not enough costs associated with inaction to justify immediate relocation of assets to reduce risk. It is recommended to wait as long as possible before incurring replacement costs. A more detailed evaluation of costs and benefits of inundation specific management options is recommended.

R37. A more detailed evaluation of costs, benefits and equitable apportionment of costs for inundation specific management options is recommended.

6.6 Performance, monitoring and reporting

A well planned monitoring and review program is essential to the success of the CHRMAP process. The guidelines suggest that the CHRMAP be reviewed and updated each 5 years to reflect the improved knowledge base and contribute to more effective planning. Regular monitoring, evaluation, review, and where necessary, amendment of adaption plans are part of the continual improvement process. Triggers for actions and review may include time frames, new site specific information, new general coastal process information, updated climate change predictions, damage assessment and improved asset condition and life cycle information.

As part of the CHRMAP, Cardno will develop a basic monitoring and review program that identifies specific triggers and helps the Shire identify other events that may be a trigger. Adaption itself can induce secondary risks and the monitoring plan will assist in the early identification of unexpected consequences, so that the triggering of a review process can occur prior to intolerable risk.

Time and cost related parameters assessed in the adaption planning stage will also be re-assessed during the monitoring and review process. This is important as these factors may change over time, such as when risks increase in likelihood and become more frequent. The priority of risks will change over time, and so will the cost/benefits and other factors, including the Shire's budget.

6.6.1 Coastal Monitoring

Wave information – Council to seek access to NWS wave monitoring data information and wave transformation modelling to assess wave characteristics at the Onslow coast during significant storms/cyclones. This information may be updated or seek advice from the BoM on incorporating annual event reports into Councils reporting system.

- S1 opportunistic shoreline surveys through aerial survey of the beach and dunes annually and immediately after significant events (10 year ARI wave event)
- S2 Shoreline surveys and sediment surveys
- S3 historic shoreline movement. Obtain aerial photography each 5 years to assess shoreline movement
- Sea Level Rise – Utilise analysis of Beadon Creek water levels to determine the actual sea level rise each 2-5 years.

If rapid erosion of Sunset Beach and the dunes is observed over next 10 years then undertake geophysical survey of dunes to assess the erodibility of soils and substrate and review of the hazard line estimates.

6.6.2 Inundation monitoring

Supplement BoM weather and rainfall monitoring with water table monitoring near the drainage basins to assess the influence of groundwater on the basin capacity during events.

Undertake flood debris level monitoring immediately after significant floods to assist assess the flood characteristics.

Utilise existing models to further assess the monitoring data and flood characteristics

6.6.3 Assets and Damage Assessment Reports

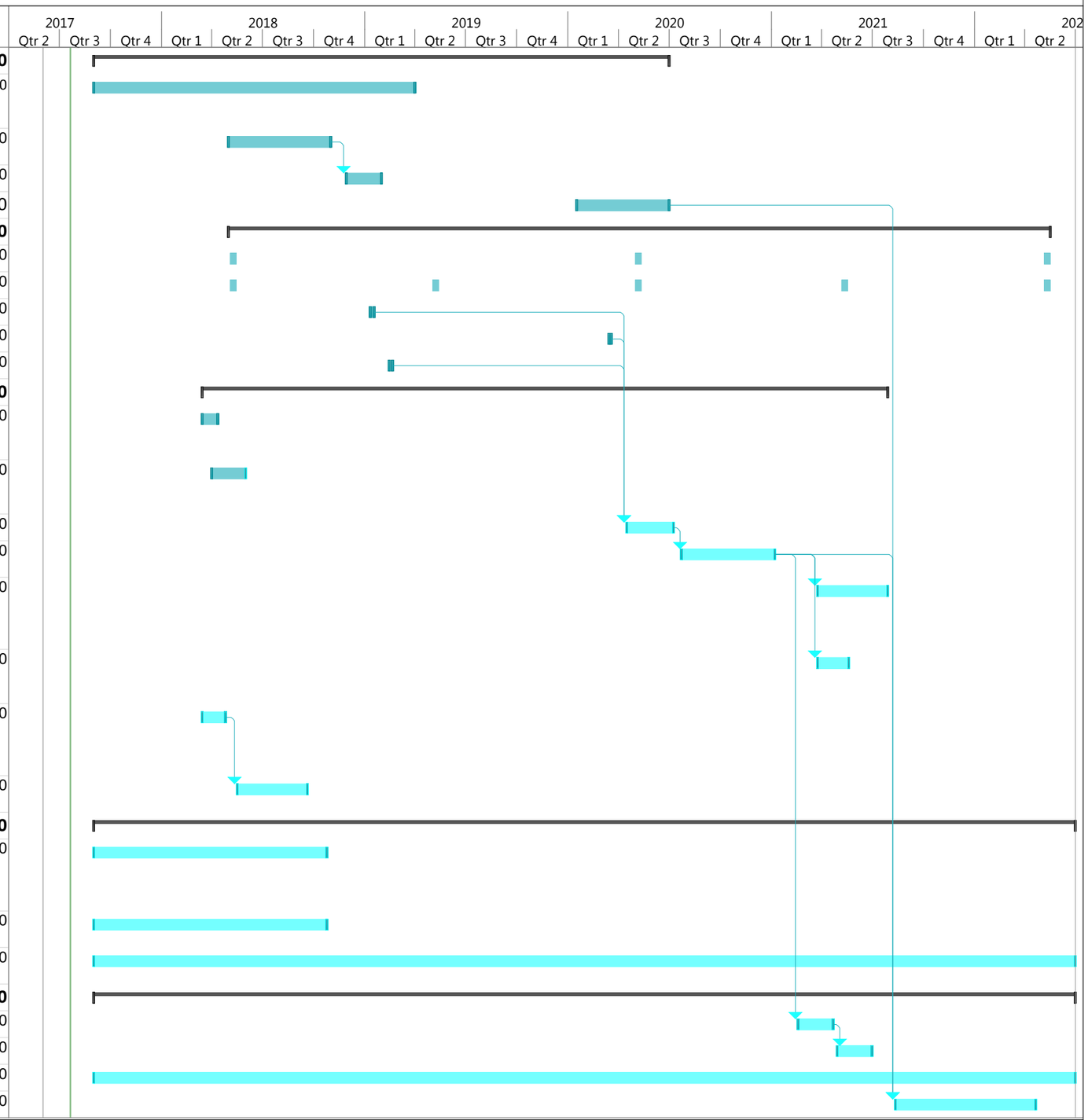
Develop asset database and tracking of post event asset damage to aid economic assessments.

6.7 Immediate Term Program Summary

A program of works for the immediate term 2017-2022, up to the next CHRMAP review is outlined in the Gantt Chart presented in Figure 6-8. The program summarises activities associated with each of the recommendations the monitoring discussed above and also highlights the linkages between the key activities.

Onslow CHRMAP 5 Year Program

ID	Task Name	Start	Finish	Cost Estimate
1	**Planning and Development Controls Review**	**1 Sep '17**	**30 Jun '20**	**$80,000**
2	Review Planning and Development Controls and Recommend Amendments as required: Recommendations R1, R2, R9, R10, R12, R14, R15, R17, R18, R21, R22, R26	1 Sep '17	31 Mar '19	$80,000
3	Amend current zone and SCA boundaries: Recommendations R3, R4, R5, R7	1 May '18	31 Oct '18	$0
4	Update SCA special provisions	29 Nov '18	30 Jan '19	$0
5	TPS 7 Update and Endorsement by WAPC	17 Jan '20	30 Jun '20	$0
6	**Monitoring**	**1 May '18**	**16 May '22**	**$220,000**
7	Horizontal Shoreline Datum (Aerial Photo Analysis)	1 May '18	2 May '22	$40,000
11	Annual Beach Profile Surveys	1 May '18	9 May '22	$125,000
17	Post wave erosion Event (>2 yr ARI wave) Beach Profiles	11 Jan '19	17 Jan '19	$30,000
18	Cyclone storm surge flooding Event	15 Mar '20	18 Mar '20	$10,000
19	Pluvial Flood Event (>2 yr ARI Rainfall)	14 Feb '19	19 Feb '19	$15,000
20	**Specialist Investigations**	**15 Mar '1**	**28 Jul '21**	**$310,000**
21	Investigate sufficient coastal foreshore reserve width allowance to extend the 2110 Hazard line a sufficient distance to accommodate future relocation of foreshore assets: Recommendation: R6	15 Mar '18	11 Apr '18	$15,000
22	Investigate planning mechanisms to allow future changes to be triggered including the ultimate retreat strategy. Recommendations: R16, R19	1 Apr '18	31 May '18	$0
23	Analysis of Flood, Storm Surge and Erosion event monitoring	16 Apr '20	8 Jul '20	$40,000
24	Develop integrated Model - Coastal Inundation, Groundwater levels and Pluvial Flooding Scenarios	23 Jul '20	6 Jan '21	$100,000
25	Investigate Pluvial Drainage and Coastal Processes Interactions to define triggers, set FFL, CHRMAP, Water Management Plans and Emergency Managemenet Plan overlaps. Recommendations: R27, R28, R29, R30, R31, R32	25 Mar '21	28 Jul '21	$50,000
26	Investigate wave runup height component for the future inundated areas. Add to the current 100 yr ARI still water level (4.5m AHD) to define the Peak Water Level and SCA extent. Recommendation: R8	25 Mar '21	19 May '21	$10,000
27	Investigate Seawall concept design, rock availability and potential stage triggers for implementing seawall upgrades, extension to Sunrise Beach and potential renourishment requriements for beach amenity. Recommendations: R24, R25, R33, R34	15 Mar '18	25 Apr '18	$15,000
28	Economic Analysis Undertake economic analysis of options. Recommendations: R35, R36, R37	17 May '18	19 Sep '18	$80,000
29	**Operational**	**1 Sep '17**	**30 Jun '22**	**$50,000**
30	Establish Data Management and GIS system (time series, spot levels and remote sensing) relating to localised and general flooding in Onslow allow identification trends over time, and Trigger assesment. Recommendations: R11, R13	1 Sep '17	24 Oct '18	$50,000
31	Update Asset database to incorporate end of life date to facilitate future management of assets. Recommendation: R19	1 Sep '17	24 Oct '18	$0
32	Notifications - Potentially affected land owners by direct contact and property titles. Recommendations: R20, R22, R23	1 Sep '17	30 Jun '22	$0
33	**CHRMAP Review and Update**	**1 Sep '17**	**30 Jun '22**	**$195,000**
34	Review Hazard line estimates (S1, S2, S3 and S4)	18 Feb '21	21 Apr '21	$25,000
35	Review Risk Assesment and Future Pathway Options	29 Apr '21	30 Jun '21	$40,000
36	Community and Stakeholder Consultation	1 Sep '17	30 Jun '22	$50,000
37	Update CHRMAP	12 Aug '21	20 Apr '22	$80,000



Project: 5 Year Implementation
Date: 21 Jul '17

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

Figure 6-8 Onslow CHRMAP Immediate term suggested program of work

7 CONCLUSIONS AND RECOMMENDATIONS

Climate change, including sea-level rise, is expected to bring changes to the West Australian coastline over coming decades. As a predominantly services oriented town Onslow has historically gone through periods of changing fortunes having been relocated in the early 1920's and ups and downs of various economic cycles centred around the agriculture, fishing, salt production, mining and oil and gas industries that support the area. The town's continued existence bears testament to its resilience and the impending threats of climate change and sea level rise are likely to present new challenges for the community. The threats of sea level rise and inundation events to property, infrastructure and the environment may ultimately again test the viability of the location of the town itself. This Coastal Hazard Mitigation and Adaption Plan (CHRMAP) has been prepared to provide a long term view of the possible strategies to adapt to the changing future conditions.

Development of the Onslow CHRMAP has followed the requirements of WA State Planning Policy 2.6: Coastal Policy (SPP2.6) and supporting guideline documents. An analysis of the coastal processes and predictions of erosion and inundation at future horizons was carried out in Part 1 of this study. The results informed the identification of vulnerable assets and a subsequent risk assesment. Based on the outcomes of the risk assessment a number of adaptation options and possible future pathways for mitigation has been considered.

A key aspect for the future of the town is the threat of steadily rising sea levels, combined with storm events - ocean storm surge, local rainfall-induced flooding and rising water tables – that will affect the viability of low lying areas of the town. In addition, coastal erosion is likely to threaten some infrastructure in the lee of the present Town Beach, including the Bindi Bindi community area. Strategies that might be adopted to respond to these threats at significant future turning points are articulated in this plan. A series of 37 recommendations for implementation in the immediate, short and long term were derived in Chapter 6 and are listed below.

In conclusion this plan outlines a series strategies that will need to be considered, revised and updated in future with the benefit of new information. Adopting the adaptive management approach will assist the community and Shire of Ashburton identify optimal solutions to the threats of climate change and sea level rise.

R1. A detailed review of current zoning and land use permissibility within zones should be undertaken in light of the results of the risk assessment outcomes.

R2. Appendix 12 SCA in LPS 7 should be reviewed to reflect the outcomes of the CHRMAP process and, where relevant, include specific clauses for example, to ensure that actions are enforceable

R3. The existing Conservation, Recreation & Nature zoning should be maintained / extended along the coastline, seaward of 2110 hazard line

R4. Move the Strategic Industry zone near jetty inland of 2110 hazard line

R5. Prior to development of Lot 381 consider adjusting north east boundary to be inland of 2110 hazard line.

R6. Consideration should be given to amending the scheme to extend the local scheme reserve for the foreshore area beyond the 2110 coastal hazard line a sufficient distance to accommodate relocation of foreshore assets. Where this may impact on private land, consideration should include risk of claims arising.

R7. The SCA should be extended inland to the 2110 coastal hazard line along the length of coastline, from the southern extent of the study area to 4 Mile Creek.

R8. For the current 100 year planning horizon the SCA extent should be defined by the 4.5 m AHD contour

R9. The SCA extent and provisions of Appendix 12 of the local planning scheme should be included in the five yearly local planning scheme review

R10. Review of the CHRMAP every five years is to include a review of the SCA extent and relevant provisions including Appendix 12 of TPS 7

R11. Data relating to localised and general flooding in Onslow (not just the SCA) should be recorded in sufficient detail to identify trends over time, including any changes that may result from development that has taken place

R12. Identify areas within the SCA and study area where avoidance of development altogether is the most advisable strategy

R13. Update of Shires GIS to include contours and flooding data from this study

R14. Intensification of development at the Bindi Bindi community should not be permitted. Renewal of existing infrastructure should only be considered with appropriate flood-resistant design

R15. No new development should be contemplated within the defined 2110 hazard line other than low impact, (relatively) low value and/or removable structures

R16. Applications in areas identified as being at risk from coastal processes should consider the predicted lifespan of the proposed development and its potential impact on other land during that lifetime. Temporary land uses that can be removed before or when a nominated trigger is reached might be considered.

R17. No further subdivision of land within the 2110 hazard line should be contemplated, nor further intensification of existing development

R18. Planning should guide the evolution of the town to less hazardous areas, from a flooding and coastal erosion perspective

R19. It is recommended that the Shire adopt a policy for relocation of public and Shire-owned assets from within the SCA at end of their lifecycle wherever possible, and that the Shire's Asset Management Plan be updated to reflect the relocation policy

R20. The outcomes of this CHRMAP report and the expectation for long term management retreat should be conveyed to Onslow Salt management.

R21. Consideration should also be given to the long term possibility of relocating the Bindi Bindi community to higher ground.

R22. Provision 6 of Appendix 12 of TPS 7 (requiring a notification be placed on the certificate of title) should remain

R23. Information on inundation risk should also be given to prospective purchasers of flood-prone by the Shire in conjunction with the issue of zoning certificates and/or property enquiries

R24. It is highly recommended that the seawall be maintained and detailed current and future maintenance specifications should be developed.

R25. Consideration should be given to extending the seawall to the east.

R26. A detailed review of current zoning within the SCA and land use permissibility within zones is recommended.

R27. Consideration should be given to the formulation of guidelines on preferred landuses within the SCA. These guidelines may be incorporated into the update to the TPS.

R28. It is recommended that the Shire undertake a full review of FFL provided in TPS Appendix 12 in relation to the flood levels provided in this document

R29. FFL provided in TPS Appendix 12 should be reviewed again following review of the town drainage system

R30. It is recommended that design guidelines be developed to specifically address measures for protection from inundation.

R31. It is recommended that prior to the next review of the CHRMAP the town drainage system be investigated and a strategy that meets the requirements of SPP2.6 and the CHRMAP Guidelines, the Water Management Plans, and other related State guidelines be developed.

R32. It is recommended that during the next phase of review Emergency Management plans incorporate the risks identified in this CHRMAP.

R33. It is recommended that the Shire initiate a dune care program.

R34. It is recommended that the Shire initiate investigations into the availability of rock materials and undertake a more detailed costing of carrying out seawall extension using a staged approach.

R35. It is recommended that the Shire initiate investigations of the drainage system and its performance/requirements in the longer term. The review to incorporate more detailed Benefit Cost Analyses to inform future decisions on adaptation of the stormwater drainage system.

R36. A more detailed evaluation of costs and benefits of erosion specific management options is recommended.

R37. A more detailed evaluation of costs and benefits of inundation specific management options is recommended.

8 REFERENCES

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CHRMAP For the Onslow Coast

APPENDIX A

ASSET DESCRIPTION

Cardno Shaping the Future

COASTAL EROSION

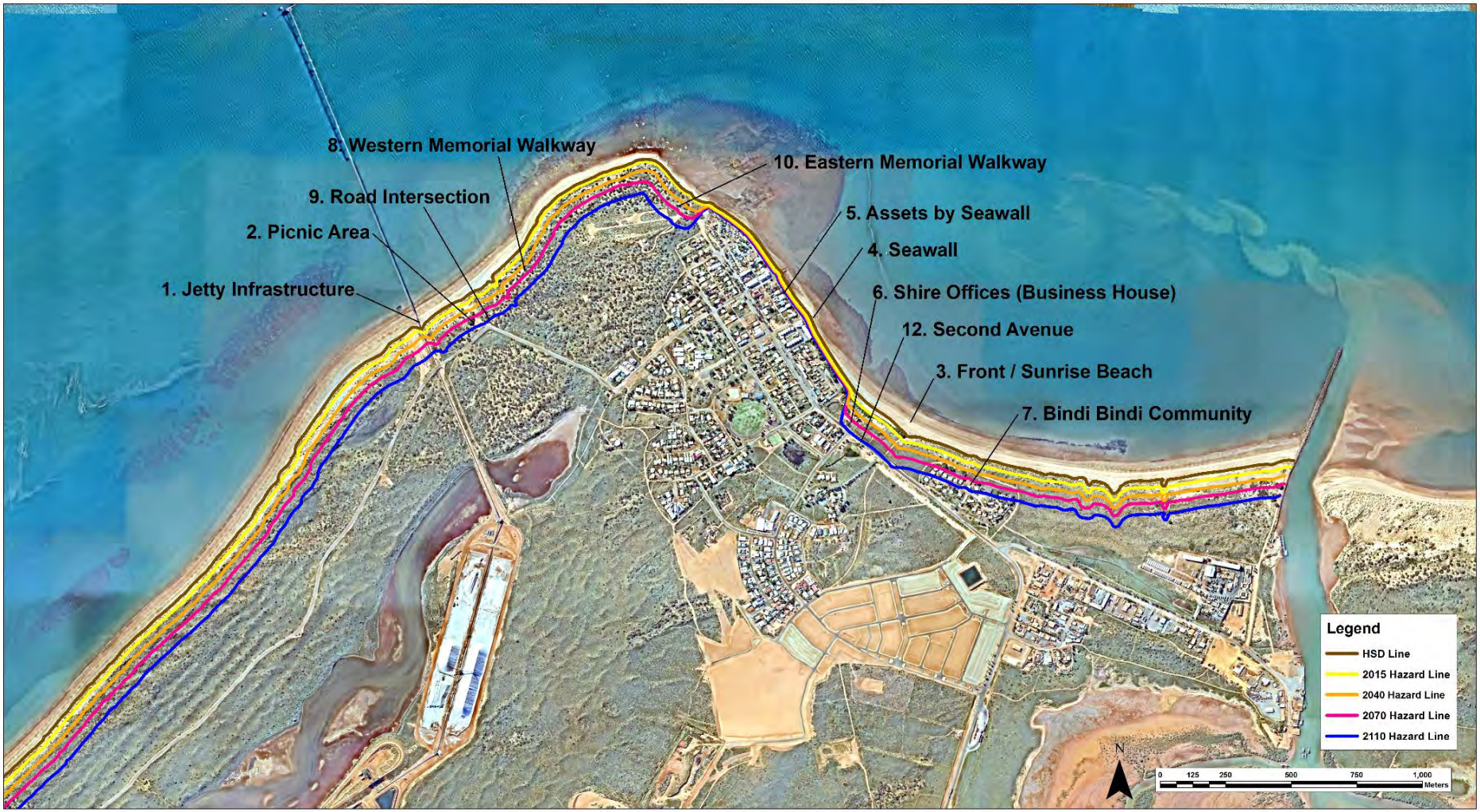
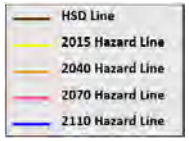


Figure A.1. Location map of assets vulnerable to future coastal erosion in Onslow.

COASTAL EROSION

Table A.1. Summary asset information for on-ground infrastructure at Onslow Jetty.

Asset ID Asset 1 On-ground infrastructure at Onslow Jetty	Asset description	Values
   	Onslow salt infrastructure supporting ship loading operations. Consists of: • Rock abutment • Permanent buildings • Demountable buildings • Plant and equipment • Conveyor infrastructure Tenure: Onslow Salt leased crown land	**Economic** Onslow Salt Asset. Estimated Replacement Value[1]: $10M - $100M Estimated Relocation Cost[1]: $1M - $10M **Social** Beach adjacent to asset is valued by community for 4WD access / fishing and passive recreation, sunset viewing. **Environmental** The asset does not have environmental value. The surrounding native vegetation and beach have natural area values.

Assigned coastal erosion risk ratings

	2015	2040	2070	2110
Likelihood	Possible	Likely	Almost Certain	Almost Certain
Consequences	Insignificant	Moderate	Moderate	Major
Adaptive Capacity	High	Moderate	Moderate	Moderate

[1] Costs provided are preliminary estimates only and will be reviewed.

COASTAL EROSION

Table A.2. Summary asset information for the Back Beach picnic area.

Asset ID Asset 2 Onslow Back Beach picnic area	Asset description	Values
 	Picnic area with cooking facilities. Irrigated grass lawn. Maintained by the Shire of Onslow	**Economic** Onsite infrastructure, i.e. barbecue areas. Estimated Replacement Value[1]: $100,000 - $1M Estimated Relocation Cost[1]: $100,000 - $1M **Social** Public amenity, maintained grassed area used for community events and recreation. Picnic infrastructure used by community. **Environmental** The asset itself does not have natural environmental value. The surrounding native vegetation and beach have natural area values.

Assigned coastal erosion risk ratings

	2015	2040	2070	2110
Likelihood	Rare	Unlikely	Possible	Likely
Consequences	Insignificant	Insignificant	Minor	Moderate
Adaptive Capacity	High	High	High	High

[1] Costs provided are preliminary estimates only and will be reviewed.

COASTAL EROSION

Table A.3. Summary asset information for Front / Sunrise Beach.

Asset ID Asset 3 Front / Sunrise Beach	Asset description	Values
 	Public beach used for recreational activities.	**Economic** Tourist destination. Estimated Replacement Value[1]: $100,000 - $1M Estimated Relocation Cost[1]: $100,000 - $1M **Social** Beach used by the community. **Environmental** Natural area. Buffer against storm events.

Assigned coastal erosion risk ratings

	2015	2040	2070	2110
Likelihood	Unlikely	Possible	Almost Certain	Almost Certain
Consequences	Insignificant	Minor	Moderate	Major
Adaptive Capacity	Very High	High	High	Moderate

[1] Costs provided are preliminary estimates only and will be reviewed.

COASTAL EROSION

Table A.4. Summary asset information for the seawall.

Asset ID Asset 4 Seawall	Asset description	Values
  	Seawall to protect Onslow from flood damage during cyclones and erosion protection. It was reconstructed in 2002. Seawall built using limestone. Maintained by the Shire of Onslow.	**Economic** Onsite infrastructure. **Social** Provides protection for the township from coastal hazards. **Environmental** Buffer

Assigned coastal erosion risk ratings

	2015	2040	2070	2110
Likelihood	Possible	Likely	Almost Certain	Almost Certain
Consequences	Moderate	Moderate	Major	Major
Adaptive Capacity	High	High	High	High

COASTAL EROSION

Table A.5. Summary information for the assets adjacent to the seawall.

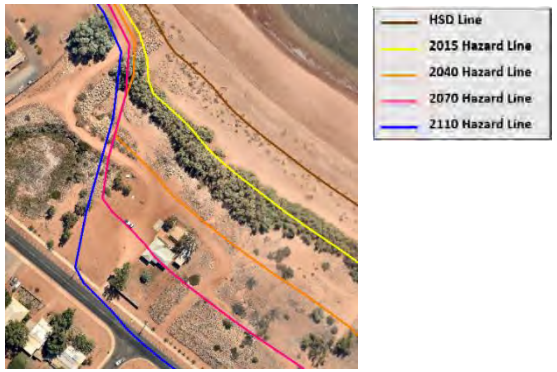
Asset ID Asset 5 Assets adjacent to crest of seawall (bins, shade structures, benches)	Asset description	Values
  	Public grassed area consisting of exercise equipment, benches, shaded structures and bins. Maintained by the Shire of Onslow.	**Economic** Public infrastructure **Social** Public amenity, maintained grassed area used for community recreation. Public infrastructure used by community. **Environmental** Assets do not have environmental value. The surrounding beach has natural area values.

Assigned coastal erosion risk ratings

	2015	2040	2070	2110
Likelihood	Unlikely	Unlikely	Possible	Likely
Consequences	Insignificant	Insignificant	Minor	Moderate
Adaptive Capacity	Moderate	Moderate	Moderate	Moderate

COASTAL EROSION

Table A.6. Summary asset information for the Shire of Ashburton Offices (Business House).

Asset ID Asset 6 Shire of Ashburton Offices (Business House) at the intersection of Second Ave and McGrath Rd	Asset description	Values
 	Office building made of prefab and steel. Asset is situated behind Front/Sunrise Beach.	**Economic** Public infrastructure for Shire services. **Social** Asset has community values as office is used to serve the community. **Environmental** The asset does not have environmental value. The adjacent beach has natural area values.

Assigned coastal erosion risk ratings

	2015	2040	2070	2110
Likelihood	Rare	Unlikely	Possible	Likely
Consequences	Moderate	Major	Major	Major
Adaptive Capacity	Low	Low	Low	Low

COASTAL EROSION

Table A.4. Summary asset information for the Bindi Bindi Aboriginal Community.

Asset ID Asset 7 Bindi Bindi Aboriginal Community on Second Ave	Asset description	Values
  	Community area with high cultural value. Area consists of residential houses, basketball court, gazebo, community office.	**Economic** Public infrastructure. **Social** Housing and public amenity for the Bindi Bindi Indigenous community. **Cultural** Indigenous community. **Environmental** The asset does not have environmental value.

Assigned coastal erosion risk ratings

	2015	2040	2070	2110
Likelihood	Rare	Unlikely	Possible	Likely
Consequences	Moderate	Major	Major	Major
Adaptive Capacity	Low	Low	Low	Low

COASTAL EROSION

Table A.8. Summary asset information for western half of the Ian Donal Blair Memorial Walkway.

Asset ID Asset 8 Western half of Ian Donald Blair Memorial Walkway	Asset description	Values
 	Western end of boardwalk near Sunset Beach. Boardwalk is made of wood and recycled plastic. Total length of boardwalk is 1017 m.	**Economic** Boardwalk connecting Beadon Point and Sunset Beach. **Social** Used for community recreation. **Environmental** The asset does not have environmental value. The surrounding native vegetation has natural area values.

Assigned coastal erosion risk ratings

	2015	2040	2070	2110
Likelihood	Rare	Rare	Likely	Almost Certain
Consequences	Minor	Minor	Minor	Minor
Adaptive Capacity	Very High	Very High	Very High	Very High

COASTAL EROSION

Table A.9. Summary asset information for the intersection of Seaview Drive and Back Beach Road.

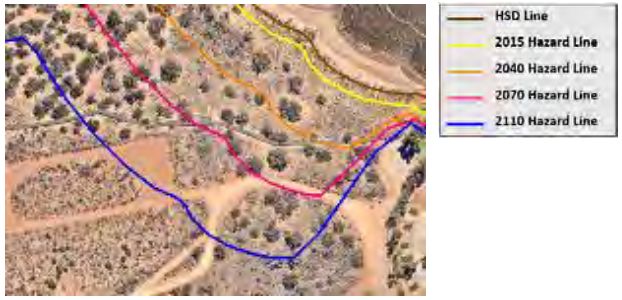
Asset ID Asset 9 Intersection of Seaview Drive and Back Beach Road	Asset description	Values
	Intersection of two asphalt roads used to access public amenities.	**Economic** Public road. **Social** Provides access to assets used by the community, i.e. barbecue area, beach. **Environmental** Asset does not have environmental value. The surrounding native vegetation and beach have natural values.

Assigned coastal erosion risk ratings

	2015	2040	2070	2110
Likelihood	Rare	Rare	Unlikely	Possible
Consequences	Minor	Minor	Minor	Minor
Adaptive Capacity	High	High	High	High

COASTAL EROSION

Table A.10. Summary asset information for eastern end of the Ian Donald Blair Memorial Walkway.

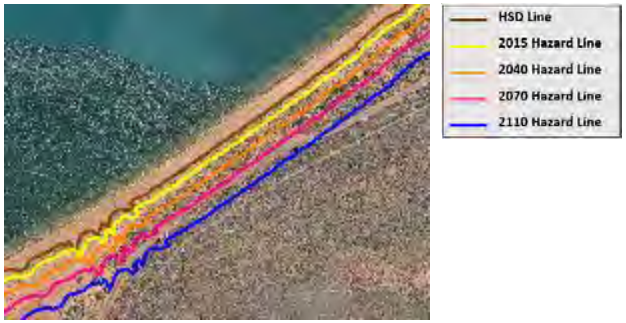
Asset ID Asset 10 Eastern end of Ian Donald Blair Memorial Walkway	Asset description	Values
  	Eastern end of boardwalk at Beadon Point (near the main township). Boardwalk is made of wood and recycled plastic. Total length of boardwalk is 1017 m.	**Economic** Boardwalk connecting Beadon Point and Sunset Beach. **Social** Used for community recreation. **Environmental** The asset does not have environmental value. The surrounding native vegetation has natural area values.

Assigned coastal erosion risk ratings

	2015	2040	2070	2110
Likelihood	Rare	Possible	Likely	Almost Certain
Consequences	Minor	Minor	Minor	Minor
Adaptive Capacity	Very High	Very High	Very High	Very High

COASTAL EROSION

Table A.11. Summary asset information for Seaview Drive near

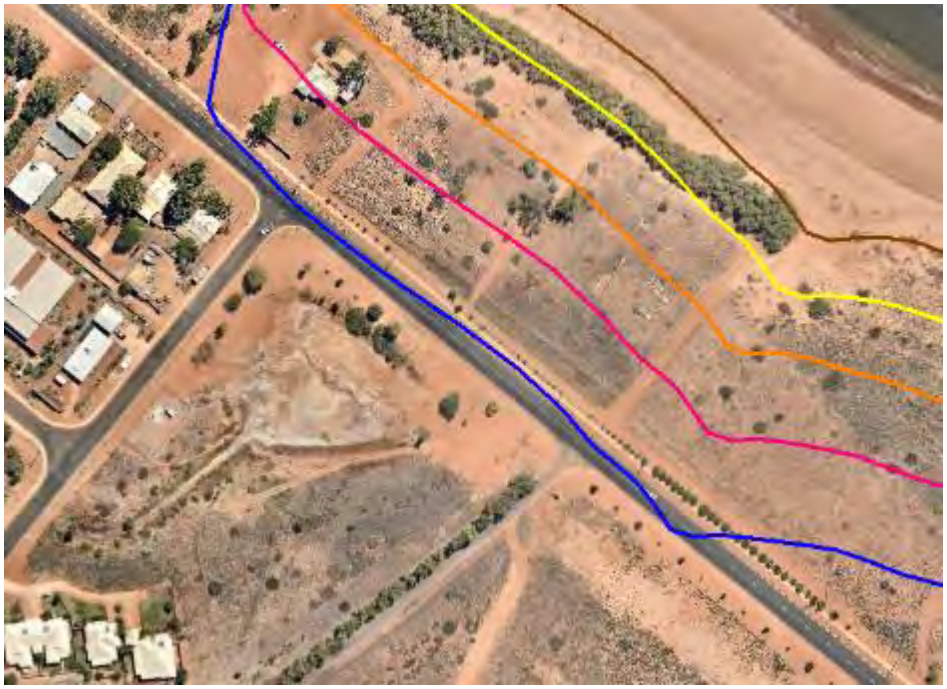
Asset ID Asset 11 Seaview Drive near Four Mile Creek	Asset description	Values
 	7 km (approximately) asphalt road connecting the township to Four Mile Creek	**Economic** Public infrastructure. **Social** Thoroughfare between assets used by the community. **Environmental** The asset does not have environmental value. The surrounding native vegetation has natural area values.

Assigned coastal erosion risk ratings

	2015	2040	2070	2110
Likelihood	Rare	Unlikely	Possible	Likely
Consequences	Minor	Minor	Minor	Minor
Adaptive Capacity	High	High	High	High

COASTAL EROSION

Table A.12. Summary asset information for Second Avenue.

Asset ID Asset 12 Second Ave	Asset description	Values
 	Highly used main road within the township.	**Economic** Public infrastructure. **Social** Thoroughfare between assets used by the community. **Environmental** The asset does not have environmental value.

Assigned coastal erosion risk ratings

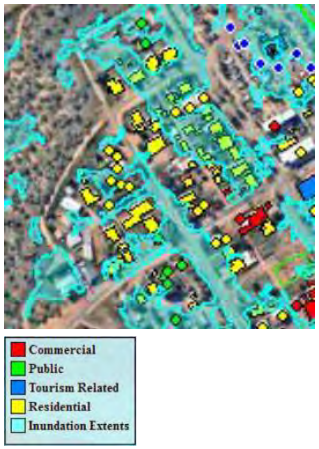
	2015	2040	2070	2110
Likelihood	Rare	Rare	Unlikely	Possible
Consequences	Moderate	Moderate	Moderate	Moderate
Adaptive Capacity	Moderate	Moderate	Moderate	Moderate

INUNDATION

Figure A.2. Location map of assets vulnerable to future inundation in Onslow.

INUNDATION

Table A.13. Summary asset information for houses, buildings and properties.

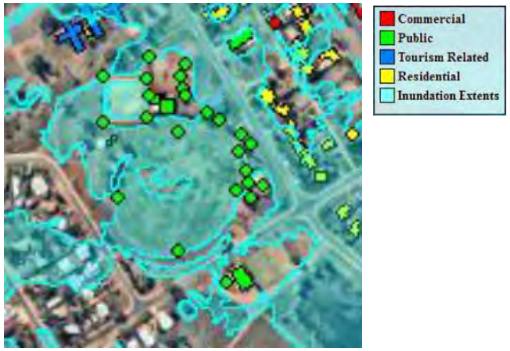
Housing, Buildings & Property	Asset description	Values
  	Number of assets: 319 Assets in this category include: > Residential homes > Office buildings > Public toilets > Permanent structures > Accommodation buildings > Caravans	Commercial Public Tourism Residential

Assigned 100 yr ARI inundation risk ratings

	2015	2040	2070	2110
Likelihood	Possible	Likely	Likely	Almost Certain
Consequences	Moderate	Moderate	Major	Major
Adaptive Capacity	Low	Low	Low	Low

INUNDATION

Table A.14. Summary asset information for parks and recreation grounds.

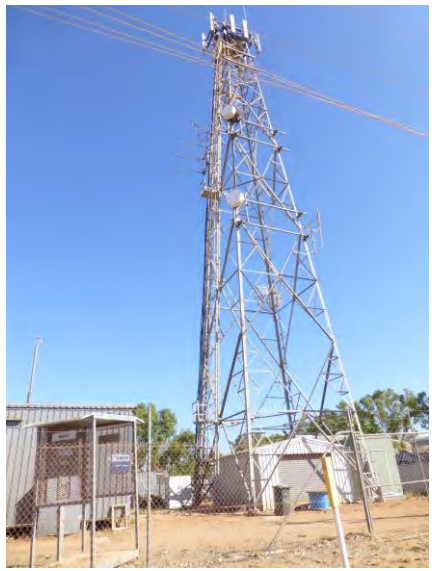
Parks & Recreation Grounds	Asset description	Values
 	Number of assets: 4 Assets in this category include: > Public open spaces > Public pools > Sports grounds	Commercial Public

Assigned 100 yr ARI inundation risk ratings

	2015	2040	2070	2110
Likelihood	Possible	Likely	Likely	Almost Certain
Consequences	Insignificant	Insignificant	Minor	Minor
Adaptive Capacity	High	High	High	High

INUNDATION

Table A.15. Summary asset information for public infrastructure.

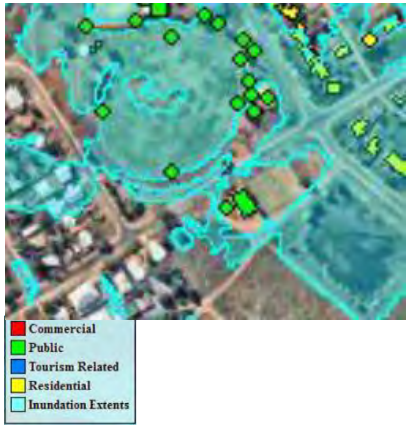
Public Infrastructure	Asset description	Values
  	Number of assets: 118 Assets in this category include: > Gazebos > Water tanks > Light and electrical poles > Benches > Fencing > Playgrounds > Barbecue areas	Commercial Public Tourism Residential

Assigned 100 yr ARI inundation risk ratings

	2015	2040	2070	2110
Likelihood	Possible	Likely	Likely	Almost Certain
Consequences	Minor	Minor	Moderate	Moderate
Adaptive Capacity	Moderate	Moderate	Moderate	Moderate

INUNDATION

Table A.16. Summary asset information for carparks.

Carparks	Asset description	Values
  	Number of assets: 11 Assets in this category include: > Side road parking > Undercover parking > Residential garages not connected to the house or do not have any utility services connected	Commercial Public Residential

Assigned 100 yr ARI inundation risk ratings

	2015	2040	2070	2110
Likelihood	Possible	Likely	Likely	Almost Certain
Consequences	Insignificant	Insignificant	Minor	Minor
Adaptive Capacity	Moderate	Moderate	Moderate	Moderate

INUNDATION

Table A.17. Summary asset information for roads and footpaths.

Roads/footpaths	Asset description	Values
 	Number of assets: Approximately 5 km of roads within the inundation prone area	Public Commercial

Assigned 100 yr ARI inundation risk ratings

	2015	2040	2070	2110
Likelihood	Possible	Likely	Likely	Almost Certain
Consequences	Minor	Minor	Moderate	Moderate
Adaptive Capacity	Moderate	Moderate	Moderate	Moderate

INUNDATION

Table A.18. Summary asset information for sheds.

Sheds	Asset description	Values
  	Number of assets: 112 Assets in this category include: > Private/commercial sheds > Sea containers used for storage purposes	Residential Commercial

Assigned 100 yr ARI inundation risk ratings

	2015	2040	2070	2110
Likelihood	Possible	Likely	Likely	Almost Certain
Consequences	Minor	Minor	Moderate	Moderate
Adaptive Capacity	Moderate	Moderate	Moderate	Moderate

CHRMAP For the Onslow Coast

APPENDIX B

MULTI-CRITERIA ASSESSMENT

Cardno Shaping the Future

COASTAL EROSION

Figure B.1: On-ground Infrastructure at Onslow Jetty

Main asset type Commercial
Long term pathway Managed Retreat / Accomodate
Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	High	High	Extreme
Vulnerability	Low	High	High	Very High

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning									Recommended
Managed Retreat	MR1	Accept and repair losses									Not recommended
	MR2	Relocate outside of hazard zone									Recommended
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title									Recommended
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Recommended
Protect	PR1	Dune care program									Recommended
	PR2	Beach nourishment or replenishment									Not recommended
	PR3	Seawall									Not recommended
	PR4	Groyne									Not recommended
Do Nothing	DN	No prohibitions or development regulations									Not recommended

Figure B.2: Onslow Back Beach Picnic Area

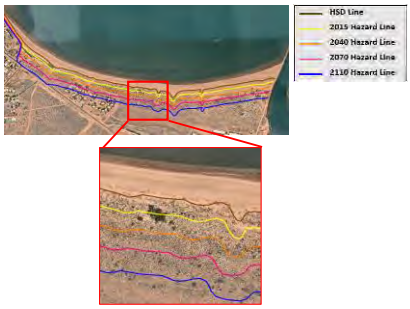
Main asset type Recreational
Long term pathway Managed Retreat / Accommodate
Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	Low	Low	Medium
Vulnerability	Low	Low	Low	Medium

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning	N/A								
Managed Retreat	MR1	Accept and repair losses									Not recommended
	MR2	Relocate outside of hazard zone									Recommended
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title	N/A								
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Investigate
Protect	PR1	Dune care program									Not recommended
	PR2	Beach nourishment or replenishment									Not recommended
	PR3	Seawall									Not recommended
	PR4	Groyne									Not recommended
Do Nothing	DN	No prohibitions or development regulations									Not recommended

COASTAL EROSION

Figure B.3: Front Beach / Sunrise Beach



Main asset type Recreational / Environmental

Long term pathway Managed Retreat / Protect

Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	Low	High	Extreme
Vulnerability	Low	Low	High	Very High

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning	N/A								
Managed Retreat	MR1	Accept and repair losses									Not recommended
	MR2	Relocate outside of hazard zone	N/A								
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title	N/A								
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact	N/A								
Protect	PR1	Dune care program									Investigate
	PR2	Beach nourishment or replenishment									Investigate
	PR3	Seawall									Investigate
	PR4	Groyne									Investigate
Do Nothing	DN	No prohibitions or development regulations									Not recommended

Figure B.4: Seawall (if not maintained)

Main asset type Commercial

Long term pathway Accommodate / Protect

Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Medium	Medium	Extreme	Extreme
Vulnerability	Medium	Medium	High	High

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid	N/A								
	AV2	Re-zoning	N/A								
Managed Retreat	MR1	Accept and repair losses									Not recommended
	MR2	Relocate outside of hazard zone	N/A								
	MR3	Prohibit further development / redevelopment	N/A								
Accommodate	AC1	Notification on title	N/A								
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Recommended
Protect	PR1	Dune care program	N/A								
	PR2	Beach nourishment or replenishment									Investigate
	PR3	Seawall	N/A								
	PR4	Groyne									Investigate
Do Nothing	DN	No prohibitions or development regulations									Not recommended

Figure B.5: Assets adjacent to crest of seawall (bins, shade structures, benches)

Main asset type Commercial / Public Infrastructure

Long term pathway Accommodate / Protect

Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	Low	Low	Medium
Vulnerability	Low	Low	Low	Medium

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning	N/A								
Managed Retreat	MR1	Accept and repair losses									Not recommended
	MR2	Relocate outside of hazard zone	N/A								
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title	N/A								
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Recommended
Protect	PR1	Dune care program	N/A								
	PR2	Beach nourishment or replenishment									Investigate
	PR3	Seawall									Investigate
	PR4	Groyne									Investigate
Do Nothing	DN	No prohibitions or development regulations									Not recommended

Figure B.6: Shire of Ashburton Offices (Business House) at the intersection of Second Ave and McGrath Rd

Main asset type Commercial

Long term pathway Managed Retreat

Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	Medium	High	High
Vulnerability	Low	High	Very High	Very High

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning									Recommended
Managed Retreat	MR1	Accept and repair losses									Not recommended
	MR2	Relocate outside of hazard zone									Investigate
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title									Recommended
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Investigate
Protect	PR1	Dune care program									Recommended
	PR2	Beach nourishment or replenishment									Investigate
	PR3	Seawall									Investigate
	PR4	Groyne									Investigate
Do Nothing	DN	No prohibitions or development regulations									Not recommended

Figure B.7: Bindi Bindi Aboriginal Community on Second Ave

Main asset type Heritage

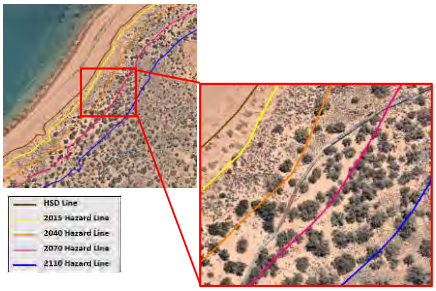
Long term pathway Accommodate / Protect

Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	Medium	High	High
Vulnerability	Low	High	Very High	Very High

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning									Recommended
Managed Retreat	MR1	Accept and repair losses									Not recommended
	MR2	Relocate outside of hazard zone									Investigate
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title									Recommended
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Investigate
Protect	PR1	Dune care program									Investigate
	PR2	Beach nourishment or replenishment									Investigate
	PR3	Seawall									Investigate
	PR4	Groyne									Investigate
Do Nothing	DN	No prohibitions or development regulations									Not recommended

Figure B.8: Western half of Ian Donald Blair Memorial Walkway



Main asset type Public Infrastructure / Heritage

Long term pathway Managed Retreat / Accommodate

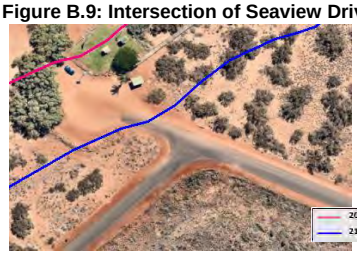
Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	Low	Medium	Medium
Vulnerability	Low	Low	Medium	Medium

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning	N/A								
Managed Retreat	MR1	Accept and repair losses									Investigate
	MR2	Relocate outside of hazard zone									Recommended
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title	N/A								
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Investigate
Protect	PR1	Dune care program									Recommended
	PR2	Beach nourishment or replenishment									Not recommended
	PR3	Seawall									Not recommended
	PR4	Groyne									Not recommended
Do Nothing	DN	No prohibitions or development regulations									Investigate

COASTAL EROSION

Figure B.9: Intersection of Seaview Drive and Back Beach Road



Main asset type Public Infrastructure / Commercial

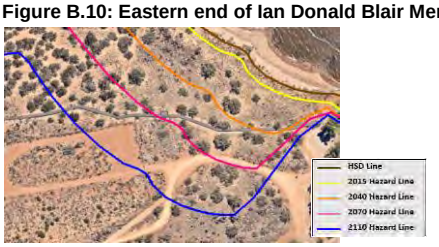
Long term pathway Managed Retreat / Accommodate

Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	Low	Low	Low
Vulnerability	Low	Low	Low	Low

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning	N/A								
Managed Retreat	MR1	Accept and repair losses									Recommended
	MR2	Relocate outside of hazard zone									Recommended
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title	N/A								
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Investigate
Protect	PR1	Dune care program									Recommended
	PR2	Beach nourishment or replenishment									Not recommended
	PR3	Seawall									Not recommended
	PR4	Groyne									Not recommended
Do Nothing	DN	No prohibitions or development regulations									Not recommended

Figure B.10: Eastern end of Ian Donald Blair Memorial Walkway



Main asset type Public Infrastructure / Heritage

Long term pathway Managed Retreat / Accommodate

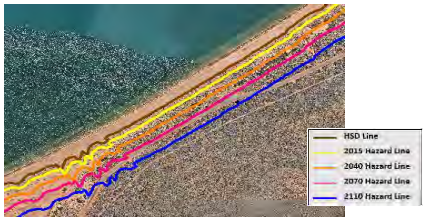
Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	Low	Medium	Medium
Vulnerability	Low	Low	Medium	Medium

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning	N/A								
Managed Retreat	MR1	Accept and repair losses									Investigate
	MR2	Relocate outside of hazard zone									Recommended
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title	N/A								
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Investigate
Protect	PR1	Dune care program									Recommended
	PR2	Beach nourishment or replenishment									Investigate
	PR3	Seawall									Investigate
	PR4	Groyne									Investigate
Do Nothing	DN	No prohibitions or development regulations									Investigate

COASTAL EROSION

Figure B.11: Seaview Drive near Four Mile Creek



Main asset type Public Infrastructure / Commercial

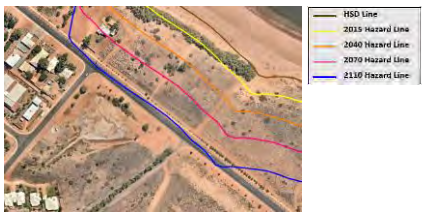
Long term pathway Managed Retreat / Accommodate

Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	Low	Low	Medium
Vulnerability	Low	Low	Low	Medium

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning	N/A								
Managed Retreat	MR1	Accept and repair losses									Recommended
	MR2	Relocate outside of hazard zone									Recommended
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title	N/A								
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Investigate
Protect	PR1	Dune care program									Recommended
	PR2	Beach nourishment or replenishment									Investigate
	PR3	Seawall									Investigate
	PR4	Groyne									Investigate
Do Nothing	DN	No prohibitions or development regulations									Not recommended

Figure B.12: Second Ave



Main asset type Public Infrastructure / Commercial

Long term pathway Managed Retreat / Protect

Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	Low	Medium	Medium
Vulnerability	Low	Low	Medium	Medium

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning	N/A								
Managed Retreat	MR1	Accept and repair losses									Not recommended
	MR2	Relocate outside of hazard zone									Investigate
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title	N/A								
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Not recommended
Protect	PR1	Dune care program									Recommended
	PR2	Beach nourishment or replenishment									Investigate
	PR3	Seawall									Investigate
	PR4	Groyne									Investigate
Do Nothing	DN	No prohibitions or development regulations									Not recommended

Figure B.13: Housing, Buildings and Property (100 yr ARI)

Main asset type Housing, Buildings and Property
Long term pathway Managed Retreat / Accommodate
Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Medium	High	Extreme	Extreme
Vulnerability	High	Very High	Very High	Very High

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning									Recommended
Managed Retreat	MR1	Accept and repair losses									Recommended
	MR2	Relocate outside of hazard zone									Investigate
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title									Recommended
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Investigate
Protect	PR1	Levee									Not Recommended
	PR2	Levees and pump systems									Not Recommended
Do Nothing	DN	No prohibitions or development regulations									Not Recommended

Figure B.14: Parks & Recreation Grounds (100 yr ARI)

Main asset type Recreational
Long term pathway Managed Retreat
Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	Low	Medium	Medium
Vulnerability	Low	Low	Medium	Medium

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Investigate
	AV2	Re-zoning	N/A								
Managed Retreat	MR1	Accept and repair losses									Recommended
	MR2	Relocate outside of hazard zone									Investigate
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title	N/A								
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Recommended
Protect	PR1	Levees									Not Recommended
	PR2	Levees and pump systems									Not Recommended
Do Nothing	DN	No prohibitions or development regulations									Not Recommended

Figure B.15: Public Infrastructure (100 yr ARI)

Main asset type Public Infrastructure
Long term pathway Managed Retreat / Accommodate
Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Medium	Medium	High	High
Vulnerability	Medium	Medium	High	High

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning	N/A								
Managed Retreat	MR1	Accept and repair losses									Recommended
	MR2	Relocate outside of hazard zone									Recommended
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title	N/A								
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Recommended
Protect	PR1	Levee									Not Recommended
	PR2	Levees and pump systems									Not Recommended
Do Nothing	DN	No prohibitions or development regulations									Investigate

Figure B.16: Carparks (100 yr ARI)

Main asset type Carparks
Long term pathway Accommodate
Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Low	Low	Medium	Medium
Vulnerability	Low	Low	Medium	Medium

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning									Recommended
Managed Retreat	MR1	Accept and repair losses									Recommended
	MR2	Relocate outside of hazard zone									Investigate
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title									Recommended
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Investigate
Protect	PR1	Levee									Not Recommended
	PR2	Levees and pump systems									Not Recommended
Do Nothing	DN	No prohibitions or development regulations									Not Recommended

Figure B.17: Roads / Footpaths (100 yr ARI)

Main asset type Roads / Footpaths
Long term pathway Accommodate
Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Medium	Medium	High	High
Vulnerability	Medium	Medium	High	High

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning									Recommended
Managed Retreat	MR1	Accept and repair losses									Recommended
	MR2	Relocate outside of hazard zone									Recommended
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title									Recommended
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Recommended
Protect	PR1	Levee									Investigate
	PR2	Levees and pump systems									Investigate
Do Nothing	DN	No prohibitions or development regulations									Not recommended

Figure B.18: Sheds (100 yr ARI)

Main asset type Sheds
Long term pathway Accommodate
Risk and Vulnerability timeframe

Time	2015	2040	2070	2110
Existing Risk	Medium	Medium	High	High
Vulnerability	Medium	Medium	High	High

Option Category	Option Code	Option Name	Preliminary Feasibility			Preliminary Acceptability		Preliminary Financial Implication			Recommendation
			Effectiveness	Legal / Approval Risk	Reversibility / Adaptability	Environmental / Social Impact	Community Acceptability	Economic gain / Avoidance of loss	Capital Cost	Ongoing Cost	
Avoid	AV1	Avoid									Recommended
	AV2	Re-zoning									Recommended
Managed Retreat	MR1	Accept and repair losses									Recommended
	MR2	Relocate outside of hazard zone									Recommended
	MR3	Prohibit further development / redevelopment									Recommended
Accommodate	AC1	Notification on title									Recommended
	AC2	Emergency plans and controls									Recommended
	AC3	Re-design to withstand impact									Investigate
Protect	PR1	Levee									Not Recommended
	PR2	Levees and pump systems									Not Recommended
Do Nothing	DN	No prohibitions or development regulations									Not Recommended

CHRMAP For the Onslow Coast

APPENDIX C

ASSET MANAGEMENT PATHWAYS

Cardno Shaping the Future

COASTAL EROSION

Figure C.1: On-ground Infrastructure at Onslow Jetty

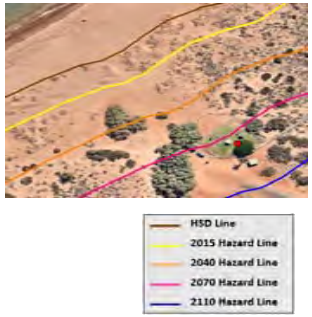
Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
Risk Rating	Low	Low	High	High	Extreme
Vulnerability Rating	Low	Low	High	High	Very High
Asset life cycle				Estimated end of lifecycle	
Pathway	*Avoid / Monitor and review*	*Accommodate*	*Managed Retreat*		
Recommended Actions	Avoid further development	Continue to implement avoid and basic protection actions	Redesign to withstand Impact	Relocate outside of hazard zone	
		Accept and Repair	Relocate outside of hazard zone		
	Emergency Plans Dune Care Program	Redesign to withstand Impact			
		Prohibit further development			
			Protect		
		Investigate protection options	Initiate protection actions		

Reactive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	Erosion landward of 2015 hazard line	Distance between HSD line and the asset is less than S1 OR End of asset life cycle	Significant erosion or storm damage resulting in damage to property and risk to worker safety OR Cessation of Industry
Action	Implement accommodate actions	Implement retreat or protect actions	Implement retreat actions or decommission infrastructure
Responsibility	Onslow Salt	Onslow Salt	Onslow Salt

Residual Risk

Time	2015	2040	2070	2110
Initial Risk	Low	High	High	Extreme
Adaptation pathway	*Avoid / Monitor and review*	*Managed Retreat*		
Residual Risk	Low	Medium	Medium	Medium

Figure C.2: Onslow Back Beach picnic area



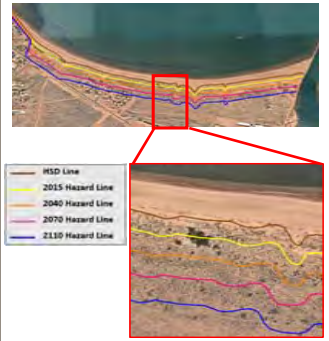
Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
Risk Rating	Low	Low	Low	Low	Medium
Vulnerability Rating	Low	Low	Low	Low	Medium
Asset life cycle					**Estimated end of lifecycle**
Pathway	*Avoid / Monitor and review*		*Accommodate*		*Managed Retreat*
Recommended Actions	Avoid further development Prohibit further development Emergency Plans		Investigate protection options Investigate re-design options to withstand impact Continue to implement avoid and basic protection actions Accept and Repair Plan for managed retreat options, e.g. re-zoning		Relocate outside of hazard zone

Reactive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	Erosion landward of 2040 hazard line	Distance between HSD line and the asset is less than S1	Significant erosion or storm damage to assets OR End of asset life cycle
Action	Implement accommodate actions	Implement retreat actions	Implement retreat actions
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton

Residual Risk

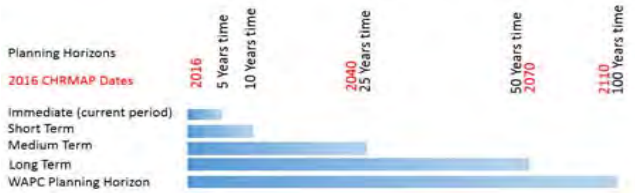
Time	2015	2040	2070	2110
Initial Risk	Low	Low	Low	Medium
Adaptation pathway	*Avoid / Monitor and review*	*Accommodate*	*Managed Retreat*	
Residual Risk	Low	Low	Low	Low

Figure C.3: Front Beach / Sunrise Beach



Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
Risk Rating **Vulnerability Rating**	Low Low	Low Low	Low Low	High High	Extreme Very High
Pathway	*Avoid / Monitor and review*	*Accommodate*			
Recommended Actions	Emergency Plans Dune Care	Continue to implement avoid and basic protection actions Investigate protection options			
			Protect Initiate protection actions		

Reactive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	Erosion landward of 2016 hazard line	Loss of beach amenity	Unacceptable loss of Beach Amenity
Action	Implement accommodate actions	Investigate protect actions	Implement protect actions
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton



Residual Risk

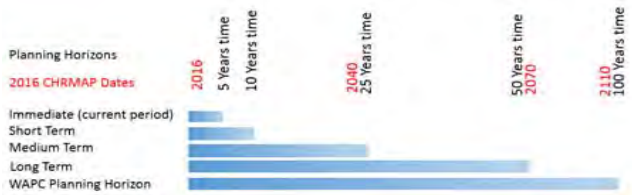
Time	2015	2040	2070	2110
Initial Risk	Low	Low	High	Extreme
Adaptation pathway	*Avoid / Monitor and review*	*Accommodate*		
Residual Risk	Low	Low	Medium	Medium

COASTAL EROSION

Figure C.4: Seawall (if not maintained)

Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
Risk Rating	Medium	Medium	Medium	Extreme	Extreme
Vulnerability Rating	Medium	Medium	Medium	High	High
Asset life cycle		**Estimated end of lifecycle**			
Pathway	*Accommodate*				
Recommended Actions	Implement avoid and basic protection actions Emergency Plans Accept and Repair Redesign to withstand Impact Investigate protection options, e.g. beac nourishment, groyne	Continue to implement avoid and basic protection actions Investigate protection options	*Protect* Initiate protection actions		

Reactive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	Erosion reaching bottom of seawall	Storm damage resulting in significant impact on seawall function OR End of asset life cycle	Significant storm damage resulting in damage to property
Action	Implement accommodate actions	Implement protect actions	Implement protect actions
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton



Residual Risk

Time	2015	2040	2070	2110
Initial Risk	Medium	Medium	Extreme	Extreme
Adaptation pathway	*Protect*			
Residual Risk	Low	Low	Low	Low

Figure C.5: Assets adjacent to crest of seawall (bins, shade structures, benches)

	Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
	**Risk Rating**	Low	Low	Low	Low	Medium
	Vulnerability Rating	Low	Low	Low	Low	Medium
	Asset life cycle			**Estimated end of lifecycle**		
	Pathway	*Avoid / Monitor and review*		*Accommodate*		*Managed Retreat*
	Recommended Actions	Avoid further development Prohibit further development Emergency Plans		Redesign to withstand Impact Relocate outside of hazard zone Continue to implement avoid and basic protection actions Accept and Repair Investigate protection options		Relocate outside of hazard zone
		Protect				
		Seawall is structural protection against erosion impacts to these assets Continue to maintainand raise seawall as required				

Reactive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	Occasional overtopping or erosion impacts to seawall	Frequent overtopping or erosion impacts landward of seawall	Significant storm damage resulting in damage to property and risk to community safety
Action	Implement accommodate actions	Implement retreat actions	Implement retreat or protect actions
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton

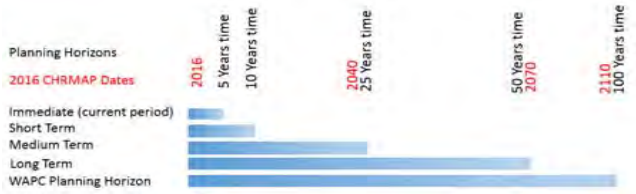
Residual Risk

Time	2015	2040	2070	2110
Initial Risk	Low	Low	Low	Medium
Adaptation pathway	*Protect*			
Residual Risk	Low	Low	Low	Medium

Figure C.6: Shire of Ashburton Offices (Business House) at the intersection of Second Ave and McGrath Rd

	Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
	**Risk Rating** **Vulnerability Rating** Asset life cycle	Low Low	Low Low	Medium High Estimated end of lifecycle	High Very High	High Very High
	Pathway	*Avoid / Monitor and review*	*Accommodate*	*Managed Retreat*		
	Recommended Actions	Avoid further development Emergency Plans Dune Care Investigate protection options Plan on implementing protect or managed retreat options	Continue to implement avoid and basic protection actions Redesign to withstand Impact *Protect* Initiate protection actions	Prohibit further development Redesign to withstand impact Relocate outside of hazard zone		

Reactive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	Erosion landward of 2015 hazard llne	Distance between HSD line and the asset is less than S1 OR End of asset life cycle	Significant erosion or storm damage resulting in damage to property and risk to community safety
Action	Implement accommodate actions	Implement retreat or protect actions	Implement retreat actions
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton



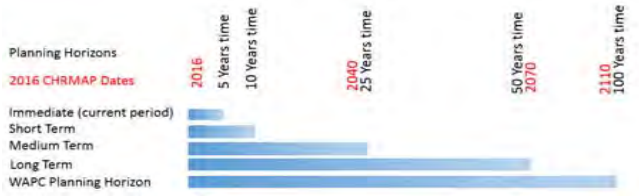
Residual Risk

Time	2015	2040	2070	2110
Initial Risk	Low	Medium	High	High
Adaptation pathway	*Avoid / Monitor and review*	*Protect*		
Residual Risk	Low	Medium	Medium	Medium

Figure C.7: Bindi Bindi Aboriginal Community on Second Ave

	Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
	**Risk Rating** **Vulnerability Rating** Asset life cycle	Low Low	Low Low	Medium High Estimated end of lifecycle	High Very High	High Very High
	Pathway	*Avoid / Monitor and review*	*Accommodate*	*Managed Retreat*		
	Recommended Actions	Avoid further development Emergency Plans Dune Care Investigate protection options	Continue to implement avoid and basic protection actions Redesign to withstand Impact Investigate protection options *Protect* Initiate protection actions	Prohibit further development Redesign to withstand impact Relocate outside of hazard zone		

Reactive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	Erosion landward of 2015 hazard line	Distance between HSD line and the asset is less than S1 OR End of asset life cycle	Significant erosion or storm damage resulting in damage to property and risk to community safety
Action	Implement accommodate actions	Implement retreat or protect actions	Implement retreat actions
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton



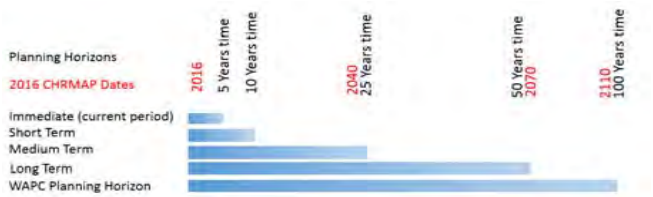
Residual Risk

Time	2015	2040	2070	2110
Initial Risk	Low	Medium	High	High
Adaptation pathway	*Avoid / Monitor and review*	*Protect*		
Residual Risk	Low	Medium	Medium	Medium

Figure C.8: Western half of Ian Donald Blair Memorial Walkway

	Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
	Risk Rating	Low	Low	Low	Medium	Medium
	Vulnerability Rating	Low	Low	Low	Medium	Medium
	Asset life cycle				**Estimated end of lifecycle**	
	Pathway	*Avoid / Monitor and review*		*Accommodate*	*Managed Retreat*	
	Recommended Actions	Avoid further development Prohibit further development Emergency Plans Dune Care		Continue to implement avoid and basic protection actions Accept and Repair Redesign to withstand Impact	Relocate outside of hazard zone Redesign to withstand impact	

Reactive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	Erosion landward of 2015 hazard lIne	Erosion up to 2040 hazard line OR End of assett life cycle	Significant erosion or storm damage to asset
Action	Implement accommodate actions	Implement retreat actions	Implement retreat actions
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton



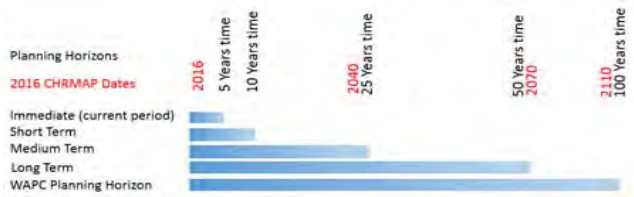
Residual Risk

Time	2015	2040	2070	2110
Initial Risk	Low	Low	Medium	Medium
Adaptation pathway	*Avoid / Monitor and review*	*Managed Retreat*		
Residual Risk	Low	Low	Low	Low

Figure C.9: Intersection of Seaview Drive and Back Beach Road

	Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
	**Risk Rating** **Vulnerability Rating** Asset life cycle	Low Low	Low Low	Low Low	Low Low	Low Low Estimated end of lifecycle
	Pathway	*Avoid / Monitor and review*			*Accommodate*	*Managed Retreat*
	Recommended Actions	Avoid further development Prohibit further development Emergency Plans Dune Care			Redesign to withstand Impact Accept and Repair Continue to implement avoid and basic protection actions	Relocate outside of hazard zone

Reactive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	Erosion landward of 2070 hazard line	Distance between HSD line and the asset is less than S1 OR End of asset life cycle	Significant erosion or storm damage to asset
Action	Implement accommodate actions	Implement retreat actions	Implement retreat actions or decommission asset
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton



Residual Risk

Time	2015	2040	2070	2110
Initial Risk	Low	Low	Low	Low
Adaptation pathway	*Avoid / Monitor and review*	*Accommodate*	*Managed Retreat*	
Residual Risk	Low	Low	Low	Low

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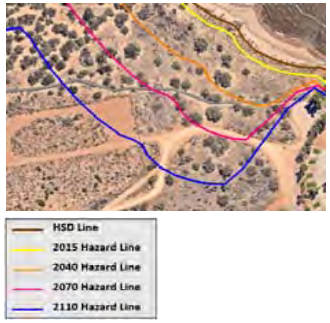
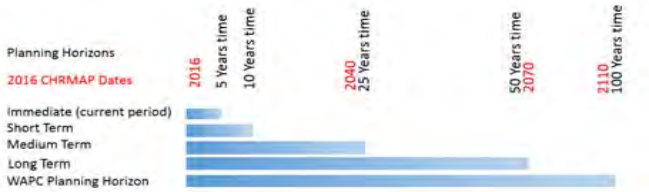
Figure C.10: Eastern end of Ian Donald Blair Memorial Walkway

	Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
	**Risk Rating** **Vulnerability Rating** Asset life cycle	Low Low	Low Low	Low Low	Medium Medium Estimated end of lifecycle	Medium Medium
	Pathway	*Avoid / Monitor and review*		*Accommodate*	*Managed Retreat*	
	Recommended Actions	Avoid further development Prohibit further development Emergency Plans Dune Care		Continue to implement avoid and basic protection actions Accept and Repair Investigate re-design option Investigate protection options	Relocate outside of hazard zone Redesign to withstand impact	

Reactive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	Erosion landward of 2015 hazard lIne	Distance between HSD line and the asset is less than S1 OR End of asset life cycle	Significant erosion or storm damage resulting in damage to asset
Action	Implement accommodate actions	Implement retreat or protect actions	Implement retreat actions
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton

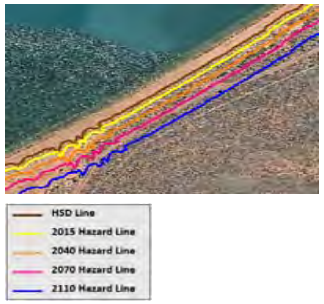


Residual Risk

Time	2015	2040	2070	2110
Initial Risk	Low	Low	Medium	Medium
Adaptation pathway	*Avoid / Monitor and review*	*Managed Retreat*		
Residual Risk	Low	Low	Low	Low

COASTAL EROSION

Figure C.11: Seaview Drive near Four Mile Creek

	Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
	**Risk Rating** **Vulnerability Rating** Asset life cycle	Low Low	Low Low	Low Low	Low Low	Medium Medium Estimated end of lifecycle
	Pathway	*Avoid / Monitor and review*		*Accommodate*		*Managed Retreat*
	Recommended Actions	Avoid further development Prohibit further development Emergency Plans Dune Care		Continue to implement avoid and basic protection actions Accept and Repair Redesign to withstand Impact		Relocate outside of hazard zone Redesign to withstand Impact

Reactive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	Erosion landward of 2015 hazard lIne	Erosion landward of 2040 hazard lIne	Significant erosion loss or damage to asset
Action	Implement accommodate actions	Implement retreat or protect actions	Implement retreat actions
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton

Residual Risk

Time	2015	2040	2070	2110
Initial Risk	Low	Low	Low	Medium
Adaptation pathway	*Avoid / Monitor and review*	*Accommodate*	*Managed Retreat*	
Residual Risk	Low	Low	Low	Low

COASTAL EROSION

Figure C.12: Second Ave

	Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
	**Risk Rating** **Vulnerability Rating** Asset life cycle	Low Low	Low Low	Low Low	Medium Medium	Medium Medium Estimated end of lifecycle
	Pathway	*Avoid / Monitor and review*	*Accommodate*		*Managed Retreat*	
	Recommended Actions	Avoid further development Prohibit further development Emergency Plans Dune Care	Continue to implement avoid and basic protection actions Accept and Repair Redesign to withstand Impact Investigate protection options		Relocate outside of hazard zone Redesign to withstand Impact *Protect* Initiate protection actions	

Reactive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	Erosion landward of 2015 hazard lIne	Distance between HSD line and the asset is less than S1	Significant erosion or storm damage resulting in damage to property and risk to community safety
Action	Implement accommodate actions	Implement retreat or protect actions	Implement retreat actions or decommission infrastructure
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton

Residual Risk

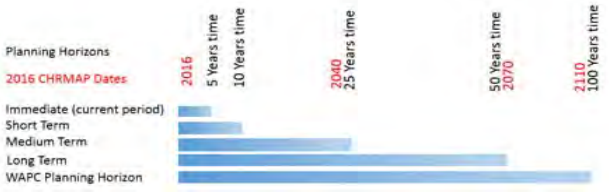
Time	2015	2040	2070	2110
Initial Risk	Low	Low	Medium	Medium
Adaptation pathway	*Avoid / Monitor and review*	*Protect*		
Residual Risk	Low	Low	Low	Medium

INUNDATION

Figure C.13: Housing, Buildings and Property (100 yr ARI)

Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
Risk Rating	Medium	Medium	High	Extreme	Extreme
Vulnerability Rating	High	High	Very High	Very High	Very High
Asset life cycle		Estimated end of lifecycle	Estimated end of lifecycle	Estimated end of lifecycle	Estimated end of lifecycle
Pathway	*Avoid / Monitor and review*		*Managed Retreat*		
Recommended Actions	Prohibit further development Monitor Flood heights, Drainage Outlet Berm height Assess long term drainage needs Integrate Coastal and Water Management Plans		Investigate redesign options Prohibit further development	Redesign to withstand impact Relocate outside of hazard zone	
	Accommodate				
	Design assets to withstand flooding Land use zoning for acceptable use Emergency Plans				
	Protect				
	Maintain / extend seawall Maintain and inmprove drainage controls		Investigate appropriateness of levee systems	Implement levee systems	

Adaptive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	30% of assets inundated during storm event	60% of assets inundated during storm event with significant damage OR End of life cycle	85% of assets inundated during storm event, significant damage and risk to community safety OR End of life cycle
Action	Implement first set of retreat actions	Implement second set of retreat actions	Implement retreat actions or decommission asset
Responsibility	Asset owners / Shire of Ashburton	Asset owners / Shire of Ashburton	Asset owners / Shire of Ashburton



Residual Risk

Time	2015	2040	2070	2110
Initial Risk	Medium	High	Extreme	Extreme
Adaptation pathway	*Avoid / Accommodate / Protect and Retreat*			
Residual Risk	Medium	Medium	Medium	Medium

INUNDATION

Figure C.14: Parks & Recreation Grounds (100 yr ARI)

Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
Risk Rating	Low	Low	Low	Medium	Medium
Vulnerability Rating	Low	Low	Low	Medium	Medium
Asset life cycle					**Estimated end of lifecycle**
Pathway	*Avoid / Monitor and review*				*Managed Retreat*
Recommended Actions	Prohibit further development Emergency Plans Monitor Flood heights, Drainage Outlet Berm height Assess long term drainage needs Integrate Coastal and Water Management Plans			Plan for retreat	Relocate outside of hazard zone
	Accommodate				
	Design assets to withstand flooding				

Adaptive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	50% of assets inundated during storm event	70% of assets inundated during storm event with significant damage OR End of life cycle	90% of assets inundated during storm event, significant damage and risk to community safety OR End of life cycle
Action	Implement accommodate actions	Implement retreat options	Implement retreat options or decomission asset
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton

Residual Risk

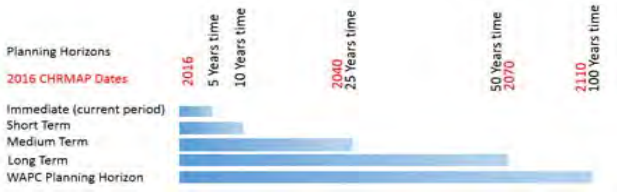
Time	2015	2040	2070	2110
Initial Risk	Low	Low	Medium	Medium
Adaptation pathway	*Accommodate*			
Residual Risk	Low	Low	Low	Medium

INUNDATION

Figure C.15: Public Infrastructure (100 yr ARI)

Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
Risk Rating	Medium	Medium	Medium	High	High
Vulnerability Rating	Medium	Medium	Medium	High	High
Asset life cycle			**Estimated end of lifecycle**		
Pathway	*Avoid / Monitor and review*		*Managed Retreat*		
Recommended Actions	Prohibit further development Emergency Plans Monitor Flood heights, Drainage Outlet Berm height Assess long term drainage needs Integrate Coastal and Water Management Plans		Continue to implement avoid and basic protection actions Accept and repair Plan for relocation of assets Prohibit further development	Relocate outside of hazard zone	
	Accommodate				
	Design assets to withstand flooding				

Adaptive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	30% of assets inundated during storm event	50 % assets inundated during storm event with significant damage OR End of life cycle	75% of assets inundated during storm event, significant damage and risk to community safety OR End of life cycle
Action	Implement accommodate actions	Implement retreat options	Implement retreat options or decomission asset
Responsibility	Shire of Ashburton / State agency / service provider	Shire of Ashburton / State agency / service provider	Shire of Ashburton / State agency / service provider



Residual Risk

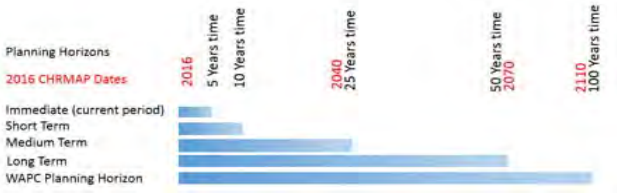
Time	2015	2040	2070	2110
Initial Risk	Medium	Medium	High	High
Adaptation pathway	*Accommodate*			
Residual Risk	Medium	Medium	Medium	Medium

INUNDATION

Figure C.16: Carparks (100 yr ARI)

Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
Risk Rating	Low	Low	Low	Medium	Medium
Vulnerability Rating	Low	Low	Low	Medium	Medium
Asset life cycle				Estimated end of lifecycle	
Pathway	*Avoid / Monitor and review*				*Managed Retreat*
Recommended Actions	Prohibit further development		Continue to implement avoid and basic protection actions		Relocate outside of hazard zone
	Emergency Plans			Plan for relocation of assets	
	Monitor Flood heights, Drainage Outlet Berm height			Prohibit further development	
	Assess long term drainage needs				
	Integrate Coastal and Water Management Plans				
	Accommodate				
	Design assets to withstand flooding				
	Accept and repair				

Adaptive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	50% of assets inundated during storm event	70% of assets inundated during storm event with significant damage OR End of life cycle	90% of assets inundated during storm event, significant damage and risk to community safety OR End of life cycle
Action	Implement accommodate actions	Implement retreat options	Implement protect options or decomission asset
Responsibility	Asset owners / Shire of Ashburton	Asset owners / Shire of Ashburton	Asset owners / Shire of Ashburton



Residual Risk

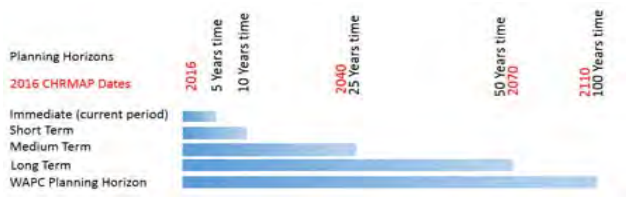
Time	2015	2040	2070	2110
Initial Risk	Low	Low	Medium	Medium
Adaptation pathway	*Accommodate*			
Residual Risk	Low	Low	Medium	Medium

INUNDATION

Figure C.17: Roads / Footpaths (100 yr ARI)

Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
Risk Rating	Medium	Medium	Medium	High	High
Vulnerability Rating	Medium	Medium	Medium	High	High
Asset life cycle				Estimated end of lifecycle	
Pathway	*Avoid / Monitor and review*		*Managed Retreat*		
Recommended Actions	Prohibit further development Emergency Plans Monitor Flood heights, Drainage Outlet Berm height Assess long term drainage needs Integrate Coastal and Water Management Plans		Plan for relocation of assets Prohibit further development	Relocate outside of hazard zone	
	Accommodate				
	Design assets to withstand flooding Accept and repair				

Adaptive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	30% assets inundated during storm event	50% assets inundated during storm event with significant damage OR End of life cycle	70% assets inundated during storm event, significant damage and risk to community safety OR End of life cycle
Action	Implement accommodate actions	Implement retreat options	Implement retreat options or decomission asset
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton



Residual Risk

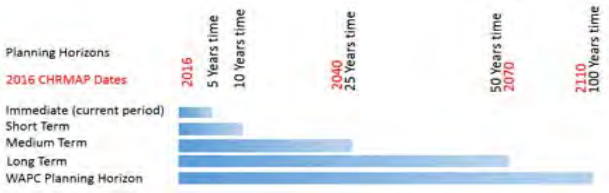
Time	2015	2040	2070	2110
Initial Risk	Medium	Medium	High	High
Adaptation pathway	*Accommodate*			
Residual Risk	Medium	Medium	Medium	Medium

INUNDATION

Figure C.18: Sheds (100 yr ARI)

Predicted Pathway	Immediate (<5 yrs)	Short Term (5-10 yrs)	Medium Term (10-25 yrs)	Long Term (25-50 yrs)	WAPC 100 year (50 - 100 yrs)
Risk Rating	Medium	Medium	Medium	High	High
Vulnerability Rating	Medium	Medium	Medium	High	High
Asset life cycle			**Estimated end of lifecycle**		
Pathway	*Avoid / Monitor and review*		*Managed Retreat*		
Recommended Actions	Prohibit further development Emergency Plans Monitor Flood heights, Drainage Outlet Berm height Assess long term drainage needs Integrate Coastal and Water Management Plans	Continue to implement avoid and basic protection actions Accept and repair	Plan for relocation of assets Prohibit further development	Redesign to withstand impact Relocate outside of hazard zone	
	Accommodate				
	Design assets to withstand flooding Accept and repair				

Adaptive Management Pathway	Trigger 1	Trigger 2	Trigger 3
Trigger	30% of assets inundated during storm event	50% of assets inundated during storm event with significant damage OR End of life cycle	70% of assets inundated during storm event, significant damage and risk to community safety OR End of life cycle
Action	Implement accommodate actions	Implement retreat options	Implement retreat options or decomission asset
Responsibility	Shire of Ashburton	Shire of Ashburton	Shire of Ashburton



Residual Risk

Time	2015	2040	2070	2110
Initial Risk	Medium	Medium	High	High
Adaptation pathway	*Accommodate*			
Residual Risk	Medium	Medium	Medium	Medium

CHRMAP For the Onslow Coast

APPENDIX D

TOWN PLANNING SCHEME NO. 7 – AMENDMENT NO. 24

Cardno
Shaping the Future

PL406*

PLANNING AND DEVELOPMENT ACT 2005

APPROVED LOCAL PLANNING SCHEME AMENDMENT

Shire of Ashburton

Town Planning Scheme No. 7—Amendment No. 24

Ref: TPS/1022

It is hereby notified for public information, in accordance with section 87 of the *Planning and Development Act 2005* that the Minister for Planning approved the Shire of Ashburton local planning scheme amendment on 16 July 2014 for the purpose of—

1. To replace and introduce a revised provision Clause 7.3 as follows—

"7.3 Onslow Coastal Hazard Area

7.3.1 Applications for planning approval within the Special Control Area shall be assessed under Appendix 12 and all development shall conform to the requirements of Appendix 12.

7.3.2 Applications for planning approval not in conformity with Appendix 12 shall not be supported."

2. To replace and introduce a revised provision Clause 6.20.2 and Clause 6.20.3 as follows—

"6.20.2 In areas not subject to Onslow Coastal Hazard Area provisions contained in Clause 7.3 of the Scheme but where the Local Government considers development to be potentially incompatible with land prone to flood and storm surge events, it must be satisfied that approval of such planning applications has regard to flood and storm surge events and may approve, with or without conditions, or refuse proposals at its discretion.

6.20.3 Prior to considering planning applications under Clause 6.20.2 the Local Government shall consult with the relevant agencies regarding the most up-to-date information available about potential flood and storm surge events as relevant to the land subject to the planning application."

3. Introducing a new provision of Appendix 12 as follows—

"APPENDIX 12—Requirements for Onslow Coastal Hazard Area

Purpose—

- To ensure that all development within the Onslow Coastal Hazard Area is designed and developed with finished floor levels to reflect the direction of State Planning Policy 2.6 and State Planning Policy 3.4.

1. To ensure that all development within the Onslow Coastal Hazard Area is designed and developed with finished floor levels to reflect the direction of State Planning Policy 2.6 and State Planning Policy 3.4.
2. For the purpose of Appendix 12, the following land use descriptions apply—
   i. 'Entertainment, recreation and Culture' use means—
      - Clubrooms
      - Equestrian Centre
      - Private Recreation
      - Public Recreation
   ii. 'Commercial-Strategic' use means—
      - Shop (greater than 150m² GLA)
   iii. 'Commercial-non Strategic' use means—
      - Caretaker's Dwelling
      - Display Home Centre
      - Entertainment Venue
      - Exhibition, Display and Outdoor Sales Facilities

viii. 'Temporary and/or Transient' use means use and development that have a limited tenure and operation on land and may include—

- caravan Park;
- transient workforce accommodation that is only required on a temporary basis;
- car Park;
- ablutions;
- any other use and development that is temporary in nature and where the local government resolves that is consistent with the Purposes of Appendix 12.

3. Within the Onslow Coastal Hazard Area the following land use and development shall achieve the following minimum finished floor levels to the satisfaction of the local government—
   i. Health, Welfare and Community Services—Strategic use and development shall be at a minimum finished floor level of 6.4m AHD.
   ii. Commercial—Strategic use and development shall have a minimum finished floor level of 5.9m AHD.
   iii. Commercial—Strategic use and development shall have a minimum finished floor level of 5.9m AHD.
   iv. Residential use and development shall have a minimum finished floor level of 5.9m AHD.
   v. Industry use and development shall be at a minimum finished floor level of 4.9m AHD.
   vi. Commercial—non Strategic use and development shall have a minimum finished floor level of 4.9m AHD.
   vii. Health, Welfare and Community Services—non Strategic use and development shall have a minimum finished floor level of 4.9m AHD.
   viii. Temporary and/or Transient use and development may be approved at a minimum finished floor level of 4m AHD. Where planning approval is issued, the use and development shall not remain beyond 31 December 2040. All such approved uses shall be removed from the land by 31 December 2040.
   ix. Entertainment, Recreation and Culture use and development may have a minimum finished floor level of 2.5m AHD.
4. All land subject of a planning approval within the Onslow Coastal Hazard Area shall have minimum finished ground level of 2.5m AHD.
5. Any filling of land within the Onslow Coastal Hazard Area shall require the approval of the local government. Filling to achieve a finished ground level higher than 2.5m AHD will generally not be supported.
6. A planning approval issued for land located within the Onslow Coastal Hazard Area shall include a condition requiring that a notification be placed on the certificate of title stating: VULNERABLE COASTAL AREA—This lot is located in an area likely to be subject to coastal erosion and/or inundation over the next 100 years.
7. Notwithstanding any provision of Appendix 12, where land is specifically included in an adopted Municipal Inventory of Heritage Places or State Heritage Register, the local government may approve an application for planning approval on land at a finished floor level less than that prescribed in Appendix 12 provided—
   i. such approval is in keeping with the historic nature of the existing buildings; and
   ii. planning approval includes a notification on title as required in by Part 6.
8. Notwithstanding Part 3 of Appendix 12, any application for use and development of the following kinds—
   i. Commercial—non Strategic;
   ii. Industry; or
   iii. Health, Welfare and Community Services—non Strategic;

   may be considered by the local government at the minimum finished floor level prescribed in Part 3 where—
   i. the application includes a strategy and management measures to—
      (a) ensure that any storage, warehousing, electrical fittings/switchboards (but not including electrical power-points) are provided above 5.9m AHD;
      (b) address how an approved use can be removed or adapted as the case may be by the date referred to in ii. below;
   ii. an approved use is removed or adapted as the case may be from the land as follows—
      (a) where the finished floor level is between 4.0m—4.8m AHD, the development shall be removed by 31 December 2040; and
      (b) where the finished floor level is between 4.9m—5.8m AHD, the development shall be removed or adapted by 31 December 2060.

- Holiday Accommodation
- Hotel
- Market
- Motel
- Movable Dwelling
- Motor Vehicle and/or Marine Repair
- Motor Vehicle and/or Marine Sales & Hire
- Motor Vehicle and/or Marine Service Station
- Motor Vehicle and/or Marine Wrecking
- Motor Vehicle Wash
- Office
- Outdoor Display
- Reception Centre
- Restaurant
- Shop (less than 150m² GLFA)
- Showroom
- Commerce continued
- Take-away Food Outlet
- Warehouse
- Transient Workforce Accommodation

iv. 'Health, Welfare and Community Services—non Strategic' use means—

- Carpark
- Childcare Service
- Community Use
- Consulting Rooms
- Education Establishment
- Funeral Parlour
- Place of Animal Care
- Place of Public Meeting, Assembly or Worship

v. 'Health, Welfare and Community Services—Strategic' use means—

- Emergency Services
- Hospital
- Medical Centre
- Nursing Home
- Public Utility

vi. 'Industry' use means—

- Abattoir
- Agriculture
- Arts and Crafts Centre
- Harbour and Marina Facilities
- Hire Service (Industrial)
- Home Business
- Home Occupation
- Industry—Extractive
- Industry—General
- Industry—Light
- Industry—Resource Processing
- Industry—Rural
- Industry—Service
- Infrastructure
- Intensive Agriculture
- Research Laboratory
- Stockyard
- Storage facility/depot/laydown area

vii. 'Residential' use means—

- Aged or Dependent Persons Dwelling
- Grouped Dwelling
- Multiple Dwelling
- Residential Building
- Single House

9. Where a planning approval is issued under Part 7 or Appendix 12 or where a Temporary and/or Transient use and development is approved, the local government shall not support subdivision unless it is an amalgamation of land.

K. WHITE, President.
N. HARTLEY, Chief Executive Officer.

CHRMAP For the Onslow Coast

APPENDIX E

STRATEGIC ECONOMIC ASSESSMENT

Cardno
Shaping the Future

Economic Summary Report

CHRMAP for the Onslow Coast

59916801

Prepared for
The Shire of Ashburton

22 December 2016

Cardno
Shaping the Future

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Version	Effective Date	Description of Revision	Prepared by:	Reviewed by:
V1	16/12/16	Draft for Cardno Review	Maisie Sargent	Leo Drynan

Table of Contents

1 Introduction

This document outlines Cardno's strategic economic assessment of the impact of pluvial inundation and coastal erosion to the town of Onslow. The purpose of this report is to provide a high level understanding of the costs to the Shire of Ashburton associated with pluvial inundation and coastal erosion under a 'do nothing' scenario (i.e. no adaptation measures undertaken). At this high level stage of analysis, the associated benefits of potential mitigation measures have not been assessed. The aim of this summary is to provide initial, order of magnitude quantification of inundation and erosion risks to aid decision makers in the prioritisation of research, mitigation and management efforts.

It is a recommended that following this initial assessment, a suite of preferred management actions are developed that target prioritised infrastructure, considering the costs of inaction presented herein. Detailed cost benefit analysis could then be undertaken to demonstrate the economic feasibility of the management actions and compare between options as to which provides the greatest return on investment.

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2 Pluvial Inundation

The physical property damage and impacts of pluvial inundation was assessed under the 10 Year ARI scenario and the 100 Year ARI scenario. It is important to note that these flood events are only two select scenarios among then entire spectrum of possible flood events. Eg. Onslow experiences pluvial flooding related to 5 Year ARI events, 20 Year ARI events and so forth. The cumulative expected value of all flooding events in any one year has not currently been determined. A detailed flood profile and curve would need to be developed to estimate this accurately. The two scenarios selected have been used as conservative proxies to establish the order of magnitude costs associated with flooding.

Further, for the purposes of this assessment a number of assumptions have been made to facilitate the estimation of economic values, these include:

> Numerous types of assets are impacted from pluvial inundation, including: buildings; park and recreation grounds; public infrastructure such as fencing, light poles; carparks; roads and footpaths and sheds. For the purposes of this assessment, only buildings (residential and commercial) have been included. By ignoring other assets, this assessment will under-estimate the true damage costs of flooding events;

> The following estimates of affected buildings were utilised as part of the analysis based on the number of buildings and other assets within Onslow, and mapped flood extents:

Table 2-1: Number of buildings affected by pluvial inundation

Scenario	Buildings Impacted
10 Year ARI (current)	102
100 Year ARI (current)	147
10 Year ARI (2110)	147
100 Year ARI (2110)	211

> An assumed damage cost per property has been adopted:

Table 2-2: Flood damage cost

Scenario	Damage Cost per Asset
10 Year ARI (current)	$65,720
100 Year ARI (current)	$67,535
10 Year ARI (2110)	$67,535
100 Year ARI (2110)	$68,871

Damage costs are based on Floodplain Management Guidelines No. 4 Residential Flood Damage Calculation (the then NSW Department of Natural Resources, now Office of Environment and Heritage) and the average flood depth per building impacted. It should be noted that while the inputs to the damage curve (e.g. weekly earnings) are similar to those of the Shire of Ashburton, the development of an Onslow-specific flood damage cost curve is recommended for input in future analyses.

> Assuming the realisation of climate change predictions, a 10 year ARI flood in 2110 will resemble a present day 100 year ARI flood. Similarly, the impact of a 100 year ARI flood in 2110 will be worse, and therefore more costly (affecting more properties and to a greater extent), than a 100 year ARI flood in 2015; and

> An economic evaluation period of 100 years was adopted.

Based on the number of buildings impacted and the damage cost per asset, the damage cost per any one event is presented in **Table 2-3**.

Table 2-3: Pluvial inundation damage cost per single event in 2016

Scenario	Damage Cost per Event
10 Year ARI (current)	$6.7M
100 Year ARI (current)	$9.9M
10 Year ARI (2110)	$9.9M
100 Year ARI (2110)	$14.5M

Table 2-4 presents the expected present value costs (expected value = probability x cost of damage / repair) of each scenario given their likelihood of occurrence over the 100 year period.

Table 2-4: Pluvial inundation damage cost over 100 years

Scenario	Expected value of damage cost over 100 years	Present expected value of damage cost over 100 year assessment period
10 Year ARI	$78.6M	$10.8M
100 Year ARI	$11.6M	$1.6M

The present value cost of the 10 Year ARI event over the 100 year assessment period is approximately $10.8 million. The present value cost of the 100 Year ARI event over the 100 year assessment period is approximately $1.6 million. The 10 Year ARI event is less intense but more frequent and as such is more costly than the 100 Year ARI event. This results also reflects:

1) That the number of properties currently affected under the 100 year ARI, although greater that 10 year ARI, increases at a lower rate over time, in comparison to the 10 year ARI.
2) The coarse damage cost per asset adopted does not adequately gauge the increased damages likely to be incurred, per property, under a 100 yr ARI event in comparison to a 10 year ARI event.

These ongoing damage costs can be compared to the total value of assets impacted (nb. not the cost of impact) by pluvial inundation. The median property price for Onslow over the last five years is $762,000 (REAI, 2016). **Table 2-5** shows the total asset value being affected by flooding under the four scenarios. The values are very high in comparison to the damage incurred under any one event. This suggests that relocation of assets (assuming costs of relocation are roughly similar to asset value) is unlikely to be economically feasible as a management measure.

Table 2-5: Value of assets impacted by pluvial inundation

Scenario	Value of impacted assets	Present value of impacted assets
10 Year ARI (current)	$77.6M	$77.6M
100 Year ARI (current)	$111.7M	$111.7M
10 Year ARI (2110)	$111.7M	$0.2M
100 Year ARI (2110)	$160.9M	$0.3M

Analysis of Results

The results of the economic analysis highlight the high cost of damage / repair related to pluvial inundation events. **Figure 2-1** presents the expected flood damage cost by year for the 10 Year ARI and the 100 Year ARI. The damage cost of the 10 Year ARI increases substantially overtime. The damage cost related to the 100 Year ARI remains relatively stable over time as the probably of this event occurring is low.

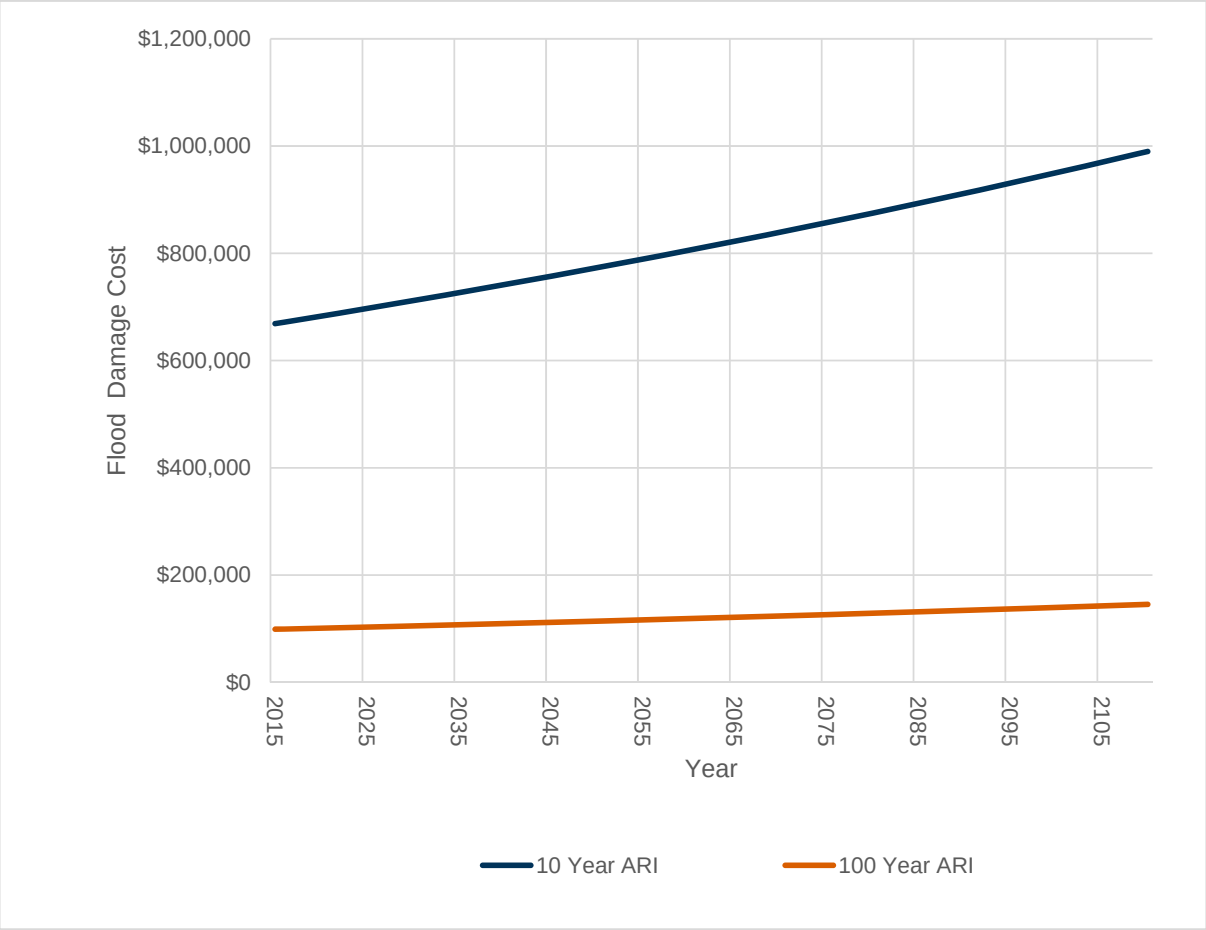

Figure 2-1: Annual flood expected damage cost by year

Figure 2-2 presents the cumulative present value damage cost curves of flood events compared to the total value of the impacted assets under each flood scenario. The present value of annual damage costs are less than the total present value of impacted assets until 2047. After 2047, the present value in 2015 dollars of replacing the assets is less than the cumulative expenditure incurred. However, if you consider the scenario from a 2047 perspective, the savings in damages do not outweigh the replacement cost of impacted assets. If all impacted assets were replaced in 2047, the replacement cost would be approximately $88 million in 2047 dollars and the total savings in damage costs for the 100 year period thereafter would be approximately $12 million (2047$).

Based on this analysis, the costs of maintenance are not high enough to warrant relocation in any one year. However, the current assessed scenario considers the replacement of all impacted assets. It is recommended to undertake a more detailed analysis as it may be economically justifiable to replace only those assets that suffer the greatest damage.

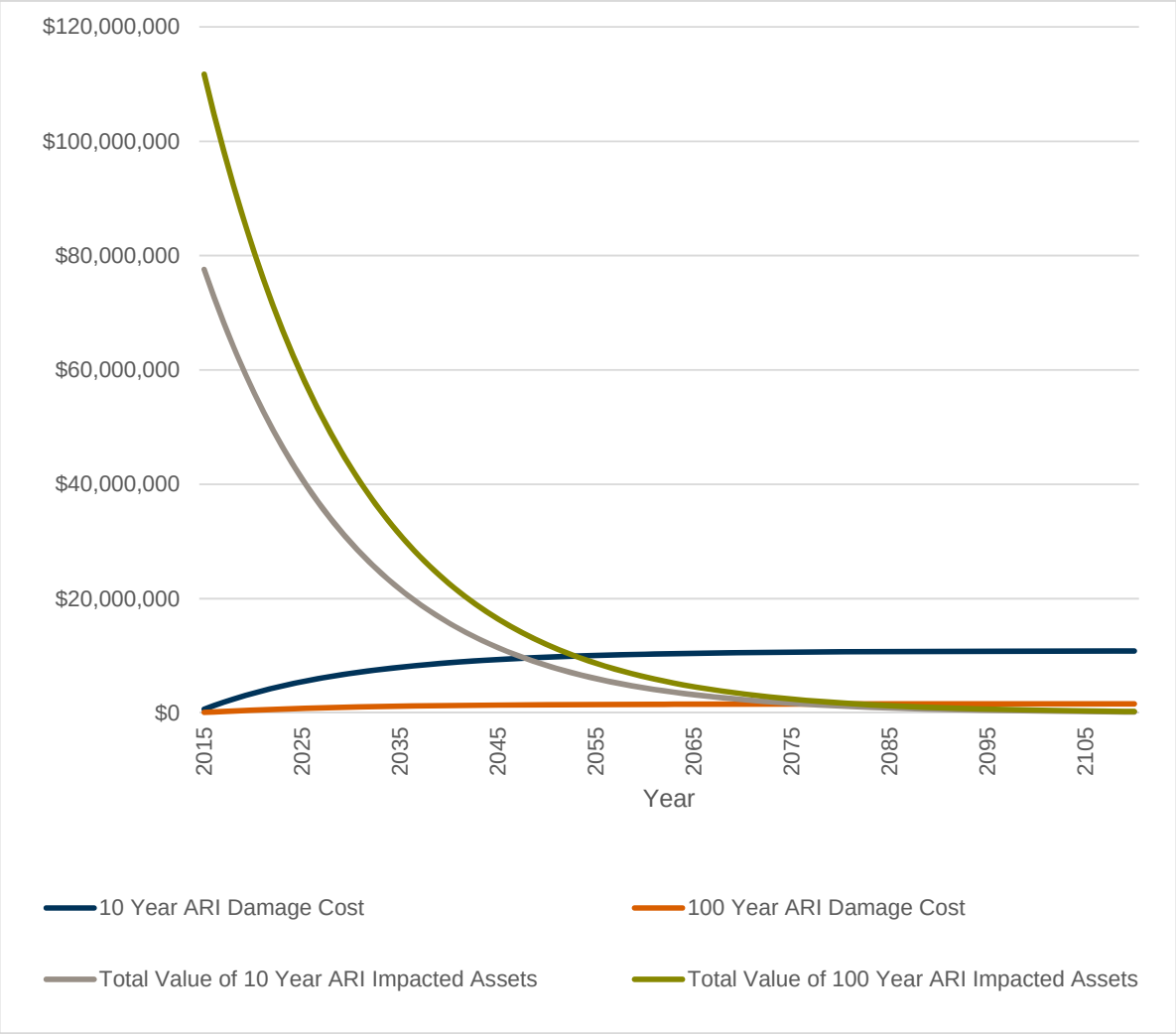

Figure 2-2: Damage cost in comparison to the value of impacted assets

Sensitivity Analysis

As a sensitivity, the flood scenarios have been assessed assuming flood intensity remains constant from present day (ie. no climate change impact) (**Table 2-6**). This is in comparison to the results presented in **Table 2-4** which assumes an increase in the intensity (and associated impact magnitude) of storm events.

Table 2-6: Damage cost per event with and without increasing storm intensity

Scenario	Damage Cost per Event (storm intensity increasing)	Damage Cost per Event (storm intensity constant)
10 Year ARI (current)	$6.7M	$6.7M
100 Year ARI (current)	$9.9M	$9.9M
10 Year ARI (2110)	$9.9M	$6.7M
100 Year ARI (2110)	$14.5M	$9.9M

Table 2-7 presents a comparison of the present value of the expected present value of damages for the two scenarios.

Table 2-7: Sensitivity analysis

Scenario	Present value of damage cost
10 Year ARI – increased storm intensity	$10.8M
10 Year ARI – constant conditions	$10.2M
100 Year ARI – increased storm intensity	$1.6M
100 Year ARI – constant conditions	$1.5M

The results presented in **Table 2-6** reflect the high cost of repair due to pluvial inundation, regardless of climate change. The impact of climate change is seen to be relatively low in present value terms. The increased magnitude of damage and associated costs does not increase fast enough to outweigh the 7% discount rate used to account for the time value of money.

Further sensitivity analyses have been undertaken and are presented in **Table 2-8**. However, a more detailed analysis and understanding of how damage costs vary between flood events would need to be established to gain a robust understanding of climate change impacts and long term management strategies. The comparatively significant expected costs associated with the 10 year ARI events (in comparison to the 100 year ARI) suggests that significant savings could be achieved through implementation of measures that minimise risk of inundation under lower magnitude, higher frequency flooding events.

Table 2-8: Sensitivity analysis

Scenario	Present value of damage cost
10 Year ARI, -20% damage costs	$8.7M
10 Year ARI, +20% damage costs	$13.0M
10 Year ARI, -20% number of buildings	$8.7M
10 Year ARI, +20% number of buildings	$13.0M
100 Year ARI, -20% damage costs	$1.3M
100 Year ARI, +20% damage costs	$1.9M
100 Year ARI, -20% number of buildings	$1.3M
100 Year ARI, +20% number of buildings	$1.9M

3 Coastal Erosion

Table 3-1 presents the results of the risk and vulnerability assessment of assets to coastal erosion, between the present day and 2110. The outcomes presented in this table are used as the basis of the coastal erosion economic assessment.

Table 3-1: Risk and Vulnerability Assessment

Risk and Vulnerability Assessment		2015	2040	2070	2110
	Asset	Risk			
1	On-ground infrastructure at Onslow Jetty	Low	Medium	High	Extreme
2	Onslow Back Beach picnic area	Low	Low	Low	Medium
3	Front Beach / Sunrise Beach	Low	Low	High	Extreme
4	Seawall (if not maintained)	Medium	Medium	Extreme	Extreme
5	Assets adjacent to crest of seawall (bins, shade structures, benches	Low	Low	Low	Medium
6	Shire of Ashburton Offices at the intersection of Second Ave and M	Low	Medium	High	High
7	Bindi Bindi Aboriginal Community on Second Ave	Low	Medium	High	High
8	Western half of Ian Donald Blair Memorial Walkway	Low	Low	Medium	Medium
9	Intersection of Seaview Drive and Back Beach Road	Low	Low	Low	Low
10	Eastern end of Ian Donald Blair Memorial Walkway	Low	Low	Medium	Medium
11	Seaview Drive near 12 Mile Creek / 4 Mile Beach	Low	Low	Low	Medium
13	Second Ave	Low	Low	Medium	Medium

	Asset	Vulnerability			
1	On-ground infrastructure at Onslow Jetty	Low	Medium	High	Very High
2	Onslow Back Beach picnic area	Low	Low	Low	Medium
3	Front Beach / Sunrise Beach	Low	Low	High	Very High
4	Seawall (if not maintained)	Medium	Medium	High	High
5	Assets adjacent to crest of seawall (bins, shade structures, benches	Low	Low	Low	Medium
6	Shire of Ashburton Offices at the intersection of Second Ave and M	Low	High	Very High	Very High
7	Bindi Bindi Aboriginal Community on Second Ave	Low	High	Very High	Very High
8	Western half of Ian Donald Blair Memorial Walkway	Low	Low	Medium	Medium
9	Intersection of Seaview Drive and Back Beach Road	Low	Low	Low	Low
10	Eastern end of Ian Donald Blair Memorial Walkway	Low	Low	Medium	Medium
11	Seaview Drive near 12 Mile Creek / 4 Mile Beach	Low	Low	Low	Medium
13	Second Ave	Low	Low	Medium	Medium

For the purposes of this assessment a number of assumptions have been made to facilitate the estimation of economic values, these include:

> Per annum seawall maintenance cost of $300,000;

> A replacement value of the on ground infrastructure at Onslow Salt Jetty of approximately $10 million;

> A replacement value of the Shire of Ashburton Offices equal to the median house value of approximately $762,000;

> The replacement value of the Bindi Bindi community is 23 times the median house value (there are 23 dwellings within the community), or $17.5 million; and

> Beach renourishment cost of $100,000 per annum once impacted by coastal erosion.

Using the timeframes of changes in risk/vulnerability detailed in **Table 3-1**, the present value of relocating/maintaining the assets was determined (**Table 3-2**). It is seen that if assets are replaced when the reach either very high vulnerability or extreme risk (eg. this is in 2070 for seawalls) the present value of implementing the management measure is $0.6 million. In contrast, relocation/maintaining assets once they reach high risk or vulnerability has a greater present value ($3.7 million) as this event occurs earlier in time. In order to determine which response is the preferred strategy a more detailed analysis of the costs of inaction / benefits of maintenance are required to understand how these costs may be offset.

Table 3-2: Replacement costs due to coastal erosion impacts

Scenario	Present value of cost over the 100 year assessment period
Replacement of assets at very high / extreme risk or vulnerability	$0.6M
Replacement of assets at high risk or vulnerability	$3.7M

Analysis of Results

The assets impacted by coastal erosion are costly to replace. However, coastal erosion impacts substantially fewer assets than pluvial inundation. The costs associated with pluvial inundation are over $12.4 million (present value, $2016), compared to the $0.6 to $3.7 million (present value, $2016) associated with coastal erosion.

Based on the existing information, there are not enough costs associated with inaction to justify the relocation of assets. It is recommended to wait as long as possible before incurring replacement costs. However, the limited data available for this analysis restricts its applicability. A more detailed evaluation of costs and benefits of erosion / inundation specific management options is reccommended.

About Cardno

Cardno is an ASX200 professional infrastructure and environmental services company, with expertise in the development and improvement of physical and social infrastructure for communities around the world. Cardno's team includes leading professionals who plan, design, manage and deliver sustainable projects and community programs. Cardno is an international company listed on the Australian Securities Exchange [ASX:CDD].

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Cardno
Shaping the Future

Ashburton
Traffic Digest

2009/10 - 2014/15

mainroads WESTERN AUSTRALIA

Information Sheet

Traffic Digest

Overview

This report summarises the average number of vehicles and heavy vehicles travelling at locations within Western Australia. Traffic volumes and percentage of heavy vehicles are provided for the latest available six years.

Main Roads undertakes traffic counting throughout Western Australia. Strategic locations are monitored on a continuous basis and are referred to as Network Performance Sites (NPS). Sampling of the wider network is performed using portable equipment over a short period. Although many Local Government roads are counted the focus is on providing information about the State road network.

Using the report

The traffic volumes in this report are expressed as the average number of vehicles at each location on a typical weekday (Monday to Friday) for the metropolitan area, and a typical day (Monday to Sunday) for regions outside the metropolitan area.

Where sufficient information is available from continuous monitoring sites the short term samples can be adjusted to remove the effect of seasonal variation.

If multiple counts have occurred at the same location within a given year, for example before and after a network change, only the latest count is used.

The count type may vary at the location between axle counts and classification counts. Axle counts record the number of axle hits at a site divided by two. This method gives an indicative number of vehicles, assuming all vehicles have only two axles. Locations where axle counts are used are those where there is very little freight movement.

Classification counts detect the axle configuration of each vehicle and determine the type of vehicle being counted (using the AustRoads 1994 Classification Scheme). This method of counting gives the actual number of vehicles at the location and can be identified in the report by the presence of a value in the right column of each year. This value is the proportion of heavy vehicles (which include buses, trucks and road trains). Speed information can also be obtained from these collections.

Changes to the road network may affect traffic volumes. For example, the extension of a freeway or closure of a road may affect traffic behaviour on surrounding roads. To assist in identifying these a list of major network changes is included at the end of the report. This list is not exhaustive and is predominantly changes to roads managed by Main Roads Western Australia (known as state roads).

Public holidays are excluded and vehicles numbers are rounded to the nearest ten. All years reported are financial years, commencing 1 July and ending 30 June. The State is divided for reporting using Main Roads regions or Local Government boundaries.

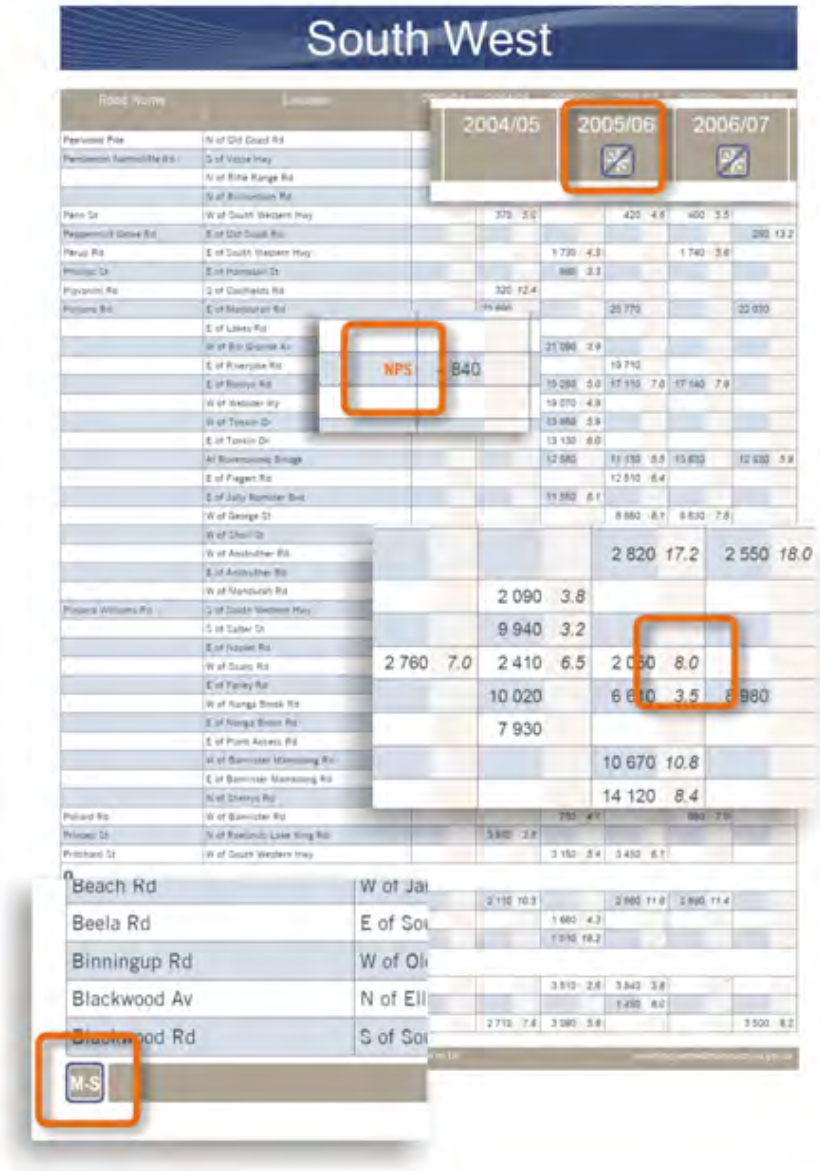
Further information

If you require further information please email reporting.centre@mainroads.wa.gov.au or telephone 08 9323 4653 (9am to 5pm, Monday to Friday)

Information Sheet

Traffic Digest

Report Sample



Seasonal Adjustment

Years with this symbol cannot be adjusted to remove the effect of seasonal variation. The volumes reported are from samples taken over a short period and may not represent typical behaviour.

Continuous Monitoring

Network Performance Sites (NPS) provide continuous monitoring, 24 hours a day, 7 days a week.

Percentage of Heavy Vehicles

Classification counts record the composition of the traffic and the percentage of heavy vehicles is shown on the report where a count of this type has been used.

Traffic Statistics

The traffic volumes can be calculated to represent the average number of vehicles on a weekday (Monday to Friday, M-F) or daily (Monday to Sunday, M-S).

Ashburton

Road Name	Location	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
A							
Ansia Access Rd	W of Onslow Rd NPS				720 *43.9*	810 *52.8*	610 *55.6*
B							
Bingarn Rd	S of Nanutarra Rd		270 *27.5*		280 *37.6*		350 *35.4*
	N of Rubbish Tip Rd (Tom Price)	260 *31.4*					
	S of Killawarra Dr		700 *17.9*		730 *22.5*		780 *25.1*
G							
Great Northern Hwy	S of Yandi Mine Access Rd		800 *52.3*		830 *58.6*		820 *52.8*
	S of Karijini Dr NPS	500 *54.4*	540 *49.7*	660 *61.3*	770 *57.6*	720 *58.6*	
	S of Munjina Rd	480 *51.8*			870 *59.5*		530 *67.3*
	N of Munjina Rd		510 *51.6*		770 *56.8*		
K							
Karijini Dr	W of Great Northern Hwy NPS	240 *30.7*	250 *33.6*	310 *43.0*	340 *43.4*	310 *43.1*	290 *42.6*
	W of Juna Downs Rd		270 *42.9*		360 *43.0*		
	E of Hamersley Mount Bruce Rd		320 *34.1*		420 *41.8*		420 *29.8*
	W of Hamersley Mount Bruce Rd		320 *40.1*		440 *33.6*		410 *35.9*
	E of Paraburdoo Tom Price Rd	490 *32.4*	490 *35.3*		680 *38.8*		520 *34.2*
M							
Mine Rd	S of Bingarn Rd		2 430 *21.2*		3 420 *20.3*		3 090 *18.3*
	W of West Rd		3 180 *17.1*		3 490 *22.7*		3 160 *22.6*
Munjina Rd	W of Great Northern Hwy		90 *11.7*		160 *48.6*		90 *40.9*
N							
Nanutarra Rd	E of North West Coastal Hwy NPS	80 *27.5*	90 *26.0*	100 *26.5*			130 *25.9*
	E of Onslow Mount Stuart Rd	90 *25.5*					
	W of Ashburton Downs Rd	110 *16.5*		90 *29.9*			
	W of Tom Price Rd	110 *20.0*	110 *24.8*	80 *29.0*	120 *26.8*		140 *20.6*
	N of Paraburdoo Tom Price Rd	30 *17.2*	30 *22.7*		30 *24.3*		50 *21.3*
	W of Nameless Valley Dr		140 *20.7*		450 *35.2*		200 *25.7*
	W of Karratha Tom Price Rd		220 *34.5*		250 *24.7*		280 *34.9*
	E of Tom Price Railway Rd				110 *56.0*		110 *35.6*
North West Coastal Hwy	W of Burkett Rd					500 *37.9*	
	N of Burkett Rd		400 *35.5*	480 *45.1*	520 *36.8*	620 *29.7*	
	S of Nanutarra				530 *21.5*	510 *35.8*	
	S of Nanutarra Rd						560 *34.2*
	N of Nanutarra Rd				460 *44.3*		
	S of Onslow Rd NPS	380 *39.8*	340 *41.2*	380 *43.6*	500 *40.4*	430 *47.1*	410 *45.7*
	S of Yarraloola Rd	390 *34.2*		590 *46.5*	580 *38.9*		520 *37.9*
	N of Pannawonica Rd	590 *34.6*		570 *46.7*	630 *43.5*		790 *30.6*
O							
Onslow Rd	W of Mount Minnie Station Rd	100 *20.9*		210 *37.7*	380 *54.3*		
	S of Twitchin Rd NPS				430 *58.9*	450 *69.4*	280 *59.5*
	N of Twitchin Rd	190 *14.6*		550 *38.2*	730 *35.2*		940 *23.1*
	N of Ansia Access Rd NPS				710 *27.5*	770 *30.2*	630 *35.6*
	N of Onslow Airport Rd						1 250 *23.1*

Ashburton

Road Name	Location	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
P							
Pannawonica Millstream Rd	At Mount Enid Rail Crossing			140 *14.6*			
Pannawonica Rd	E of North West Coastal Hwy	170 *23.0*		260 *27.3*	230 *29.0*		310 *42.5*
Paraburdoo Rd	E of Nanutarra Rd	90 *24.6*			100 *27.2*		110 *26.9*
S							
Second Av	E of Third St					1 910 *13.4*	
	W of Beadon Creek Rd					1 850 *11.2*	
T							
Tom Price Paraburdoo Rd	W of Rocklea Rd		640 *15.8*		700 *15.7*		600 *17.2*
	S of Karijini Dr	530 *24.0*	570 *25.4*		640 *26.9*		
	N of Karijini Dr	930 *29.4*	940 *22.4*		1 180 *22.9*		910 *21.7*
	S of Mine Rd		960 *25.2*				1 040 *26.7*
Towera Rd	S of North West Coastal Hwy	60 *24.4*					
Twitchin Rd	W of Onslow Rd				130 *43.6*		

Shire of Ashburton

Local Planning Strategy

Bushfire Hazard Level Assessment

August 2017

Executive summary

The Shire of Ashburton is preparing a local planning strategy to guide future land use and development across the Shire, in particular the townsites of Onslow, Tom Price and Paraburdoo. Areas within and around these townsites are within a designated bushfire prone area.

Bushfire risk is a key planning issue in Western Australia. State Planning Policy No. 3.7 Planning in Bushfire Prone Areas and the Guidelines for Planning in Bushfire Prone Areas sets out the framework to manage bushfire risk within planning processes and decisions. Local planning strategies integrate consideration of bushfire risk through a bushfire hazard level assessment.

A bushfire hazard level assessment was undertaken for all investigation and infill areas identified in the draft Shire of Ashburton Local Planning Strategy to consider how bushfire risk may influence future development. The assessment was undertaken in accordance with the methodology prescribed in the technical appendices to the Guidelines for Planning in Bushfire Prone Areas.

Potential townsite expansion areas in Tom Price, Paraburdoo and Onslow are influenced, for the most part, by a moderate bushfire hazard level. Whilst pockets of extreme hazard level were modelled and mapped within Tom Price, the small size and spatial extent of these areas makes it unlikely that they would present an extreme hazard in reality.

The assessment considers that future planning and development of investigation and infill areas can, subject to design, successfully address the identified bushfire hazard, demonstrated by anticipated compliance with bushfire protection criteria set out in technical appendices to the Guidelines for Planning in Bushfire Prone Areas. The nature of development and associated clearing of vegetation will reduce the hazard level for the majority of development areas, and with appropriate planning for access, services, and layout, future development will be able to achieve at least the minimum standards for bushfire exposure in line with state policy.

The role of a local planning strategy is to provide an effective local planning framework to address key issues in local planning processes and decisions. The state policy framework regarding bushfire risk is very well developed, and applies clearly to local planning applications and decisions. Therefore, the Shire of Ashburton Local Planning Strategy does not require additional policy responses to address bushfire risk, as it is adequately dealt with at the state level. Minor modifications to the draft bushfire actions in the draft local planning strategy are recommended to reflect the bushfire hazard level assessment and refine strategic responses.

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.3 and the assumptions and qualifications contained throughout the report.

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Table index

Figure index

Appendices

1. Proposal details

1.1 Introduction

The draft Shire of Ashburton Local Planning Strategy articulates the Shire's goals for land use and development and the justification and context for future review of the local planning scheme. The local planning strategy provides strategic land use plans for the townsites of Onslow, Tom Price and Paraburdoo, outlining spatial strategies and investigation areas for future urban expansion.

The Onslow, Tom Price and Paraburdoo townsites and surrounds include land within a designated bushfire prone area (see Figure 1, Figure 2 and Figure 3). In line with State Planning Policy No. 3.7 Planning in Bushfire Prone Areas (SPP3.7) and the Planning in Bushfire Prone Areas Guidelines (WAPC, 2015), a bushfire hazard level assessment is necessary to inform the local planning strategy, and ensure that areas of new land use and intensification in bushfire prone areas appropriately consider bushfire hazard.

Appendix A includes strategy plans from the draft local planning strategy that identify those areas planned for urban expansion or intensification of development.

1.2 Purpose of this report

This report provides a bushfire hazard level assessment for future investigation and infill areas identified on the Shire of Ashburton Local Planning Strategy town site strategy plans for Tom Price, Onslow and Paraburdoo. This report assesses bushfire recommendations of the local planning strategy against the bushfire protection criteria set out in technical appendices to the Guidelines for Planning in Bushfire Prone Areas (WAPC, 2015). The report makes recommendations for how the local planning strategy should respond to bushfire risk.

This report provides a technical appendix to Part 2 of the Shire of Ashburton Local Planning Strategy.

The objectives of the bushfire hazard level assessment are:

- To undertake a bushfire hazard level assessment for those area(s) being considered for urban expansion or intensification of development; and
- To identify those areas with a moderate or extreme hazard rating, that require a more detailed analysis before any development / subdivision occurs.

LEGEND

- Local Road
- Bushfire Hazard Level Assessment Area
- Bushfire Prone Areas

Paper Size A3

0 200 400 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

Shire of Ashburton
reef to range

Shire of Ashburton
Ashburton Bushfire Hazard
Level Assessment

Onslow
Bushfire Prone Areas

Job Number	61-36178
Revision	A
Date	09 Aug 2017

Figure 1

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Data source: GHD: Survey Boundary - 20170809; Landgate: Imagery, Roads, Bushfire Prone Areas - 20170801; . Created by:krawlinson

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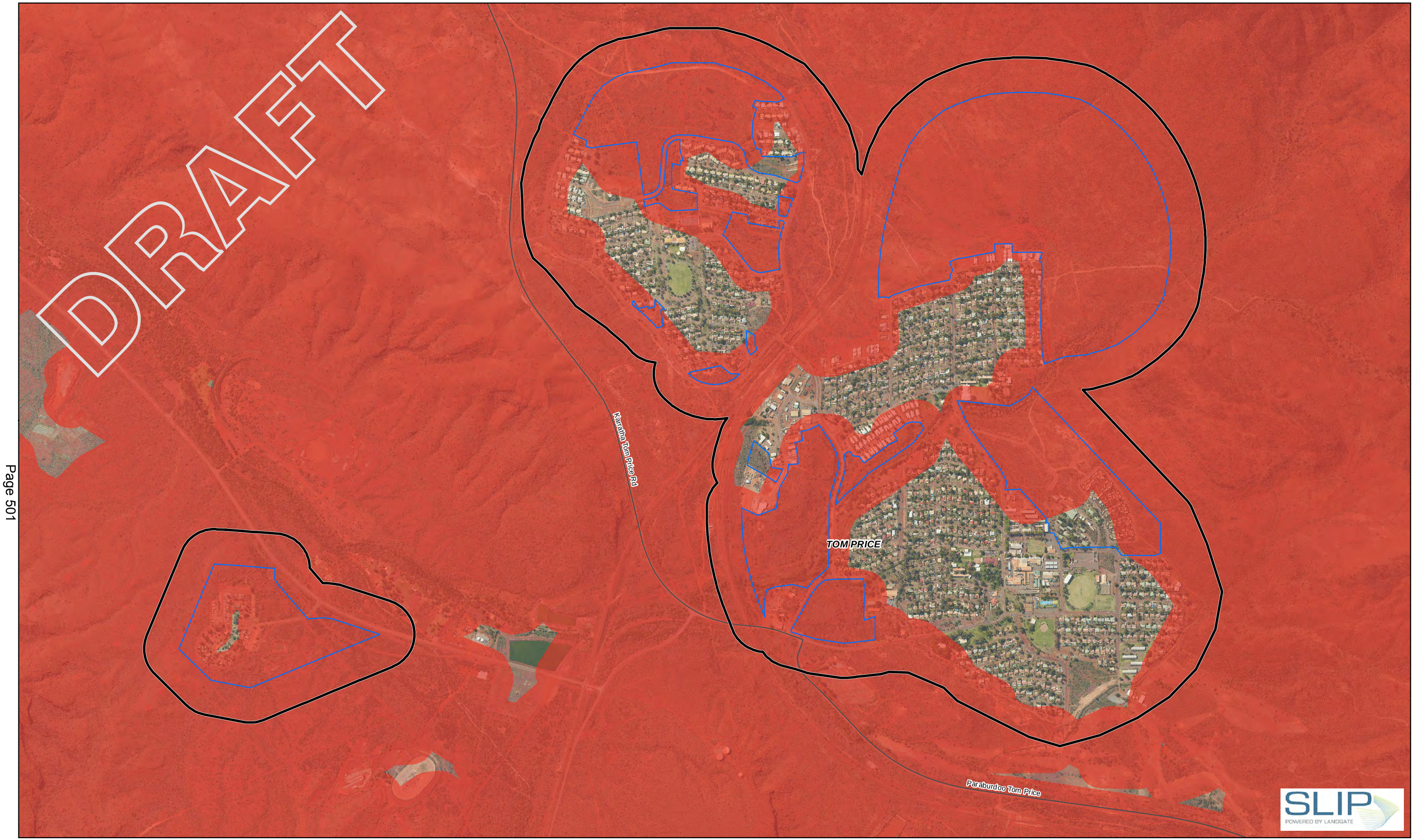

Paper Size A3

0 150 300 600

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

LEGEND

- State Road
- Investigation Area
- Bushfire Hazard Level Assessment Area
- Bushfire Prone Areas

Shire of Ashburton
Ashburton Bushfire Hazard Level Assessment

Tom Price
Bushfire Prone Areas

Job Number	61-36178
Revision	B
Date	09 Aug 2017

Figure 2

ATTACHMENT 14.1

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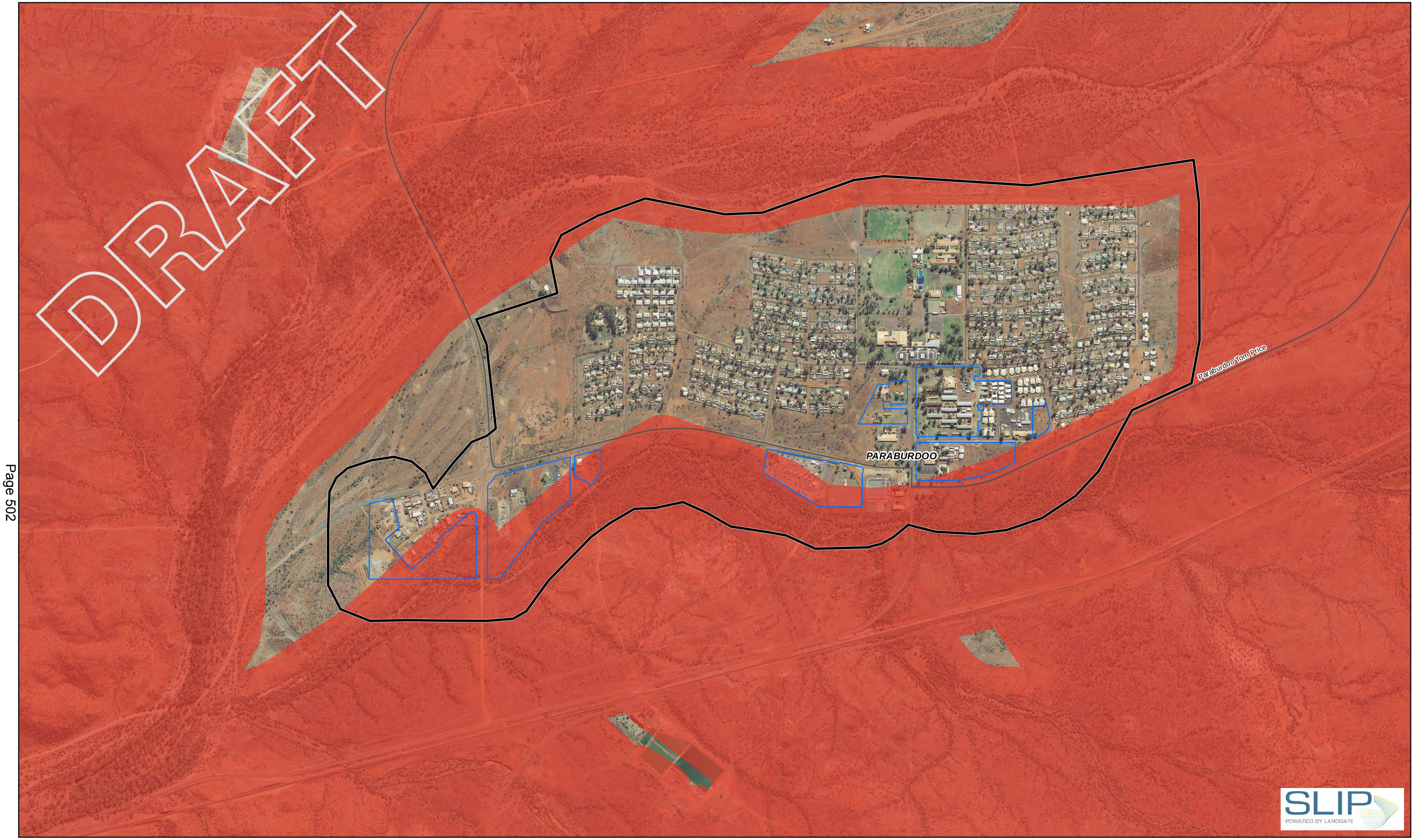

Paper Size A3

0 125 250 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

LEGEND

- State Road
- Investigation Area
- Bushfire Hazard Level Assessment Area
- Bushfire Prone Areas

Shire of Ashburton
Ashburton Bushfire Hazard Level Assessment

Paraburdoo Bushfire Prone Areas

Job Number	61-36178
Revision	B
Date	09 Aug 2017

Figure 3

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Data source: GHD: Survey Boundary - 20170809; Landgate: Imagery, Roads, Bushfire Prone Areas - 20170801; . Created by:krawlinson

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1.3 Scope and limitations

This report has been prepared by GHD for the Shire of Ashburton and may only be used and relied on by the Shire of Ashburton for the purpose agreed between GHD and the Shire of Ashburton as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than the Shire of Ashburton arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

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GHD has not been involved in the preparation of the Shire of Ashburton Local Planning Strategy and has had no contribution to, or review of the Shire of Ashburton Local Planning Strategy other than in the Shire of Ashburton Local Planning Strategy Bushfire Hazard Level Assessment. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of the Shire of Ashburton Local Planning Strategy.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by site access and the location of public viewpoints. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

The vegetation classifications in this document are for the purpose of indicative broad bushfire hazard levels only. The classifications should not be used for any other purpose, and should not be used as the basis of determining bushfire attack levels (BAL) or BAL contour maps for any sites.

2. Bushfire Hazard Level Assessment

2.1 Methodology

The bushfire hazard level assessment was undertaken in accordance with Appendix 2 of the Guidelines for Planning in Bushfire Prone Areas (as amended).

The bushfire hazard level assessment area was determined as all future investigation areas identified in the draft local planning strategy, with a 150 metre buffer. This area was modified slightly in some locations to incorporate additional, nearby bushfire prone land, or clipped where the study area overlapped with significant waterways and ocean.

Vegetation in the study area was classified in accordance with Table 2.3 of AS3959-2009 (as amended) and the Visual Guide for Bushfire Risk Assessment in Western Australian (Department of Planning, 2016). The classification of vegetation was based on interrogation of the most recently available aerial photography, verified by numerous field assessment points.

Consistent with the broad-brush nature of a bushfire hazard level assessment, the most appropriate vegetation classification was determined for contiguous stands of vegetation that broadly share similar structures and anticipated fire behaviour, although some minor variability may be recorded at individual assessment points across the sites. Any variation in vegetation within stands that would result in a higher hazard level was individually mapped (e.g. a minor area of low shubland within a larger grassland area may not be separately mapped, however any areas of scrub would be). Being a broad-brush assessment, the classification took a conservative approach in relation to defining vegetation classes. Future assessments of bushfire attack level which look at smaller extents of vegetation may result in lesser classifications.

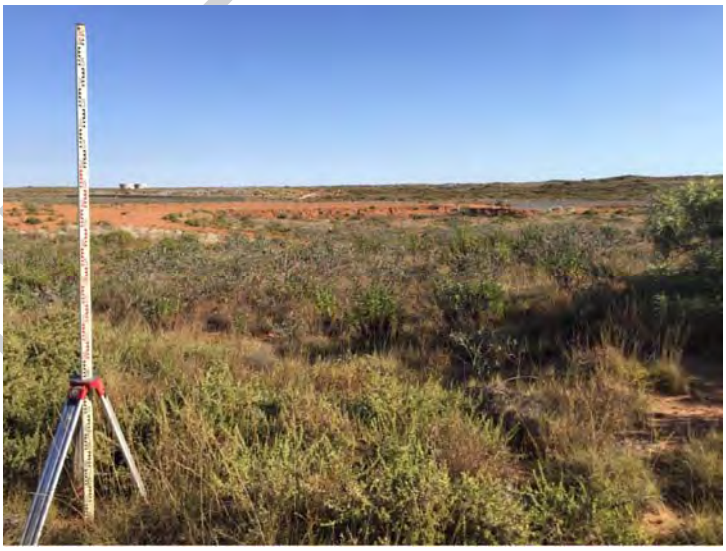
Mapped vegetation classes were combined with slope analysis based on available contour data to model the appropriate bushfire hazard level. In line with AS3959, effective slope was calculated over 100 metres, to smooth out short variations in slope/land undulation that would not influence bushfire hazard level.

2.2 Onslow Townsite

2.2.1 Vegetation Classification Mapping

Vegetation across the Onslow area reflects grassland and shrubland vegetation classifications described in AS3959. The vegetation classes are described in Table 1. Figure 4 illustrates the broad distribution of vegetation classes across the bushfire hazard level assessment area. Appendix A provides field observations and identification of vegetation class for the 46 assessment points analysed in Onslow.

Table 1 Vegetation Classes – Onslow Townsite

Vegetation class	Representative photo
Class G - Grassland All grassland forms, including situations with shrubs and trees, if the overstorey foliage cover is less than 10 percent (AS3959, Table 2.3) Landscape dominated by spinifex grasses, with occasional (foliage cover less than 10 percent) low shrubs. Some locations with scattered trees and larger shrubs.	
Class C - Shrubland Shrubs <2m high; greater than 30 percent foliage cover. Understoreys may contain grasses. (AS3959, Table 2.3) Landscape dominated by spinifex grasses, with varying density (greater than 10 percent, up to 40 percent in some areas) of low shrubs. Some locations with scattered trees and larger shrubs.	

LEGEND

- Assessment Point
- Local Road
- Investigation Area
- Bushfire Hazard Level Assessment Area

Vegetation Classification

- Class C - Shrubland
- Class G - Grassland

Paper Size A3

0 200 400 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

Shire of Ashburton
reef to range

Shire of Ashburton
Ashburton Bushfire Hazard
Level Assessment

Onslow
Vegetation Classes

Job Number	61-36178
Revision	A
Date	09 Aug 2017

Figure 4

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Data source: GHD: Survey Boundary, Vegetation Assessment, Photo Point - 20170809; Landgate: Imagery, Roads - 20170801; . Created by:krawlinson

2.2.2 Bushfire hazard level mapping

Bushfire hazard level in Onslow is predominantly influenced by vegetation classification; however there are small areas across the townsite where a slope greater than 10 degrees influences hazard level.

Figure 5 provides the modelled bushfire hazard level for Onslow Townsite. The townsite is located within a landscape reflecting a moderate bushfire hazard that will influence areas of development abutting areas of remnant vegetation.

The bushfire hazard level assessment methodology set out in the Planning in Bushfire Prone Areas Guidelines is a very broad-brush definition of hazard levels, and the actual hazard and anticipated bushfire behaviours based on vegetation characteristics within the defined hazard levels may vary.

In line with the bushfire hazard level assessment methodology, any areas within 100 metres of vegetation classified as a moderate or extreme level have been mapped as moderate. This takes into account radiant heat and ember attack that would be experienced by development in close proximity to bushfire prone vegetation. In line with AS3959, any development within 100 metres of most vegetation types is anticipated to experience some level of radiant heat and ember attack. However, for lower threat/intensity vegetation classes – in particular the grassland and low shrubland vegetation classes identified in Onslow – 100 metres is likely to be overstating the actual hazard. AS3959 identifies development at a distance greater than 50 metres from these low threat vegetation classes as BAL-LOW, meaning there is insufficient risk to warrant specific bushfire requirements beyond 50 metres from the lower level bushfire prone vegetation.

The specific nature of the low shrubland and spinifex grassland areas in and around Onslow will have similar fuel loads and fire behaviour (wind driven), despite being classified as separate classes according to Table 2.3 in AS3959. As a result, whilst shrubland areas are classified as Class C in this assessment on the basis of a shrub overstorey in excess of ten percent, these low shrublands would exhibit similar fire behaviour to grassland types, and are more aligned with the grassland assumptions set out in the detail of AS3959. This does not influence the determination of bushfire hazard (as both vegetation classes reflect a moderate hazard level) however should be considered in any future site level assessments undertaken in response to detailed bushfire risk and exposure.

LEGEND

- Local Road
- Bushfire Hazard Level Assessment Area
- Investigation Area

Bushfire Hazard Level

- Low
- Moderate
- Extreme

Paper Size A3

0 200 400 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

Shire of Ashburton
Ashburton Bushfire Hazard Level Assessment

Onslow
Bushfire Hazard Level Assessment

Job Number 61-36178
Revision B
Date 09 Aug 2017

Figure 5

G:\61\36178\GIS\Maps\Working\6136178_006_Onslow_BHLA_A3P_RevB.mxd

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Data source: GHD: Survey Boundary - 20170809; Landgate: Imagery, Roads, Bushfire Prone Areas - 20170801; . Created by:krawlinson

2.3 Tom Price

2.3.1 Vegetation classification

Vegetation within Tom Price reflects grassland and low shrubland vegetation classes, with increasing density and height of vegetation occurring with wetter conditions along drainage lines. This generates ribbons of scrub and open woodland, with small pockets of forest where the scrub understorey occurs with larger trees along the river.

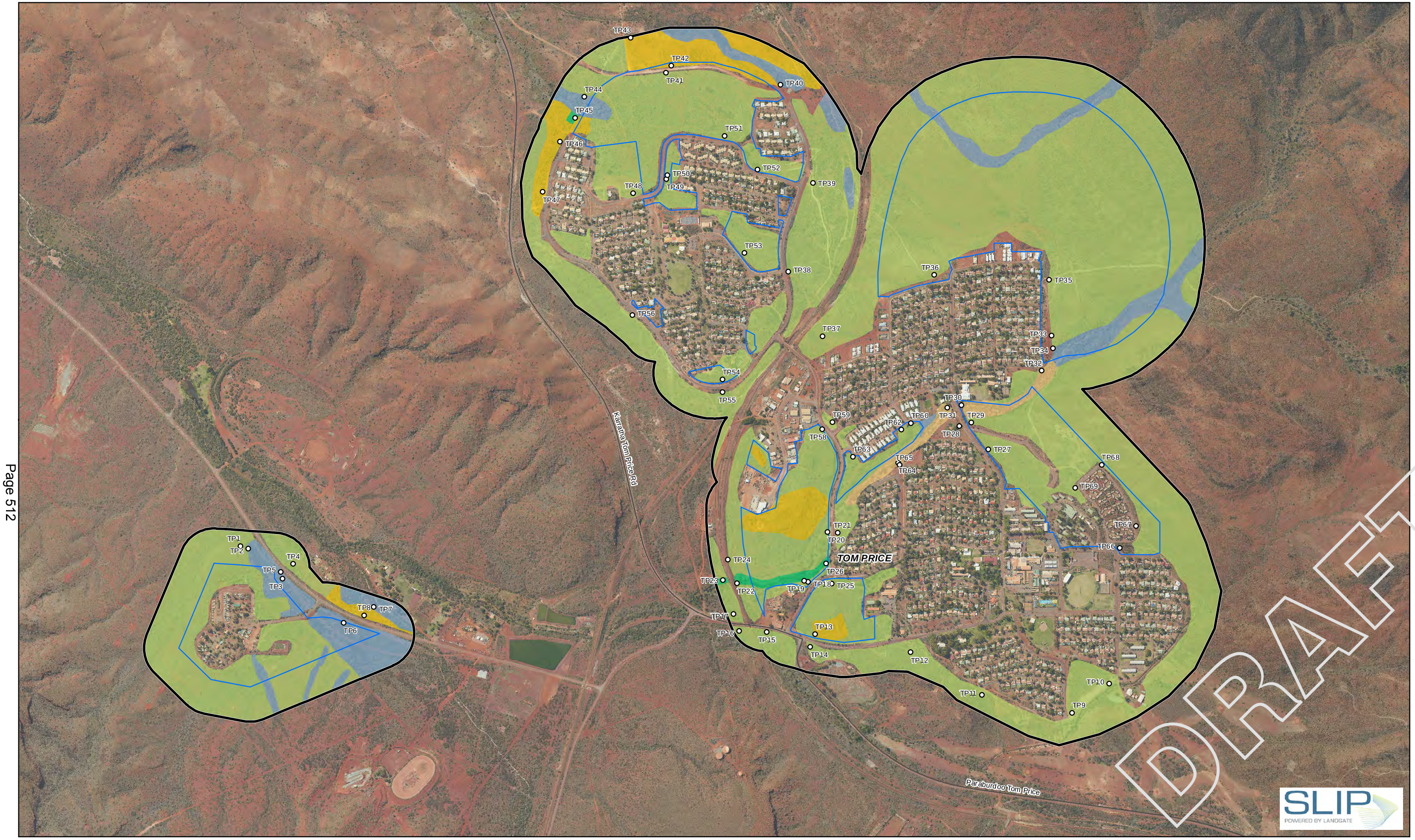
Table 2 describes the vegetation classes that occur in the area. Figure 6 illustrates the distribution of vegetation classes across the bushfire hazard level assessment area. Appendix A provides field observations and identification of vegetation class for 69 site locations assessed across Tom Price.

Table 2 Vegetation Classes – Tom Price Townsite

Vegetation class	Representative photo
Class G - Grassland All grassland forms, including situations with shrubs and trees, if the overstorey foliage cover is less than 10 percent (AS3959, Table 2.3) Landscape dominated by spinifex grasses, with occasional (foliage cover less than 10 percent) low shrubs. Some locations with scattered trees and larger shrubs.	
Class C - Shrubland Shrubs <2m high; greater than 30 percent foliage cover. Understoreys may contain grasses. (AS3959, Table 2.3) Landscape dominated by spinifex grasses, with varying density (greater than 10 percent, up to 40 percent in some areas) of low shrubs. Some locations with scattered trees and larger shrubs.	

Vegetation class	Representative photo
Class D - Scrub Shrubs greater than 2 m high; 10-30% foliage cover with a mixed species composition (AS3959, Table 2.3) Taller shrublands, with foliage cover of 15 to 20% over grasses. Associated with greater water availability in and around drainage lines and watercourses.	
Class B - Woodland Open Woodland B-06 Trees 10-30 m high; 10-30% foliage cover dominated by eucalypts. (AS3959, Table 2.3). Linear areas of trees over a highly degraded, grassland understorey. Foliage cover ~10%. Associated with watercourse areas.	

Vegetation class	Representative photo
Class A – Forest Open Forest A-03 Trees 10-30m high: 30-70% foliage cover (may include understorey of low trees and tall shrubs or grass) (AS3959, Table 2.3) Linear areas with trees over a multi-tiered understory of shrubs, grass and reeds. Associated with river.	



Paper Size A3

0 150 300 600

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

LEGEND

- Assessment Point
- State Road
- Investigation Area
- Bushfire Hazard Level Assessment Area

Vegetation Classification

- Class A - Forest
- Class B - Woodland, Open Woodland (06)
- Class C - Shrubland
- Class D - Scrub
- Class G - Grassland

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Shire of Ashburton
Ashburton Bushfire Hazard Level Assessment

Tom Price Vegetation Classes

Job Number 61-36178
Revision B
Date 09 Aug 2017

Figure 6

ATTACHMENT 14.1

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Data source: GHD: Survey Boundary, Vegetation Assessment - 20170809; Landgate: Imagery, Roads - 20170801; . Created by:krawlinson

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2.3.2 Bushfire hazard level

Bushfire hazard level in Tom Price is influenced by vegetation classification. Figure 7 provides the modelled bushfire hazard level for Tom Price.

The townsite is located within a landscape reflecting, in general, a moderate bushfire hazard that will influence development abutting remnant vegetation. Smaller areas of extreme hazard occur as a result of more intense vegetation types and areas of higher slope.

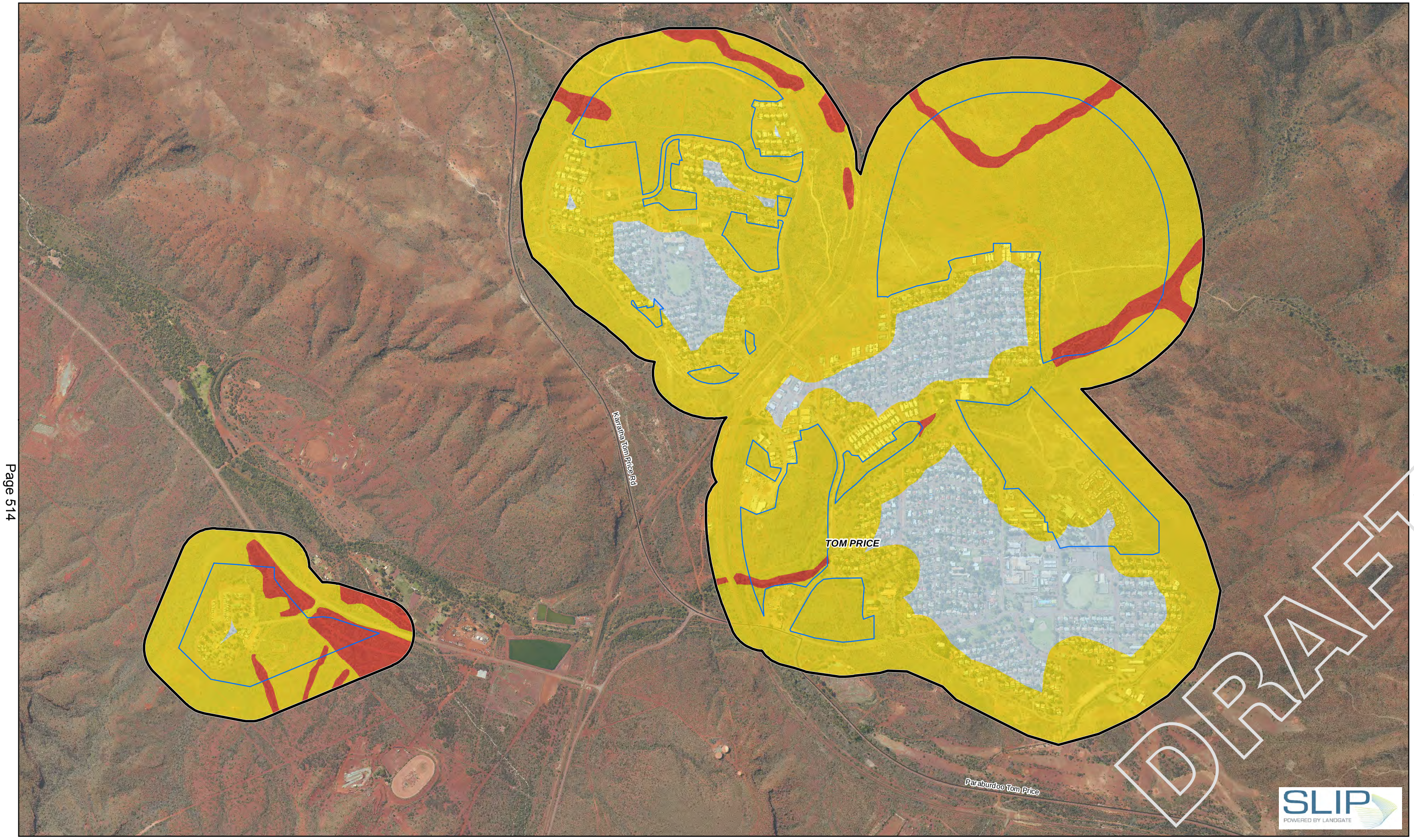
The bushfire hazard level assessment methodology set out in the Planning in Bushfire Prone Areas Guidelines is a very broad-brush definition of hazard levels, and the actual hazard and anticipated bushfire behaviours based on vegetation classifications within the defined hazard levels may vary.

Areas of extreme hazard mapped through and near the townsite result from increased density and height of vegetation with watercourses and drainage lines. Being restricted to narrow areas associated with watercourses, the extent of these scrub, woodland and forest areas would be insufficient to generate the maximum fire behaviour generated by AS3959 modelling assumptions, and therefore will not result in the fire behaviour expected of larger, contiguous areas of those vegetation classes. Whilst mapped as extreme in line with the bushfire hazard level assessment methodology, the ribbons of extreme hazard are not of a spatial extent that would generate that risk in reality.

In line with the bushfire hazard level assessment methodology, any areas within 100 metres of vegetation classified as a moderate or extreme level have been mapped as moderate. This requirement takes into account radiant heat and ember attack that would be experienced by development in close proximity to bushfire prone vegetation. In line with AS3959, any development within 100 metres of most vegetation types is anticipated to experience some level of radiant heat and ember attack. However, for lower threat/intensity vegetation classes – in particular the grassland and low shrubland vegetation classes identified in Tom Price – 100 metres is likely to be overstating the actual hazard. AS3959 identifies development at a distance greater than 50 metres from these low threat vegetation classes as BAL-LOW, meaning there is insufficient risk to warrant specific bushfire requirements beyond 50 metres from the lower level bushfire prone vegetation.

The specific nature of the low shrubland and spinifex grassland areas in and around Tom Price will have similar fuel loads and fire behaviour (wind driven), despite being classified as separate classes according to Table 2.3 in AS3959. As a result, whilst low shrubland areas are classified as Class C in this assessment on the basis of a shrub overstorey in excess of ten percent, these low shrublands would exhibit similar fire behaviour to grassland types, and are more aligned with the grassland assumptions set out in the detail of AS3959. This does not influence the determination of bushfire hazard (as both vegetation classes reflect a moderate hazard) however should be considered in any future site level assessments undertaken in response to detailed bushfire risk and exposure.

Any areas of extreme bushfire hazard within investigation areas are anticipated to be cleared to facilitate development.



Paper Size A3

0 150 300 600

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

LEGEND

- State Road
- Investigation Area
- Survey Area

Bushfire Hazard Level

- Low
- Moderate
- Extreme

Shire of Ashburton
Ashburton Bushfire Hazard Level Assessment

Tom Price
Bushfire Hazard Level Assessment

Job Number	61-36178
Revision	B
Date	09 Aug 2017

Figure 7

ATTACHMENT 14.1

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2.4 Paraburdoo

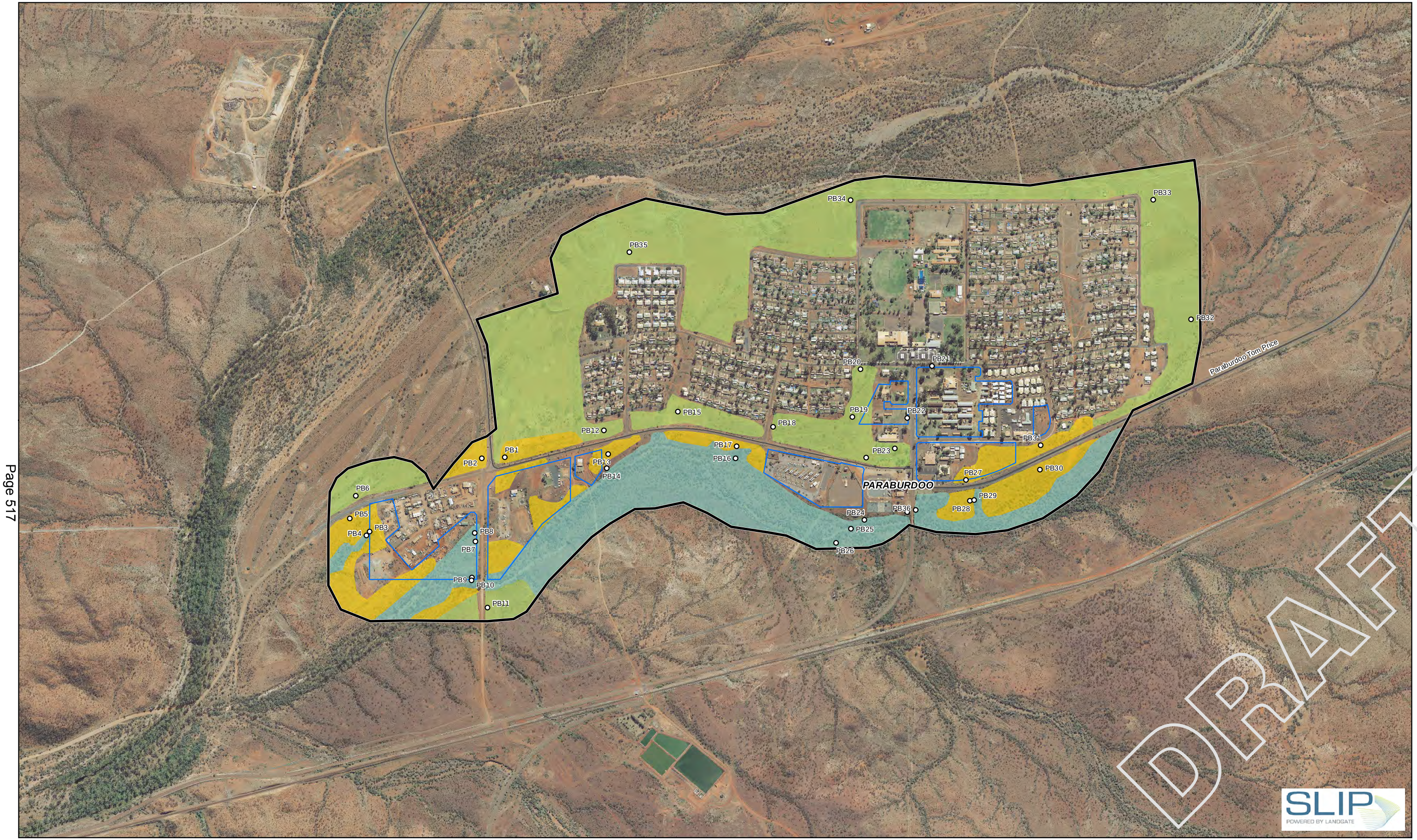
2.4.1 Vegetation classification

Vegetation across the Paraburdoo bushfire hazard level assessment area reflects grassland and shrubland vegetation classifications described in AS3959, with areas of low woodland associated with a drainage line to the south of the town. Table 3 describes the vegetation classes that occur in the area. Figure 8 illustrates the distribution of vegetation classes across the bushfire hazard level assessment area. Appendix A provides field observations and identification of vegetation class for 38 site assessment points.

Table 3 Vegetation Classes – Paraburdoo Townsite

Vegetation class	Representative photo
Class G - Grassland All grassland forms, including situations with shrubs and trees, if the overstorey foliage cover is less than 10 percent (AS3959, Table 2.3) Landscape dominated by spinifex grasses, with occasional (foliage cover less than 10 percent) low shrubs. Some locations with scattered trees and larger shrubs.	
Class C - Shrubland Shrubs <2m high; greater than 30 percent foliage cover. Understoreys may contain grasses. (AS3959, Table 2.3) Landscape characterised by spinifex grasses, with varying density (greater than 10 percent, up to 40 percent in some areas) of low shrubs. Some locations with scattered trees and larger shrubs.	

Vegetation class	Representative photo
Class B - Woodland Low Woodland B-07 Low trees and shrubs 2-10 m higher. Often have a grassy understorey or low shrubs (AS3959, Table 2.3). Low trees (5 to 8 metres) over grassland and low shrubland in areas associated with watercourse/drainage line to the south of Paraburdoo.	



Paper Size A3

0 125 250 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

LEGEND

- Assessment Point
- State Road
- Investigation Area
- Bushfire Hazard Level Assessment Area

Vegetation Classification

- Class B - Woodland, Low Woodland (07)
- Class C - Shrubland
- Class G - Grassland

GHD

Shire of Ashburton

Shire of Ashburton
Ashburton Bushfire Hazard Level Assessment

Paraburdoo Vegetation Classes

Job Number	61-36178
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Date	09 Aug 2017

Figure 8

ATTACHMENT 14.1

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Data source: GHD: Survey Boundary, Vegetation Assessment - 20170809; Landgate: Imagery, Roads - 20170801; . Created by:krawlinson

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2.4.2 Bushfire hazard level

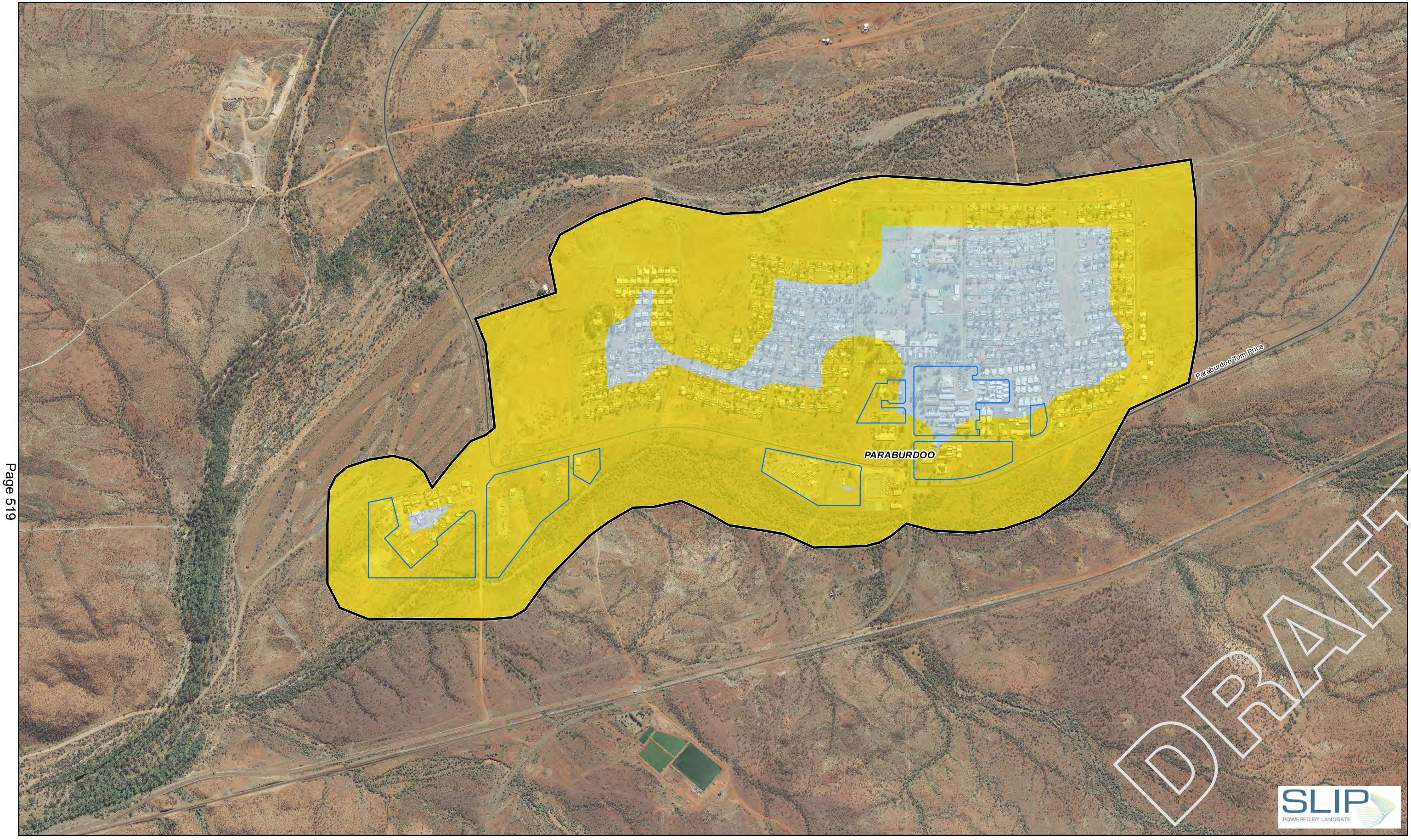
Bushfire hazard level in Paraburdoo is solely influenced by vegetation classification. Figure 9 provides the modelled bushfire hazard level for Paraburdoo Townsite.

The townsite is located within a landscape reflecting a moderate bushfire hazard that will influence development abutting remnant vegetation.

The bushfire hazard level assessment methodology set out in the Planning in Bushfire Prone Areas Guidelines is a very broad-brush definition of hazard levels, and the actual hazard and anticipated bushfire behaviours based on vegetation classifications within the defined hazard levels may vary.

In line with the bushfire hazard level assessment methodology, any areas within 100 metres of vegetation classified as a moderate or extreme level have been mapped as moderate. This requirement takes into account radiant heat and ember attack that would be experienced by development in close proximity to bushfire prone vegetation. In line with AS3959, any development within 100 metres of most vegetation types is anticipated to experience some level of radiant heat and ember attack. However, for areas adjacent to lower threat/intensity vegetation classes – in particular the grassland and low shrubland vegetation classes identified around Paraburdoo – 100 metres is likely to be overstating the actual hazard. AS3959 identifies development at a distance greater than 50 metres from these low threat vegetation classes as BAL-LOW, meaning there is insufficient risk to warrant specific bushfire requirements beyond 50 metres from the lower level bushfire prone vegetation.

The specific nature of the low shrubland and spinifex grassland areas in and around Paraburdoo will have similar fuel loads and fire behaviour (wind driven), despite being classified as separate classes according to Table 2.3 in AS3959. As a result, whilst shrubland areas are classified as Class C in this assessment on the basis of a shrub overstorey in excess of ten percent, these low shrublands would exhibit similar fire behaviour to grassland types, and are more aligned with the grassland assumptions set out in the detail of AS3959. This does not influence the determination of bushfire hazard (as both vegetation classes reflect a moderate hazard level) however should be considered in any future site level assessments undertaken in response to detailed bushfire risk and exposure.



Paper Size A3

0 125 250 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

LEGEND

- State Road
- Investigation Area
- Survey Area

Bushfire Hazard Level

- Low
- Moderate
- Extreme

Shire of Ashburton
Ashburton Bushfire Hazard Level Assessment

Paraburdoo
Bushfire Hazard Level Assessment

Job Number	61-36178
Revision	B
Date	09 Aug 2017

Figure 9

ATTACHMENT 14.1

G:\61\36178\GIS\Maps\Working\6136178_007_Veg_BHLA_A3L_RevB.mxd

Data source: GHD: Survey Boundary, Vegetation Assessment - 20170809; Landgate: Imagery, Roads - 20170801; . Created by:krawlinson

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3. Shire of Ashburton Local Planning Strategy

3.1 Compliance with bushfire protection criteria

The future development of investigation areas will result in a reduction of bushfire hazard level, as vegetation is cleared and replaced with low threat development. However, outer areas will continue to be influenced by bushfire risk from vegetation in the surrounding landscape. Future development will have to demonstrate compliance with bushfire protection criteria set out in technical appendices to the Guidelines for Planning in Bushfire Prone Areas (WAPC, 2015).

Bushfire protection criteria assist decision makers assess proposed bushfire risk management measures in strategic planning proposals, subdivisions, or development applications in bushfire prone areas. The criteria relate to four key elements: location, siting and design, vehicular access and water.

The specific performance principles and acceptable solutions for these elements are provided in Appendix B. The majority are matters for design at subsequent planning stages, and will be a component of investigating the suitability of areas for development through local structure plans. In the absence of design, it is not possible to assess these criteria at the level of a local planning strategy. In accordance with SPP 3.7 and associated bushfire planning guidelines, local structure plans and subdivision applications will be assessed against the bushfire protection criteria, and design will need to meet the acceptable solutions, or provide an alternative solution in response to the performance principles. This would be undertaken within the preparation of a bushfire management plan, informed by a more detailed, site specific investigation of bushfire exposure, such as bushfire attack level (BAL) contour maps.

Table 4 presents the performance principles from the bushfire protection criteria, and identifies the expectation for future development in meeting the criteria in later planning proposals.

Generally, based on a moderate bushfire hazard level and the nature of vegetation, all investigation and infill areas are considered capable of meeting the bushfire protection criteria with future design locating access and public open space to achieve access requirements and sufficient asset protection zones to any areas of residual bushfire risk. Provision of reticulated water will meet criteria regarding water supply. Additional care will be required in the detailed planning of some residential infill areas in Tom Price with extensions to the existing road network, and potentially additional managed open space, required in the southeast of town to ensure suitable access and asset protection zones.

Table 4 Compliance with Bushfire Protection Criteria

Element	Location	Siting and design of development	Vehicular access	Water
	The strategic planning proposal, subdivision and development application is located in an area where the bushfire hazard assessment is or will, on completion, be moderate or low, or a BAL–29 or below, and the risk can be managed. For unavoidable development in areas where BAL–40 or BAL–FZ applies, demonstrating that the risk can be managed to the satisfaction of the Department of Fire and Emergency Services and the decision-maker.	The siting and design of the strategic planning proposal, subdivision or development application, including roads, paths and landscaping, is appropriate to the level of bushfire threat that applies to the site. That it incorporates a defendable space and significantly reduces the heat intensities at the building surface thereby minimising the bushfire risk to people, property and infrastructure, including compliance with AS 3959 if appropriate.	The internal layout, design and construction of public and private vehicular access and egress in the subdivision/ development allow emergency and other vehicles to move through it easily and safely at all times.	The subdivision, development or land use is provided with a permanent and secure water supply that is sufficient for firefighting purposes.
Onslow				
Urban Investigation Areas	Expected to meet the criteria. Current BHL is moderate.	Should meet the criteria depending upon the design.	Should meet the criteria depending upon the design.	Expected to meet the criteria.
Transient Worker Accommodation & Short Stay Accommodation	Expected to meet the criteria. Current BHL is moderate.	Should meet the criteria depending upon the design.	Should meet the criteria depending upon the design.	Expected to meet the criteria.
Future Industry / Mixed Business	Expected to meet the criteria. Current BHL is moderate.	Should meet the criteria depending upon the design.	Should meet the criteria depending upon the design.	Expected to meet the criteria.
Tom Price				
Urban Investigation Areas	Expected to meet the criteria. Current BHL is moderate.	Should meet the criteria depending upon the design.	Should meet the criteria depending upon the design.	Expected to meet the criteria.
Residential Infill Areas	Expected to meet the criteria. Current BHL is moderate.	May meet the criteria subject to further investigation and design.	May meet the criteria subject to further investigation and design.	Expected to meet the criteria.
Transient Worker Accommodation & Short Stay Accommodation	Should meet the criteria depending upon the design. Some areas of extreme hazard are located in this area, however are likely to be cleared to facilitate development.	Should meet the criteria depending upon the design.	Should meet the criteria depending upon the design.	Expected to meet the criteria.
Future Industry / Mixed Business	Should meet the criteria depending upon the design. Some areas of extreme hazard are located in this area, however are likely to be cleared to facilitate development.	Should meet the criteria depending upon the design.	Should meet the criteria depending upon the design.	Expected to meet the criteria.
Paraburdoo				
Urban Investigation Areas	Expected to meet the criteria. Current BHL is moderate.	Expected to meet the criteria.	Expected to meet the criteria.	Expected to meet the criteria.
Transient Worker Accommodation & Short Stay Accommodation	Expected to meet the criteria. Current BHL is moderate.	Should meet the criteria depending upon the design.	Should meet the criteria depending upon the design.	Expected to meet the criteria.
Future Industry / Mixed Business	Expected to meet the criteria. Current BHL is moderate.	Should meet the criteria depending upon the design.	Should meet the criteria depending upon the design.	Expected to meet the criteria.

3.2 Recommended strategies and actions

Table 5 presents the draft planning strategies and actions set out in the draft Shire of Ashburton Local Planning Strategy. These have been reviewed in line with the bushfire hazard level assessment.

Table 5 Bushfire strategies and actions from draft Local Planning Strategy

Strategies	Actions
Bush Fire Risk 1. **Promote the appropriate management of bush fire risks to Townsites and Aboriginal communities.** 2. **Promote appropriate management of bush fire risks to remote camps, tourism sites and pastoral homesteads.** 3. **Identify improvements to the road network to ensure that vehicle access and egress is available and safe during a bushfire event.**	**Bush Fire Risk** 1. Ensure future planning and development within Bush Fire Prone Areas meets the requirements of State Planning Policy 3.7: *Planning in Bushfire Prone Areas* and the *Guidelines for Planning in Bushfire Prone Areas*. 2. For existing developed areas that have an extreme BHL, implement risk management measures that help reduce the risk to 'low' to 'moderate'.
	3. Prior to rezoning land identified for a future change in use or intensification of use/ development, a BHL assessment shall be undertaken and, where there are areas identified as 'moderate' to 'extreme', a Bushfire Management Plan shall also be prepared. 4. Consider the location of fire service access routes in semi-rural areas around townsites and emergency management.

In line with this bushfire hazard level assessment, some modifications to the draft actions are appropriate to better reflect the hazard levels determined.

Action 1 is an appropriate planning response to the bushfire hazard in the key townsites. The role of a local planning strategy is to provide an effective local planning framework to address key issues in local planning processes and decisions. The state policy framework regarding bushfire risk is very well developed, and applies clearly to local planning applications and decisions. Therefore, the Shire of Ashburton Local Planning Strategy does not require additional policy response to address bushfire risk, as it is adequately dealt with by the existing policy framework. Whilst this bushfire hazard level assessment has modelled bushfire hazard in some areas outside the bushfire prone area mapping, development controls set out in the state planning framework should only be applied to areas within the designated bushfire prone area. In some instances, the bushfire hazard level assessment methodology results in a defined hazard level that overstates the actual bushfire hazard for developed areas within Onslow, Tom Price and Paraburdoo. It would be unnecessary and onerous to apply the policy framework to areas outside the designated bushfire prone areas, even if this assessment has mapped a moderate bushfire hazard level for the land.

With respect of Action 2, no existing developed areas were identified as having an extreme bushfire hazard level, although some areas in Tom Price are located near to small areas of extreme hazard. The spatial extent and small size of the mapped extreme hazard areas means that, in reality, the overall hazard presented to existing development is likely to be of a moderate level. Therefore, Action 2 may not be necessary in the local planning strategy. Overall bushfire risk to existing development in the townsites should be managed through ongoing fuel management activities, such as maintaining firebreaks and land management, and through continual review and updating of emergency management plans and procedures, including

planning for emergency and fire access. Any redevelopment of these areas would consider risk in accordance with SPP3.7 and deemed provisions within the Shire of Ashburton Local Planning Scheme.

Action 3 may be considered redundant, as the bushfire hazard level assessment has been undertaken. It would be beneficial, instead, to confirm the need for more detailed understanding of likely bushfire exposure for individual development areas. In line with SPP3.7, structure plans for investigation areas should develop a bushfire attack level (BAL) contour map – taking into account areas to be cleared for development, locations of future roads and open spaces. This will determine the residual bushfire exposure risk to future development, enable detailed consideration of the bushfire protection criteria, and identify the need for any future construction standards in line with AS3959.

Action 4 presents an appropriate recommendation to enhance emergency access in semi-rural areas, however it is not clear as to what the mechanism for this action would be. It is recommended that a specific mechanism – such as an emergency management plan – be identified to more clearly articulate the project necessary for delivery to achieve the desired action.

4. Conclusion

Potential townsite expansion areas in Tom Price, Paraburdoo and Onslow are influenced, for the most part, by a moderate bushfire hazard level. Whilst pockets of extreme hazard level were modelled and mapped within Tom Price, the small size and spatial extent of these areas makes it unlikely that they would present an extreme hazard in reality. The moderate hazard influencing the towns will have implications for future planning.

Assessment of the urban investigation and infill areas against the relevant bushfire protection criteria of the Planning in Bushfire Prone areas Guidelines suggests that, subject to design, these areas can be developed in accordance with the requirements of State Planning Policy 3.7, the guidelines, and all supporting appendices. Subsequent strategic planning for the expansion areas will need to consider appropriate services provision, vehicular access, and site design to meet state policy requirements.

Appendices

Appendix A – Draft Strategy Plans

LEGEND

- Paraburdoo Townsite Boundary
- Urban
- Commercial
- Industry
- Community / Public Purpose
- Rural
- Landscape
- Public Open Space
- Railway

INVESTIGATION AREAS

- Urban Investigation Areas
- Transient Worker Accomodation & Short Stay Accomodation
- Future Industry / Mixed Business

- District Road
- Neighbourhood Road
- Residential Infill Areas
- Town Centre
- Tourism
- Caravan Park

PLAN 3 TOM PRICE TOWN SITE STRATEGY PLAN

Local Planning Strategy

A Shire of Ashbuton Project

DRAFT

0m 75 150 225m

s: 1:15.000@A3
d: 28th April 2017
p: 16/028/013B

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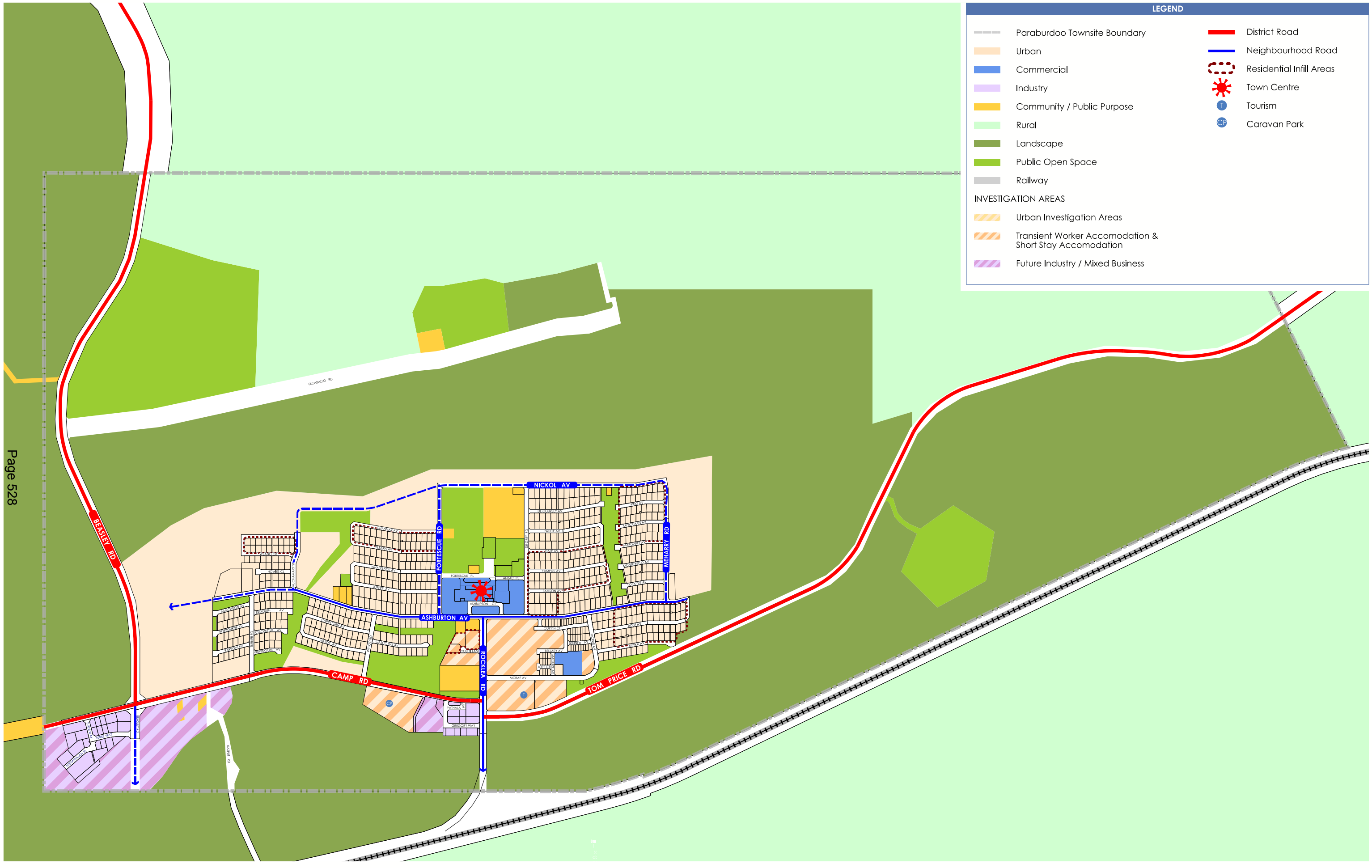

PLAN 4 PARABURDOO TOWN SITE STRATEGY PLAN

Local Planning Strategy

A Shire of Ashburton Project

DRAFT

0m 75 150 225m

s: 1:15.000@A3
d: 28th April 2017
p: 16/028/013B

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Onslow Salt Jetty

Beadon Bay

Bindi Bindi Community

BACK BEACH RD

SIMPSON ST

ONSLOW ROAD

SEAVIEW DRIVE

MCGRATH AV

SECOND AV

BEADON CREEK AV

EAGLENEST RD

McAULLAY RD

Beadon Creek Boat Harbour

Beadon Creek

Onslow Airport

Horse Agistment Investigation Area

LEGEND

- Onslow Townsite Boundary
- Urban
- Commercial
- Mixed Business
- Rural
- Industry
- Strategic Industry
- Community / Public Purpose
- Landscape
- Public Open Space
- Railway
- Waterways

INVESTIGATIONS AREAS

- Urban Investigation Areas
- Transient Worker Accomodation & Short Stay Accomodation
- Future Industry / Mixed Business

- District Road
- Neighbourhood Road
- Future Neighbourhood Road
- Town Centre
- Long-term options for strategic townsite coastal hazard adaptation and consideration of relocation of uses/development
- Tourism
- Caravan Park
- Future School Site (Indicative)

Buffers

- Waste Water Treatment Plant Buffer

PLAN 2 ONSLOW TOWNSITE STRATEGY PLAN

Local Planning Strategy

A Shire of Ashburton Project

DRAFT

0m 100 200m

s: 1:15,000@A3
d: 28th April 2017
p: 16/028/013B

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Appendix B – Field observations

PPOINT_ID	VEG_CLASS	NOTES
Onslow1	G	E facing photo, 85% cover, no foliage
Onslow2	C	PO - S; H = <1.0m; GC = 20%; Other: some grass, salt marsh
Onslow3	C	1. PO - SE; 2. Shrubs (saltbush) with grass - 40% saltbush foliage, 3. Grass, 4. <0.8m
Onslow4	G	1. Photo facing- NW, 2. Dominant veg - Grass, 3. Ground cover = 90% grass 10% shrub, 4. Foliage cover = <10%, 5. Dominant height = <1.0m
Onslow5	G	1. Photo facing- SW, 2. Dominant veg - Grass, 3. Ground cover = 70% grass 5% shrub 25% soil, 4. Foliage cover = <5%, 5. Dominant height = <1.0m
Onslow6	G	1. Photo facing- N, 2. Dominant veg - Grass, 3. Ground cover = 80% grass 5% shrub 1¡5% soil, 4. Foliage cover = <5%, 5. Dominant height = <1.0m
Onslow7	G	1. Photo facing- ESE, 2. Dominant veg - Grass, 3. Ground cover = 75% grass 5% shrub 20% soil, 4. Foliage cover = <5%, 5. Dominant height = <1.0m
Onslow8	G	1. Photo facing- NW, 2. Dominant veg - Grass, 3. Ground cover = 85% grass 5% shrub 10% soil, 4. Foliage cover = <5%, 5. Dominant height = <1.0m
Onslow9	G	1. Photo facing- E, 2. Dominant veg - Grass, 3. Ground cover = 85% grass 5% shrub 10% soil, 4. Foliage cover = <5%, 5. Dominant height = <1.0m
Onslow10	C	1. Photo facing- S, 2. Dominant veg - Scrub, 3. Ground cover = 5% shrub 95% soil, 4. Foliage cover = <5%, 5. Dominant height = <0.5m
Onslow11	G	1. Photo facing- ENE, 2. Dominant veg - Grass, 3. Ground cover = 85% grass 5% shrub 10% soil, 4. Foliage cover = <5%, 5. Dominant height = <1.0m
Onslow12	G	1. Photo facing- ESE, 2. Dominant veg - Grass, 3. Ground cover = 70% grass 10% shrub 20% soil, 4. Foliage cover = 5-10%, 5. Dominant height = <1.0m
Onslow13	C	1. Photo facing- NE, 2. Dominant veg - Shrubs, 3. Ground cover = 25% shrub <5 tree 70% soil, 4. Foliage cover = <25%, 5. Dominant height = 1.0-1.5m
Onslow14	G	1. Photo facing- W, 2. Dominant veg - Grass, 3. Ground cover = 65% grass 15% shrub 20% soil, 4. Foliage cover = 10-15%, 5. Dominant height = <1.0m
Onslow15	G	1. Photo facing- NNE, 2. Dominant veg - Grass, 3. Ground cover = 60% grass 20% shrub 20% soil, 4. Foliage cover = 20%, 5. Dominant height = <1.0m
Onslow16	G	1. Photo facing- SE, 2. Dominant veg - Grass, 3. Ground cover = 10% grass 15% shrub 15% soil, 4. Foliage cover = 20%, 5. Dominant height = <1.0m
Onslow17	G	1. Photo facing- NW, 2. Dominant veg - Grass, 3. Ground cover = 45% grass 10% shrub 45% soil, 4. Foliage cover = 10%, 5. Dominant height = <1.0m
Onslow18	G	1. Photo facing- NW, 2. Dominant veg - Grass, 3. Ground cover = 35% grass 25% shrub 40% soil, 4. Foliage cover = 25%, 5. Dominant height = <1.0m
Onslow19	G	1. Photo facing- NE, 2. Dominant veg - Grass, 3. Ground cover = 35% grass 20% shrub/tree 45% soil, 4. Foliage cover = 15%, 5. Dominant height = <1.0m
Onslow20	G	1. Photo facing- SSE, 2. Dominant veg - Grass, 3. Ground cover = 55% grass 10% shrub 35% soil, 4. Foliage cover = 5-10%, 5. Dominant height = <1.0m
Onslow21	G	1. Photo facing- NW, 2. Dominant veg - Grass, 3. Ground cover = 40% grass 5% shrub 55% soil, 4. Foliage cover = <5%, 5. Dominant height = <0.5m
Onslow22	G	1. Photo facing- NW, 2. Dominant veg - Grass, 3. Ground cover = 45% grass 15% shrub 40% soil, 4. Foliage cover = 10-15%, 5. Dominant height = <1.0m
Onslow23	O	1. Photo facing - SSE. Now developed
Onslow24	G	1. Facing- ESE, 2. Dominant veg - Grass, 3. GC = 55% grass 20% shrub & tree 25% soil, 4. Foliage cover = 20% (in gully), 5. Dominant height = <1.0m

PPOINT_ID	VEG_CLASS	NOTES
Onslow25	G	1. Photo facing- S, 2. Dominant veg - Grass, 3. Ground cover = 85% grass 5% shrub 10% soil, 4. Foliage cover = 5%, 5. Dominant height = <1.0m
Onslow26	C	1. Photo facing- WSW, 2. Dominant veg - Shrubs, 3. Ground cover = 40% shrubs 10% grass 50% soil, 4. Foliage cover = 30%, 5. Dominant height = <1.0m
Onslow27	C	1. Photo facing- SSW, 2. Dominant veg - Shrubs, 3. Ground cover = 40% grass 35% shrub 25% soil, 4. Foliage cover = 30-40%, 5. Dominant height = 1.5m
Onslow28	G	1. Photo facing- SSW, 2. Dominant veg - Grass, 3. Ground cover = 45% grass 15% shrub 40% soil, 4. Foliage cover = 10-15%, 5. Dominant height = <1.0m
Onslow29	C	1. Photo facing- W, 2. Dominant veg - Shrubs, 3. Ground cover = 25% shrub 10% Grass 65% soil, 4. Foliage cover = 20%, 5. Dominant height = <1.0m
Onslow30	G	1. Photo facing- NE, 2. Dominant veg - Grass, 3. Ground cover = 70% grass 10% shrub 20% soil, 4. Foliage cover = 10%, 5. Dominant height = <1.0m
Onslow30	G	1. Photo facing- N, 2. Dominant veg - Grass, 3. Ground cover = 85% grass 5% shrub 10% soil, 4. Foliage cover = 5%, 5. Dominant height = <0.5m
Onslow31	G	1. Photo facing- NNE, 2. Dominant veg - Grass, 3. Ground cover = 65% grass 15% shrub 20% soil, 4. Foliage cover = 15%, 5. Dominant height = <1.0m
Onslow32	G	1. Photo facing- NE, 2. Dominant veg - Grass, 3. Ground cover = 45% grass 20% shrub 35% soil, 4. Foliage cover = 15-20%, 5. Dominant height = <1.0m
Onslow33	G	1. Photo facing- NW, 2. Dominant veg - Grass, 3. Ground cover = 90% grass 5% shrub 5% soil, 4. Foliage cover = 5%, 5. Dominant height = <0.5m
Onslow34	G	1. Facing - SW, 2. Dominant veg - Grass, 3. Ground cover = 80% grass 10% shrub & tree 10% soil, 4. Foliage cover = 10%, 5. Dominant height = <1.0m
Onslow35	G	1. Photo facing- ESE, 2. Dominant veg - Grass, 3. Ground cover = 40% grass 15% shrub 45% soil, 4. Foliage cover = 10-15%, 5. Dominant height = <1.0m
Onslow36	G	1. Photo facing- NNE, 2. Dominant veg - Grass, 3. Ground cover = 45% grass 10% shrub 45% soil, 4. Foliage cover = 10%, 5. Dominant height = <1.0m
Onslow37	G	1. Photo facing- SW, 2. Dominant veg - Grass, 3. Ground cover = 55% grass 5% shrub 40% soil, 4. Foliage cover = 5%, 5. Dominant height = <1.0m
Onslow38	G	1. Photo facing- NNW, 2. Dominant veg - Grass, 3. Ground cover = 75% grass 15% shrub 10% soil, 4. Foliage cover = 10-15%, 5. Dominant height = <1.0m
Onslow39	G	1. Photo facing- NNE, 2. Dominant veg - Grass, 3. Ground cover = 40% grass 10% shrub 50% soil, 4. Foliage cover = 10%, 5. Dominant height = <1.0m
Onslow40	G	1. Photo facing- E, 2. Dominant veg - Grass, 3. Ground cover = 80% grass 10% shrub 10% soil, 4. Foliage cover = 10%, 5. Dominant height = <1.0m
Onslow41	G	Non-accessible. 1. PF - S to W, 2. DV - Grass, 3. GC = 45% grass 30% shrub 35% soil, 4. FC = 20-25%, 5. DH = <1.0m
Onslow42	G	1. PF - ESE, 2. DV - Grass, 3. GC = 50% grass 15% shrub 35% soil, 4. FC = 10%, 5. DH = <1.0m
Onslow43	G	1. PF - WSW, 2. DV - Grass, 3. GC = 45% grass 10% shrub 45% soil, 4. FC = 5-10%, 5. DH = <1.0m
Onslow44	C	1. PF - SE, 2. DV - Shrubs, 3. GC = 20% grass 25% shrub 55% soil, 4. FC = ~20%, 5. DH = <1.0m. Other - borderline grassland
Onslow45	C	1. PF - ESE, 2. DV - Grass, 3. GC = 40% grass 30% shrub 30% soil, 4. FC = ~25%, 5. DH = <1.0m. Other - borderline shrubland in places
PB1	C	1. PF - NNE, 2. DV - Shrubs, 3. GC = 35% grass 20% shrub 10% trees 35% soil, 4. FC = ~25%, 5. DH = 1.0-1.5m. Other - some shrub ~2.0m & trees >5m

PPOINT_ID	VEG_CLASS	NOTES
PB2	C	1. PF - NNW, 2. DV - Shrub, 3. GC = 15% grass 15% scrub 70% soil, 4. FC = 10%, 5. DH = <1.0m. Other - some shrub ~2.0m
PB3	C	1. PF - ESE, 2. DV - Shrub, 3. GC = 60% grass 15% scrub 35% soil, 4. FC = 10%, 5. DH = 1.0-1.5m. Other - some shrub ~2.0m
PB4	B	1. PF - SSE, 2. DV - Tree, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 20%, 5. DH = ~8.0m. Other - tree line along edge of polygon
PB5	C	1. PF - SW, 2. DV - Shrub, 3. GC = 25% grass 15% shrub 60% soil, 4. FC = 10%, 5. DH = 1.5-2m. Other - some shrub >2.0m
PB6	G	1. PF - N, 2. DV - Grass, 3. GC = 45% grass 5% shrub 50% soil, 4. FC = 5%, 5. DH = 1.5-2m. Other - some trees 5-10m
PB7	C	1. PF - W, 2. DV - Shrub, 3. GC = 20% grass 10% shrub 70% soil, 4. FC = 5-10%, 5. DH = 1.5m. Other - some shrub >2.0m
PB8	B	1. PF - WSW, 2. DV - Tree, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 15%, 5. DH = ~8.0m. Other - tree line along edge of polygon
PB9	B	1. PF - NW, 2. DV - Tree, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 20%, 5. DH = ~8.0m. Other - along river band, river bed sparse grass & shrub
PB10	B	1. PF - W, 2. DV - Tree, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 20%, 5. DH = ~8.0m. Other - along river band, river bed sparse grass & shrub
PB11	G	1. PF - E, 2. DV - Grass, 3. GC = 15% grass 10% shrub 75% soil, 4. FC = <5%, 5. DH = <0.5m. Other - looks previously cleared
PB12	G	1. PF - W, 2. DV - Grass, 3. GC = 50% grass 5% shrub 45% soil, 4. FC = 5%, 5. DH = 0.5m. Other - sparse shrub 1.5-4m occasional tree 10-15m
PB13	C	1. PF - SW, 2. DV - Shrub, 3. GC = 5% grass 15% shrub 80% soil, 4. FC = 5%, 5. DH = 1.5-2.0m. Other - sparse shrub 2.0-4.0m occasional tree 5-10m
PB14	B	1. PF - S, 2. DV - Tree, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 20%, 5. DH = 5m. Other - riverbank vegetation, some taller trees 10-15m
PB15	G	1. PF - NE, 2. DV - Grass, 3. GC = 40% grass 5% shrub 55% soil, 4. FC = 5%, 5. DH = 0.5m. Other - sparse shrub 1.5-4m occasional tree 10-15m
PB16	B	1. PF - SW, 2. DV - Tree, 3. GC = 50% grass 10% shrub 40% soil, 4. FC = 10%, 5. DH = ~8.0m.
PB17	O	Showing transition to woodland/scrub
PB18	G	1. PF - ENE, 2. DV - Grass, 3. GC = 40% grass 5% shrub 55% soil, 4. FC = 5%, 5. DH = 0.5m. Other - sparse shrub 1.5-4m occasional tree 10-15m
PB19	G	1. PF - NNW, 2. DV - Grass, 3. GC = 40% grass 5% shrub 55% soil, 4. FC = 5%, 5. DH = 0.5m. Other - sparse shrub 1.5-4m occasional tree 10-15m
PB19	G	1. PF - ESE, 2. DV - Grass, 3. GC = 35% grass 5% shrub 60% soil, 4. FC = 5%, 5. DH = 0.5m. Other - sparse shrub 1.5-4m occasional tree 10-15m
PB20	G	1. PF - SE, 2. DV - Grass, 3. GC = 35% grass 5% shrub 60% soil, 4. FC = 5%, 5. DH = 0.5m. Other - sparse shrub 1.5-4m occasional tree 10-15m
PB21	G	1. PF - SSE, 2. DV - Grass, 3. GC = 90% grass 10% soil, 4. FC = 5%, 5. DH = Occasional tree 10-20m, parkland
PB22	O	1. PF - W, 2. DV - Grass, 3. GC = 90% grass 10% soil, 4. FC = 5%, 5. DH = Occasional tree 10-20m, parkland
PB23	G	1. PF - SW, 2. DV - Grass, 3. GC = 45% grass 5% shrub 50% soil, 4. FC = 5%, 5. DH = 0.5m. Other - sparse shrub 1.5-4m occasional tree 10-15m
PB24	B	1. PF - WSW, 2. DV - Tree, 3. GC = 50% grass 10% shrub 40% soil, 4. FC = 20%, 5. DH = ~6.0m.
PB24	B	1. PF - SW, 2. DV - Tree, 3. GC = 45% grass 15% shrub 40% soil, 4. FC = 15%, 5. DH = ~8.0m.
PB25	B	Riverbed view - 5m post
PB26	B	1. PF - ENE, 2. DV - Tree, 3. GC = 45% grass 15% shrub 40% soil, 4. FC = 10%, 5. DH = ~5.0m.

PPOINT_ID	VEG_CLASS	NOTES
PB27	C	1. PF - NE, 2. DV - Shrub, 3. GC = 40% grass 15% shrub 45% soil, 4. FC = 5-10%, 5. DH = 1.5m. Other - scattered shrub 2.0m+ and trees 5m+
PB28	C	1. PF - SW, 2. DV - Shrub, 3. GC = 40% grass 20% shrub 40% soil, 4. FC = 5-10%, 5. DH = 1.5m. Other - some scattered shrub 2.0m+ and trees 5m+
PB29	B	1. PF - SS, 2. DV - Tree, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 20%, 5. DH = 10m+m. Other - follows drainage
PB30	C	1. PF - S, 2. DV - Shrub, 3. GC = 20% grass 25% shrub 55% soil, 4. FC = 15%, 5. DH = 1.5-2.0m. Other - some shrub 2.0m+ and trees 5m+
PB31	C	1. PF - NE, 2. DV - Shrub, 3. GC = 40% grass 15% shrub 45% soil, 4. FC = 5%, 5. DH = <0.5m. Other - some shrub 2.0m+ and trees 5m+, borderline grassl
PB32	G	1. PF - N, 2. DV - Grass, 3. GC = 50% grass 10% shrub 45% soil, 4. FC = 5%, 5. DH = <1.0m. Other - some shrub 2.0m+
PB33	C	1. PF - SE, 2. DV - Shrub, 3. GC = 25% grass 25% shrub 50% soil, 4. FC = 10%, 5. DH = <0.5m. Other - small shrub mostly, some shrub 2.0m+
PB34	G	1. PF - NNE, 2. DV - Grass, 3. GC = 45% grass 10% shrub 45% soil, 4. FC = 5%, 5. DH = <1.0m. Other - possible shrubland, some shrub 2.0m+
PB35	C	1. PF - SE, 2. DV - Shrub, 3. GC = 40% grass 20% shrub 40% soil, 4. FC = 10-15%, 5. DH = 1.0-1.5m. Other - some trees 2.0m+
PB36	B	1. PF - SE, 2. DV - Tree, 3. GC = 50% grass 10% shrub 40% soil, 4. FC = 20%, 5. DH = ~6.0m. Other - some trees 10m+
TP1	G	1. PF - SW, 2. DV - Grass, 3. GC = 45% grass 5% shrub 50% soil, 4. FC = 5%, 5. DH = 1.0m. Other - some shrub /trees 2-10m
TP2	D	1. PF - ESE, 2. DV - Scrub, 3. GC = 45% grass 5% shrub 50% soil, 4. FC = 30%, 5. DH = 7-8m. Other - some trees 10m+, follows roadside drainage
TP3	D	1. PF - W, 2. DV - Scrub, 3. GC = 50% grass 5% shrub 45% soil, 4. FC = 20%, 5. DH = 7-8m. Other - some trees up to 10m
TP4	G	1. PF - NNW, 2. DV - Grass, 3. GC = 55% grass 5% shrub 40% soil, 4. FC = 5%, 5. DH = 1.0m. Other - bordered by veg similar to TP3, previously cleared?
TP5	D	1. PF - NW, 2. DV - shrub, 3. GC = 50% grass 5% shrub 45% soil, 4. FC = 20%, 5. DH = ~5-6m. Other - typical roadside vegetation
TP6	D	1. PF - NW, 2. DV - shrub, 3. GC = 50% grass 5% shrub 45% soil, 4. FC = 15%, 5. DH = ~5-6m. Other - typical roadside vegetation
TP7	D	1. PF - E, 2. DV - shrub, 3. GC = 35% grass 10% shrub 55% soil, 4. FC = 15-20%, 5. DH = ~5-6m. Other - aligns waterway, woodland?
TP8	C	1. PF - SW, 2. DV - Shrub, 3. GC = 40% grass 30% shrub 30% soil, 4. FC = 30%, 5. DH = 2.0m. Other - dense roadside shrubland
TP9	G	1. PF - NE, 2. DV - Grass, 3. GC = 35% grass 5% shrub 60% soil, 4. FC = 5%, 5. DH = 0.5m. Other - sparse shrub 1.5-4m occasional tree 10-15m
TP10	G	1. PF - NE, 2. DV - Grass, 3. GC = 35% grass 5% shrub 60% soil, 4. FC = 5%, 5. DH = 0.5m. Other - sparse shrub 1.5-4m occasional tree 10-15m
TP11	G	1. PF - NW, 2. DV - Grass, 3. GC = 45% grass 5% shrub 50% soil, 4. FC = 5%, 5. DH = 1.0m. Other - some shrub/trees 2-10m
TP12	G	1. PF - NW, 2. DV - Grass, 3. GC = 45% grass 5% shrub 50% soil, 4. FC = 5%, 5. DH = 1.0m. Other - some scrub/trees 2-10m
TP13	D	1. PF - NW, 2. DV - Scrub, 3. GC = 45% grass 5% shrub 50% soil, 4. FC = 10%, 5. DH = ~7m. Other - trees 10m+
TP14	G	1. PF - NW, 2. DV - Grass, 3. GC = 60% grass 10% shrub 30% soil, 4. FC = 5%, 5. DH = 1.0m. Other - some scrub/trees 2-10m, bordered by scrub
TP15	G	1. PF - SW, 2. DV - Grass, 3. GC = 70% grass 5% shrub 25% soil, 4. FC = 5%, 5. DH = 1.0m. Other - some shrub /trees 2-10m, bordered by shrub

PPOINT_ID	VEG_CLASS	NOTES
TP16	C	1. PF - SW, 2. DV - Shrub, 3. GC = 70% grass 20% shrub 10% soil, 4. FC = 15%, 5. DH = 3.0m. Other - some shrub /trees 5-10m
TP17	G	1. PF - NW, 2. DV - Grass, 3. GC = 70% grass 5% shrub 25% soil, 4. FC = 5%, 5. DH = 1.0m. Other - some shrub /trees 2-10m, bordered by shrub
TP18	G	1. PF - N, 2. DV - Grass, 3. GC = 70% grass 5% shrub 25% soil, 4. FC = 5%, 5. DH = 1.0m. Other - some shrub /trees 2-10m, upper river bank
TP19	A	1. PF - NNW, 2. DV - Trees, 3. GC = 60% grass 30% shrub 10% soil, 4. FC = 50%, 5. DH = 10m+. Other - dense river veg, grass/reeds, understory 5m+
TP20	G	1. PF - SW, 2. DV - Grass, 3. GC = 80% grass 5% shrub 15% soil, 4. FC = 5%, 5. DH = 1.0m. Other - some shrub /trees 2-10m, scrub/woodland aligns river
TP21	G	1. PF - NNE, 2. DV - Grass, 3. GC = 70% grass 5% shrub 25% soil, 4. FC = 5%, 5. DH = 1.0m. Other - some shrub /trees 2-10m, scrub/woodland aligns river
TP23	B	1. PF - SW, 2. DV - Trees, 3. GC = 80% grass 10% shrub 10% soil, 4. FC = 10%, 5. DH = 10m+. Other -river veg, grass/reeds,possible grassland with tree
TP24	C	1. PF - ENE, 2. DV - Shrub, 3. GC = 45% grass 15% shrub 40% soil, 4. FC = 10-15%, 5. DH = 2.0-3.0m. Other - some shrub /trees 5-10m
TP22	A	1. PF - NNW, 2. DV - Trees, 3. GC = 60% grass 30% shrub 10% soil, 4. FC = 50%, 5. DH = 10m+. Other - dense river veg, grass/reeds, understory 5m+
TP25	G	1. PF - S, 2. DV - Grass, 3. GC = 45% grass 10% shrub 45% soil, 4. FC = 5%, 5. DH = 1.0m. Other - some shrub /trees 2-10m,
TP26	A	1. PF - WNW, 2. DV - Trees, 3. GC = 50% grass 40% shrub 10% soil, 4. FC = 60%, 5. DH = 10m+. Other - dense river veg, grass/reeds, understory 5m+
TP27	G	1. PF - NE, 2. DV - Grass, 3. GC = 45% grass 5% shrub 50% soil, 4. FC = 5%, 5. DH = 1.0m. Other - some shrub /trees 2-10m, rocky outcrops
TP28	O	PF - W, parkland
TP29	G	1. PF - NE, 2. DV - Grass, 3. GC = 45% grass 5% shrub 50% soil, 4. FC = 5%, 5. DH = 1.0m. Other - some shrub /trees 2-10m, rocky outcrops, same as TP27
TP30	B	1. PF - ENE, 2. DV - Trees, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 10%, 5. DH = 10m. Other - river bank veg, rock river, grass banks,tall trees
TP31	B	1. PF - SW, 2. DV - Trees, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 10%, 5. DH = 10m. Other - river bank veg, rock river, grass banks,tall trees
TP32	B	1. PF - NE, 2. DV - Trees, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 10%, 5. DH = 6-8m. Other - river bank veg, rock river, grass banks, scrub?
TP33	G	1. PF - NE, 2. DV - Grass, 3. GC = 65% grass 5% shrub 30% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 1.5-5m
TP34	D	1. PF - ESE, 2. DV - Scrub, 3. GC = 60% grass 20% shrub 20% soil, 4. FC = 15%, 5. DH = 5m
TP35	G	1. PF - NE, 2. DV - Grass, 3. GC = 45% grass 10% shrub 45% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 0.5-5m, borderline shrubland
TP36	G	1. PF - NNW, 2. DV - Grass, 3. GC = 45% grass 10% shrub 45% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 0.5-5m, borderline shrubland
TP37	G	1. PF - N, 2. DV - Grass, 3. GC = 45% grass 10% shrub 45% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 0.5-5m, borderline shrubland
TP38	G	1. PF - NE, 2. DV - Grass, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 0.5-5m, borderline shrubland
TP39	G	1. PF - E, 2. DV - Grass, 3. GC = 60% grass 10% shrub 30% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 0.5-5m, borderline shrubland
TP40	D	1. PF - NE, 2. DV - Grass, 3. GC = 60% grass 20% shrub 20% soil, 4. FC = 15%, 5. DH = 5.0m. Other - sparse shrub/scrub 0.5-5m, shrubland

PPOINT_ID	VEG_CLASS	NOTES
TP41	G	1. PF - SSW, 2. DV - Grass, 3. GC = 50% grass 5% shrub 45% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 0.5-5m
TP42	G	1. PF - NE, 2. DV - Grass, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 0.5-5m, borderline shrubland
TP43	C	1. PF - SE, 2. DV - Shrub, 3. GC = 60% grass 20% shrub 20% soil, 4. FC = 10%, 5. DH = 3.0m. Other - sparse shrub/scrub 3-5m
TP44	D	1. PF - W, 2. DV - Scrub, 3. GC = 70% grass 20% shrub 10% soil, 4. FC = 20-30%, 5. DH = ~7m. Other - possible woodland, some trees 5-10m
TP45	A	1. PF - N, 2. DV - Trees, 3. GC = 60% grass 30% shrub 10% soil, 4. FC = 30%, 5. DH = 7-8m. Other - dense river veg, understory 5m+, maybe scrub?
TP46	C	1. PF - S, 2. DV - Shrub, 3. GC = 40% grass 20% shrub 40% soil, 4. FC = 5%, 5. DH = 2.0m. Other - sparse shrub/scrub 3-5m, looks recently burned
TP47	C	1. PF - NNW, 2. DV - Shrub, 3. GC = 40% grass 20% shrub 40% soil, 4. FC = 5%, 5. DH = 2.0m. Other - sparse shrub/scrub 3-5m, looks recently burned
TP48	G	1. PF - NE, 2. DV - Grass, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 0.5-5m
TP49	A	1. PF - S, 2. DV - Trees, 3. GC = 70% grass 20% shrub 10% soil, 4. FC = 30%, 5. DH = 7-10m. Other - dense river veg, understory 5m+, maybe scrub
TP50	D	1. PF - NE, 2. DV - Scrub, 3. GC = 70% grass 20% shrub 10% soil, 4. FC = 10%, 5. DH = 3-5m. Other - possible shrubland, some trees 5-10m
TP51	G	1. PF - NE, 2. DV - Grass, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 0.5-5m
TP52	G	1. PF - ENE, 2. DV - Grass, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 0.5-5m
TP53	G	1. PF - NNE, 2. DV - Grass, 3. GC = 45% grass 10% shrub 40% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub 1.5-4m occasional tree 10-15m
TP54	C	1. PF - N, 2. DV - Shrub, 3. GC = 60% grass 15% shrub 30% soil, 4. FC = 5%, 5. DH = 2-3m. Other - sparse shrub/scrub 3-5m, grassland?
TP55	C	1. PF - N, 2. DV - Shrub, 3. GC = 60% grass 15% shrub 30% soil, 4. FC = 5%, 5. DH = 2-3m. Other - sparse shrub/scrub 3-5m, grassland?
TP56	G	Burned
TP58	G	1. PF - SW, 2. DV - Shrub, 3. GC = 50% grass 15% shrub 35% soil, 4. FC = 10%, 5. DH = 1.5-2m. Other - sparse scrub 2-4m occasional tree 10m
TP59	G	1. PF - E, 2. DV - Trees, 3. GC = 50% grass 5% shrub 45% soil, 4. FC = 10%, 5. DH = 10-15m. Other - typical street side trees
TP60	D	1. PF - S, 2. DV - Scrub, 3. GC = 80% grass 10% shrub 10% soil, 4. FC = 30%, 5. DH = 7m. Small patch of forest, further south scrub
TP62	G	1. PF - SE, 2. DV - Grass, 3. GC = 80% grass 5% shrub 15% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 0.5-5m
TP63	G	1. PF - S, 2. DV - Grass, 3. GC = 80% grass 5% shrub 15% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub/scrub 0.5-5m, some trees 5-10m
TP64	B	1. PF - N, 2. DV - Trees, 3. GC = 70% grass 10% shrub 20% soil, 4. FC = 10%, 5. DH = 15m. Other - river woodland, sparse understory, mostly grass
TP65	G	PF - ENE, Parkland, cleared, grass
TP66	B	1. PF - E, 2. DV - Trees, 3. GC = 60% grass 10% shrub 30% soil, 4. FC = 10%, 5. DH = 10m
TP67	G	1. PF - E, 2. DV - Grass, 3. GC = 40% grass 10% shrub 40% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub 1.5-4m occasional tree 10-15m
TP68	G	1. PF - NNE, 2. DV - Grass, 3. GC = 40% grass 10% shrub 40% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub 1.5-4m occasional tree 10-15m
TP69	G	1. PF - W, 2. DV - Grass, 3. GC = 40% grass 10% shrub 40% soil, 4. FC = 5%, 5. DH = 1.0m. Other - sparse shrub 1.5-4m occasional tree 10-15m

Appendix C – Bushfire protection criteria

ELEMENT 1: LOCATION

Intent: To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk of bushfire to facilitate the protection of people, property and infrastructure.

PERFORMANCE PRINCIPLE	ACCEPTABLE SOLUTIONS
The intent may be achieved where:	*To achieve compliance with this Element using an acceptable solution, the following acceptable solution (A1.1) must be met*
P1 The strategic planning proposal, subdivision and development application is located in an area where the bushfire hazard assessment is or will, on completion, be moderate or low, or a BAL–29 or below, and the risk can be managed. For unavoidable development in areas where BAL–40 or BAL–FZ applies, demonstrating that the risk can be managed to the satisfaction of the Department of Fire and Emergency Services and the decision-maker.	**A1.1 Development location** The strategic planning proposal, subdivision and development application is located in an area that is or will, on completion, be subject to either a moderate or low bushfire hazard level, or BAL–29 or below.

EXPLANATORY NOTES

Land is most suitable for land use intensification where hazard levels are low. Where there is an extreme bushfire hazard or requirement for use of BAL–40 or BAL–FZ construction standards, the land is not considered suitable for development unless it meets the definition of minor or unavoidable development.

ELEMENT 2: SITING AND DESIGN OF DEVELOPMENT

Intent: To ensure that the siting and design of development minimises the level of bushfire impact.

PERFORMANCE PRINCIPLE	ACCEPTABLE SOLUTIONS
The intent may be achieved where:	*To achieve compliance with this Element the following acceptable solution must be met.*
P2 The siting and design of the strategic planning proposal, subdivision or development application, including roads, paths and landscaping, is appropriate to the level of bushfire threat that applies to the site. That it incorporates a defendable space and significantly reduces the heat intensities at the building surface thereby minimising the bushfire risk to people, property and infrastructure, including compliance with AS 3959 if appropriate.	**A2.1 Asset Protection Zone (APZ)** Every habitable building is surrounded by, and every proposed lot can achieve, an APZ depicted on submitted plans, which meets the following requirements: • **Width**: Measured from any external wall or supporting post or column of the proposed building, and of sufficient size to ensure the potential radiant heat impact of a bushfire does not exceed 29kW/m² (BAL-29) in all circumstances. • **Location**: the APZ should be contained solely within the boundaries of the lot on which the building is situated, except in instances where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, in perpetuity (see explanatory notes). • **Management**: the APZ is managed in accordance with the requirements of *'Standards for Asset Protection Zones'*. (see Schedule 1).

ELEMENT 2: SITING AND DESIGN OF DEVELOPMENT

EXPLANATORY NOTES

Figure 13: Separation distance required where no additional construction standards are proposed

In the absence of additional construction standards a minimum separation distance of 100 metres between buildings and the hazard must be provided in order to protect them from burning debris, radiant heat and direct flame contact

Figure 14: A reduced separation distance may necessitate increased construction standards

It may be possible to reduce the minimum distances, for example by increasing the construction standard of the building – in this example the building would need to be constructed to BAL–29

ELEMENT 3: VEHICULAR ACCESS

Intent: To ensure that the vehicular access serving a subdivision/development is available and safe during a bushfire event.

PERFORMANCE PRINCIPLE	ACCEPTABLE SOLUTIONS
The intent may be achieved where:	*To achieve the intent, all applicable 'acceptable solutions' must be addressed.*
P3 The internal layout, design and construction of public and private vehicular access and egress in the subdivision/development allow emergency and other vehicles to move through it easily and safely at all times.	**A3.1 Two access routes** Two different vehicular access routes are provided, both of which connect to the public road network, provide safe access and egress to two different destinations and are available to all residents/the public at all times and under all weather conditions. **A3.2 Public road** A public road is to meet the requirements in Table 4, Column 1. **A3.3 Cul-de-sac (including a dead-end road)** A cul-de-sac and/or a dead end road should be avoided in bushfire prone areas. Where no alternative exists (i.e. the lot layout already exists and/or will need to be demonstrated by the proponent), the following requirements are to be achieved: ▪ Requirements in Table 4, Column 2; ▪ Maximum length: 200 metres (if public emergency access is provided between cul-de-sac heads maximum length can be increased to 600 metres provided no more than eight lots are serviced and the emergency access way is no more than 600 metres); and ▪ Turn-around area requirements, including a minimum 17.5 metre diameter head. **A3.4 Battle-axe** Battle-axe access leg should be avoided in bushfire prone areas. Where no alternative exists, (this will need to be demonstrated by the proponent) all of the following requirements are to be achieved: ▪ Requirements in Table 4, Column 3; ▪ Maximum length: 600 metres; and ▪ Minimum width: six metres.

ELEMENT 3: VEHICULAR ACCESS

PERFORMANCE PRINCIPLE	ACCEPTABLE SOLUTIONS

A3.5 Private driveway longer than 50 metres

A private driveway is to meet all of the following requirements:

- Requirements in Table 4, Column 3;
- Required where a house site is more than 50 metres from a public road;
- Passing bays: every 200 metres with a minimum length of 20 metres and a minimum width of two metres (i.e. the combined width of the passing bay and constructed private driveway to be a minimum six metres);
- Turn-around areas designed to accommodate type 3.4 fire appliances and to enable them to turn around safely every 500 metres (i.e. kerb to kerb 17.5 metres) and within 50 metres of a house; and
- Any bridges or culverts are able to support a minimum weight capacity of 15 tonnes.
- All-weather surface (i.e. compacted gravel, limestone or sealed).

A3.6 Emergency access way

An access way that does not provide through access to a public road is to be avoided in bushfire prone areas. Where no alternative exists (this will need to be demonstrated by the proponent), an emergency access way is to be provided as an alternative link to a public road during emergencies. An emergency access way is to meet all of the following requirements:

- Requirements in Table 4, Column 4;
- No further than 600 metres from a public road;
- Provided as right of way or public access easement in gross to ensure accessibility to the public and fire services during an emergency; and
- Must be signposted.

A3.7 Fire service access routes (perimeter roads)

Fire service access routes are to be established to provide access within and around the edge of the subdivision and related development to provide direct access to bushfire prone areas for fire fighters and link between public road networks for fire-fighting purposes. Fire service access routes are to meet the following requirements:

- Requirements Table 4, Column 5;
- Provided as right of ways or public access easements in gross to ensure accessibility to the public and fire services during an emergency;
- Surface: all-weather (i.e. compacted gravel, limestone or sealed)
- Dead end roads are not permitted;
- Turn-around areas designed to accommodate type 3.4 appliances and to enable them to turn around safely every 500 metres (i.e. kerb to kerb 17.5 metres);
- No further than 600 metres from a public road;
- Allow for two-way traffic and;
- Must be signposted.

ELEMENT 3: VEHICULAR ACCESS

PERFORMANCE PRINCIPLE	ACCEPTABLE SOLUTIONS
	A3.8 Firebreak width Lots greater than 0.5 hectares must have an internal perimeter firebreak of a minimum width of three metres or to the level as prescribed in the local firebreak notice issued by the local government.

Table 4: Vehicular access technical requirements

TECHNICAL REQUIREMENTS	1 Public road	2 Cul-de-sac	3 Private driveway	4 Emergency access way	5 Fire service access routes
Minimum trafficable surface (m)	6*	6	4	6*	6*
Horizontal clearance (m)	6	6	6	6	6
Vertical clearance (m)	4.5	N/A	4.5	4.5	4.5
Maximum grade <50 metres	1 in 10	1 in 10	1 in 10	1 in 10	1 in 10
Minimum weight capacity (t)	15	15	15	15	15
Maximum crossfall	1 in 33	1 in 33	1 in 33	1 in 33	1 in 33
Curves minimum inner radius (m)	8.5	8.5	8.5	8.5	8.5
*Refer to E3.2 Public roads: Trafficable surface					

ELEMENT 4: WATER

Intent: To ensure that water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.

PERFORMANCE PRINCIPLE	ACCEPTABLE SOLUTIONS
The intent may be achieved where:	*To achieve the intent, all applicable 'acceptable solutions' must be addressed.*
P4 The subdivision, development or land use is provided with a permanent and secure water supply that is sufficient for fire fighting purposes.	**A4.1 Reticulated areas** The subdivision, development or land use is provided with a reticulated water supply in accordance with the specifications of the relevant water supply authority and Department of Fire and Emergency Services. **A4.2 Non-reticulated areas** Water tanks for fire fighting purposes with a hydrant or standpipe are provided and meet the following requirements: • Volume: minimum 50,000 litres per tank; • Ratio of tanks to lots: minimum one tank per 25 lots (or part thereof); • Tank location: no more than two kilometres to the further most house site within the residential development to allow a 2.4 fire appliance to achieve a 20 minute turn-around time at legal road speeds; • Hardstand and turn-around areas suitable for a type 3.4 fire appliance (i.e. kerb to kerb 17.5 metres) are provided within three metres of each water tank; and • Water tanks and associated facilities are vested in the relevant local government. **A4.3 Individual lots within non-reticulated areas (Only for use if creating 1 additional lot and cannot be applied cumulatively)** • Single lots above 500 square metres need a dedicated static water supply on the lot that has the effective capacity of 10,000 litres.

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Shire of Ashburton Environmental Profile

Prepared for Taylor Burrell Barnett

By Essential Environmental

November 2016

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1 INTRODUCTION

The Shire of Ashburton ('the Shire') has commenced preparation of a Local Planning Strategy. This Environmental Profile provides a summary of the natural environment of the Shire for input into the Strategy, highlighting issues associated with the environmental characteristics of the Shire in the context of future growth and development.

This report addresses the environmental context of the Shire of Ashburton only. It is recognised that this will need to be considered, together with economic and community (social) issues and opportunities, as part of the preparation of the local planning strategy.

Preparation of the Environmental Profile has included a review of available information relating to the natural environment, resources and environmental land use planning within the Shire of Ashburton. This is summarised in Section 2 and Appendix 1.

1.1 The study area

The Shire of Ashburton ('the Shire') is the southern most local government area in the Pilbara region. It is located approximately 1,000 km north of Perth and comprises over 100,000 km^2. The Shire is bound by the local governments of Exmouth and Carnarvon to the west, Upper Gascoyne and Meekatharra to the south, East Pilbara to the east, and Karratha and Port Hedland to the north.

It stretches approximately 500 km west to east from the coastal beaches, rocky hedlands, mudflats and mangroves around Onslow, across the Stewart Hills to Pannawonica, and the Hamersley Ranges to Tom Price and Paraburdoo (Figure 1). The Shire's populated places include Onslow, a coastal port town and the oldest townsite in the Shire, established in 1885 for exporting wool from sheep stations of the Pilbara hinterland. Tom Price, Paraburdoo and Pannawonica are towns largely based on the development of major mining operations, with Tom Price being the Shire's seat of government and administrative centre (see Table 1 for 2011 locality populations). Pannawonica is a 'closed town', and primarily serves to house Rio Tinto Iron Ore employees and their families. It is managed by Rio Tinto and not by the Shire. Although these towns contain the majority of the Shire's population of almost 11,000 residents, many Aboriginal people reside in the communities of Bindi Bindi, Wakathuni, Jundaru, Bellary (Innawonga), Youngaleena and Ngurawaana.

Table 1: Census 2011 locality populations - Shire of Ashburton

Locality	Population	Per cent of local government population
Onslow	667	6.7
Pannawonica	651	6.5
Paraburdoo	1,509	15.1
Tom Price	3,134	31.3

Source: Australian Bureau of Statistics (2012), QuickStats: Onslow (UCL), Pannawonica (UCL), Paraburdoo (UCL) & Tom Price (UCL).

The Shire is best known for mining, agriculture and fishing, and for its rugged, ancient landscape supporting tourism in the region. It is home to some of the world's largest open cut mines, immense pastoral leases and cattle stations, and prawn, pearl and mackerel fishing industries.

The North West Coastal Highway is the main road transport link in the west, traversing the Shire in a north-south direction. Great Northern Highway similarly crosses the Shire in the east (Figure 1).

1.2 Key guidance documents

Strategic guidance for the Shire is provided by a number of key documents at both local and regional level. These include:

- Shire of Ashburton 10 Year Community Strategic Plan 2012 – 2022 (SoA, 2012);
- Onslow Townsite Strategy (DoP and SoA, 2011);
- Onslow Townsite Strategy Background Report (SoA, 2010);
- Onslow Townsite Expansion Development Plan (TPG, 2012);
- Shire of Ashburton Tourism Destination Development Strategy (RBA Consulting, 2011);
- Pilbara Planning and Infrastructure Framework (WAPC, 2012) and
- Pilbara Regional Investment Blueprint (PDC, 2015).

In addition, the following local planning policies were considered as part of the development of this environmental profile:

- ELM21 Tree Management Overview Policy;
- ENG08 Bushfires; and
- LPP25 Onslow Coastal Hazard Area – Scheme Control Area.

These documents are described briefly below. Additional documents which have been considered as part of the preparation of this report are summarised in Appendix 1.

1.2.1 Shire of Ashburton 10 Year Community Strategic Plan 2012 – 2022

The Shire of Ashburton *10 Year Community Strategic Plan 2012 – 2022* is the key guiding document for the Shire. It outlines a mission of

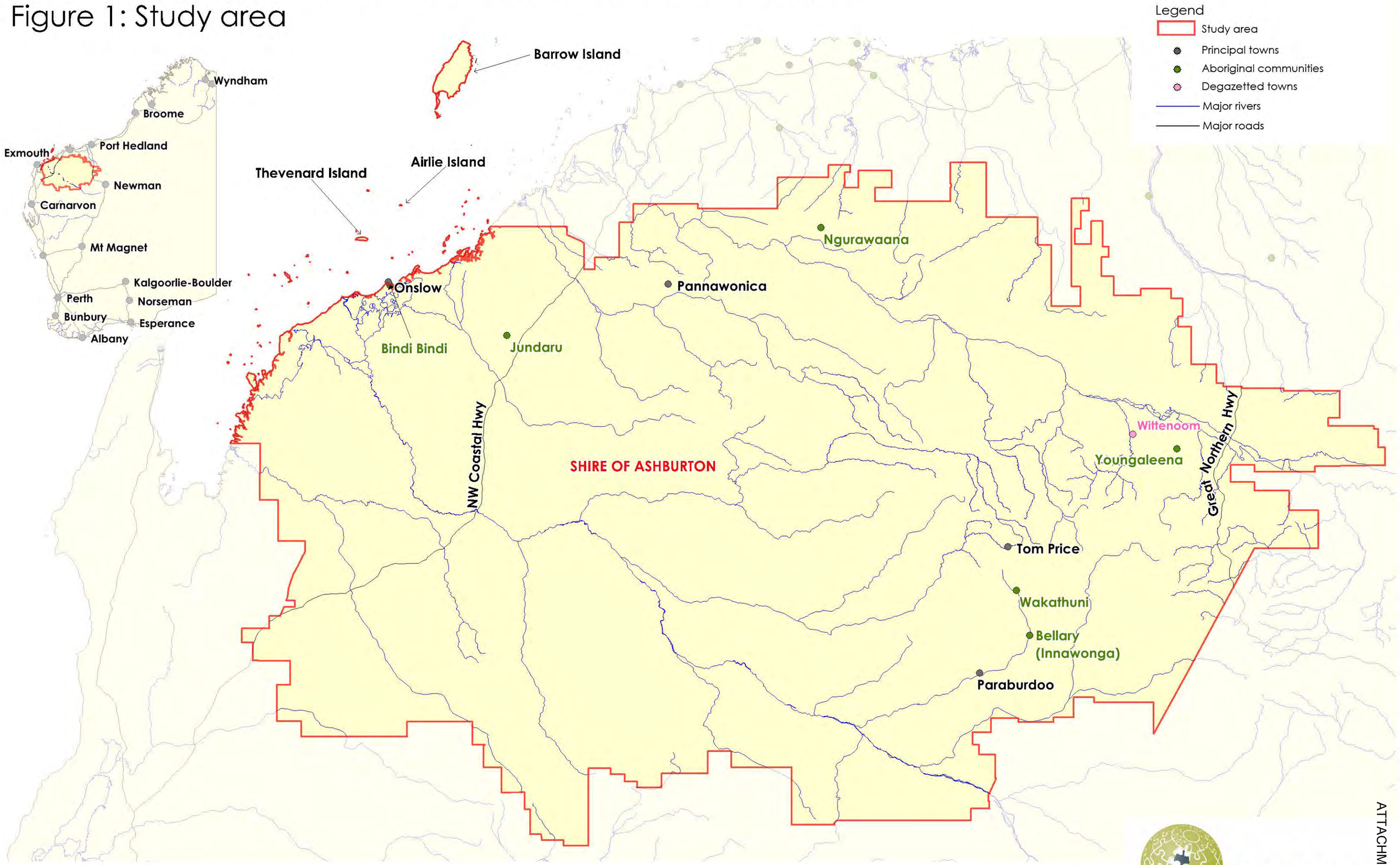
> *'working together, enhancing lifestyle and economic vitality'*

The Strategic Plan defines key environmental outcomes to be delivered in the Shire of Ashburton as maintaining the integrity and quality of the Shire's natural environments, together with celebrating and valuing the Aboriginal and European history and heritage, with the aim of being a recognised leader in sustainability practices. These outcomes are to be delivered via a number of strategic directions that are outlined under *Goal 3: Unique Heritage and Environment*, and *Goal 4: Distinctive and well serviced places*.

The objectives, strategic directions, desired outcomes and key contributors are summarised in Table 2. These objectives and strategic directions should guide preparation of the Local Planning Strategy.

Taylor Burrell Barnett - Shire of Ashburton Environmental Profile

Figure 1: Study area



Scale 1: 1,500,000 @ A3
0 60 km

essential environmental

Table 2: CSP Goal 3 objectives and directions relevant to the Environmental Profile

Goal 3: Unique Heritage and environment		
Objective	**Strategic directions**	**Key contributors**
Objective 1: Flourishing natural environments	Encourage Aboriginal participation in the management of natural assets Protect (manage) the diversity of the Shire's natural environments Improve recreational access to natural environments with a focus on signage, access and safety Manage the industry/natural asset interface	• Shire of Ashburton • Aboriginal communities • Aboriginal corporations • Key industry stakeholders • Local environmental groups • Local schools
Desired outcome:	The integrity and quality of the Shire's natural environments are maintained	
Objective 2: Leading regional sustainability	Build capacity to encourage protection of natural assets, good air quality and responsible use of electricity and water Implement waste minimisation strategies	• Shire of Ashburton • Key industry stakeholders • Community representatives • Local schools
Desired outcome:	The Shire of Ashburton is a recognised leader in sustainability practices	
Objective 3: Celebration of history and heritage	Initiate programs and attract funding to celebrate the Aboriginal and European history and heritage of the Shire	• Shire of Ashburton • Key industry stakeholders • Aboriginal communities • Aboriginal corporations • Local museums • Libraries • Local schools • Community groups
Desired outcome:	The Aboriginal and European history and heritage of the Shire is celebrated and valued	
Goal 4: Distinctive and well serviced places		
Objective 1: Quality public infrastructure	Facilitate development of the Tom Price to Karratha Road – Key factor in linking Tom Price and Parraburdoo to the Pilbara Cities Provide and maintain affordable infrastructure that serves the current and future needs of the community, environment, industry and business Develop strategies to effectively manage the planned transition of municipal services in Aboriginal communities, ensuring active engagement of communities and stakeholders Actively advocate for the supply and cost of utilities and services that meet commercial, industrial and retail needs Develop plans for water conservation and water-wise use across the Shire	• Shire of Ashburton • Key industry stakeholders • Business associations • Residents associations • Aboriginal communities • Aboriginal corporations
Desired outcome:	Adequate, accessible and sustainable public infrastructure	

Objective	Strategic directions	Key contributors
Objective 3: Well planned towns	Plan appropriately for future housing and accommodation needs balancing State government growth targets, changing industry needs, community expectations and the need for timely and affordable release of land and housing Ensure new developments are sensitive to the natural and built environments Ensure buildings and landscaping enhance the local character of towns and integrate with the natural environment, with a focus on beautification Incorporate social planning and ecological sustainable development principles in planning strategies and policies Provide a diverse range of high quality open spaces Ensure there is an effective interface between government and industry to ensure holistic planning and development	• Shire of Ashburton • Key industry stakeholders • State government agencies
Desired outcome:	Distinctive and well functioning towns	

1.2.1 Growth outlook

The relationship between employment and population growth is more pronounced in the mining towns of the Pilbara than in many other areas of the State. Consequently, population growth in the resource sector oriented towns of the Shire tends not to occur at a steady rate, rather in bursts, driven by resource project cycles. This dynamic makes preparing accurate population forecasts challenging (WAPC, 2015a).

The direct connection between employment in the resource sector and regional population has meant that population growth in the Shire has slowed down with the end of the mining boom. Department of Planning forecasts also suggests that the high rate of population growth in the Shire of Ashburton is unlikely to continue (WAPC, 2015a).

The most recent estimated residential population of the Shire for 2015 is 10,951 (ABS, 2016). The ABS has estimated that population growth in the Shire has significantly decreased from 7.5% growth in 2011, to 0.04% growth in 2015 (ABS, 2016), with a similar slowdown observed across the region.

Tom Price, the Shire's largest town, has experienced relatively modest population growth in recent years. Most of the additional workforce requirements created by resources projects have been met by fly-in fly-out (FIFO) workers who generally stay at camps outside town. Recent population data has also shown that growth in Tom Price has not been as pronounced as in other major Pilbara centres (WAPC, 2015a).

The Pilbara Industry's Community Council predicts that the total minerals and energy workforce in the Shire of Ashburton will decline over the next seven years. Projects currently under construction are moving into operational phase and no major new projects are likely to commence in the Shire.

The Pilbara Industry's Community Council employment-based forecasts indicate that the population of Tom Price could potentially increase by 1,400 residents to a population of approximately 4,750 in 2020. Achieving growth of this nature is likely to require an increase in the proportion of resident workers relative to FIFO, or a substantial expansion of the town's role as a service hub for mining operations in the area. Available data suggests that population growth will stagnate in the near future, unless industry projects within the Shire are developed.

The Shire of Ashburton Working Group (Department of Housing, Department of Lands, LandCorp, Pilbara Development Commission, Rio Tinto, and Shire of Ashburton) identified a lack of accurate knowledge and understanding of the current population and accommodation profile, future employment and population growth trends for Tom Price, Onslow and Paraburdoo (WAPC, 2015a). Therefore, the Pilbara Development Commission, together with the governance of the Working Group, has instigated an Assessment of Accommodation Need in the major towns of Tom Price and Onslow and the townsite of Paraburdoo (WAPC, 2015a).

1.2.2 Onslow Townsite Strategy (2011)

The Onslow Townsite Strategy was developed to define a way to achieve the following vision:

> *'That Onslow be a vibrant, sustainable and prosperous place for work, living and leisure - for both residents and visitors'*

and to ensure that Onslow is known as a 'town with LNG plants and not an LNG town'.

The townsite strategy seeks to fulfil the following three goals:

1. Sustainable living
2. Economic vitality
3. Community wellbeing

Based on the development of Ashburton North Strategic Industrial Area and associated population growth, the strategy identified that significant reorientation of Onslow's urban structure is required to accommodate the residential, community and civic needs of an anticipated residential population expansion. A basic premise of the strategy is that there are no operational workforce camps within the Onslow area. The townsite strategy seeks to balance pressure for the establishment of new living areas with the need to revitalise and, where appropriate, restructure the existing residential precincts. The strategy identifies that the introduction of higher densities in existing areas will provide the opportunity to:

- make these areas more viable in terms of urban and community services;
- reduce the urban footprint thus conserving land with high biodiversity, cultural and pastoral value; and
- identify under utilised land for 'community purposes' for residential use.

The strategy provides development principles and desired future character for:

- new residential areas;
- commercial centre;
- Onslow Salt area;
- Townsite industrial areas;
- Beadon Creek Harbour;
- Airport area;
- Beaches; and
- transient workforce accommodation.

1.2.3 *Shire of Ashburton Tourism Destination Development Strategy (2011)*

The Shire of Ashburton Tourism Development Strategy was prepared to identify opportunities to diversify and expand the tourism industry in the Shire, and generate employment for local people outside of the resource industry. The Strategy identifies that there are opportunities for tourism to take advantage of and leverage off substantial infrastructure constructed by the larger resources industry. It recognises that the Shire includes significant natural environmental assets, both inland (most obviously Karijini and Millstream Chichester National Parks) and on the coast in the form of recreational fishing and diving opportunities. Outside of the nature based attractions, the strategy also focuses on tourism potential at the town centres of Tom Price and Onslow, as Paraburdoo and Pannawonica are recognised as focussing on the servicing of local resource projects in the near future.

In summary, the Strategy identifies that to develop tourism as a thriving economic centre in the Shire, the following actions are required:

- increase tourism products;
- improve quality and value;
- enhance infrastructure that support tourism;
- improve visitor servicing in particular delivery of visitor information (visitor centres, website, information bays, brochures);
- create new experiences that will attract visitors and encourage existing to stay longer; and
- create a positive image of Indigenous tourism in the region.

1.2.4 *Pilbara Planning and Infrastructure Framework (2012)*

The *Pilbara Planning and Infrastructure Framework* defines a strategic direction for the future development of the Pilbara region over the next 25 years. It seeks to ensure that development and change in the Pilbara is achieved in a way that improves people's lives and enhances the character and environment of the region.

In summary, the *Framework*:

- addresses the scale and distribution of future population growth and housing development, as well as identifying strategies for economic growth, environmental issues, transport, infrastructure, water resources, tourism and the emerging impacts of climate change;
- sets out regional planning principles, together with goals, objectives and actions to achieve these. It represents an agreed 'whole of government' position on the broad future planning direction for the Pilbara, and will guide the preparation of local planning strategies and local planning schemes; and
- informs government on infrastructure priorities across the Pilbara and gives the private sector more confidence to invest in the region. The infrastructure priorities identified in the Framework have been determined following extensive liaison with State Government agencies, local government and other key stakeholders.

1.2.5 *Pilbara Regional Investment Blueprint (2015)*

The *Pilbara Regional Investment Blueprint* was recently developed in recognition that there is a need to drive new growth in the region. The vision of the Blueprint is underpin by economic diversity and enhanced liveability for the region in 2050.

In particular, the Blueprint has a strong focus on opportunities for growth in and diversification into agriculture, aquaculture, tourism (nature-based and Aboriginal heritage) and energy (uranium, LNG, and renewable energy production and export) projects. These can be new sources of long-term sustainable growth for the region, in addition to continued support of the minerals and energy industries. In this way the Blueprint seeks to transform the Pilbara as a region of mining towns into more developed and sustainable Pilbara Cities which offer diversity of jobs and career opportunities, high standards of services, and vibrant community life. It builds on the Pilbara Cities Vision to sustainably grow and develop communities that meet the aspirations of their people. The Blueprint Vision is supported by nine regional investment "Pillars" based on analysis of needs, regional interests and comparative advantages that will deliver new sources of growth.

2 EXISTING ENVIRONMENT

2.1 Climate

The climate in the Shire of Ashburton is typical of the Pilbara region, characterised by high temperatures, particularly during the summer months and variable rainfall patterns interspersed with long dry periods. The Bureau of Meteorology (BoM) defines the wet season for the Pilbara as the period extending from December to the end of March. Tropical cyclones are a feature of the summer months and usually develop between November and May, often bringing intense rainfall and resulting in flooding. Some areas of the Pilbara have the highest average annual evaporation rate in Australia (Van Vreeswyk *et al.*, 2004). The annual evaporation rate throughout the Pilbara is considerably higher than the average rainfall.

The climate of the Pilbara region can be broadly described by two climate categories: tropical along the coastal areas and arid through the central and eastern parts of the region. Regional variations in rainfall occur, with coastal areas and western inland areas located in the path of tropical cyclones often receiving higher rainfall. The arid desert areas in the central east of the region are characterised by higher temperatures and significantly lower rainfall.

Given the coastal location of the Shire it may be described as experiencing a tropical climate. However, as a result of the breadth of the local government area, from the coastal areas around Onslow to the inland ranges around Tom Price and Paraburdoo approximately 500 km away, some variability in temperature and rainfall occurs between the west and east. In order to demonstrate this variability, climate data was obtained from BoM stations at Onslow Airport (no. 5017), Pannawonica (no. 5069) Paraburdoo Aero (no. 7185), and Wittenoom (no. 5026). Mean maximum and minimum temperatures are shown in Chart 1, and mean rainfall is shown in Chart 2 below.

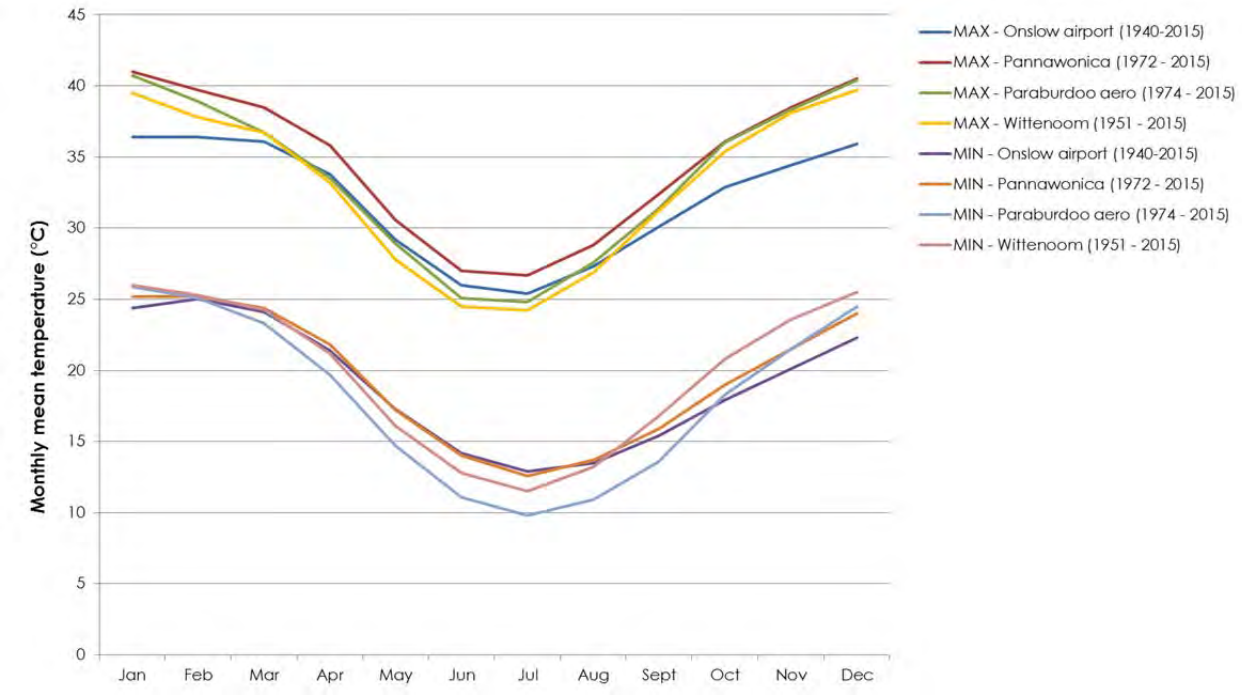


Chart 1: Shire of Ashburton mean monthly maximum and minimum temperature (BoM, 2016a)

Maximum temperatures in the Shire of Ashburton occur in summer and minimum temperatures occur in winter, with average maximum temperatures peaking in December-January at

approximately 36°C in Onslow and 40-41°C at inland locations, and average minimum temperatures occurring at approximately 10-13°C in July (BoM, 2016a)(Chart 1). Temperature data confirms that coastal areas in the Shire (Onslow) experience a more moderate climate than inland areas.

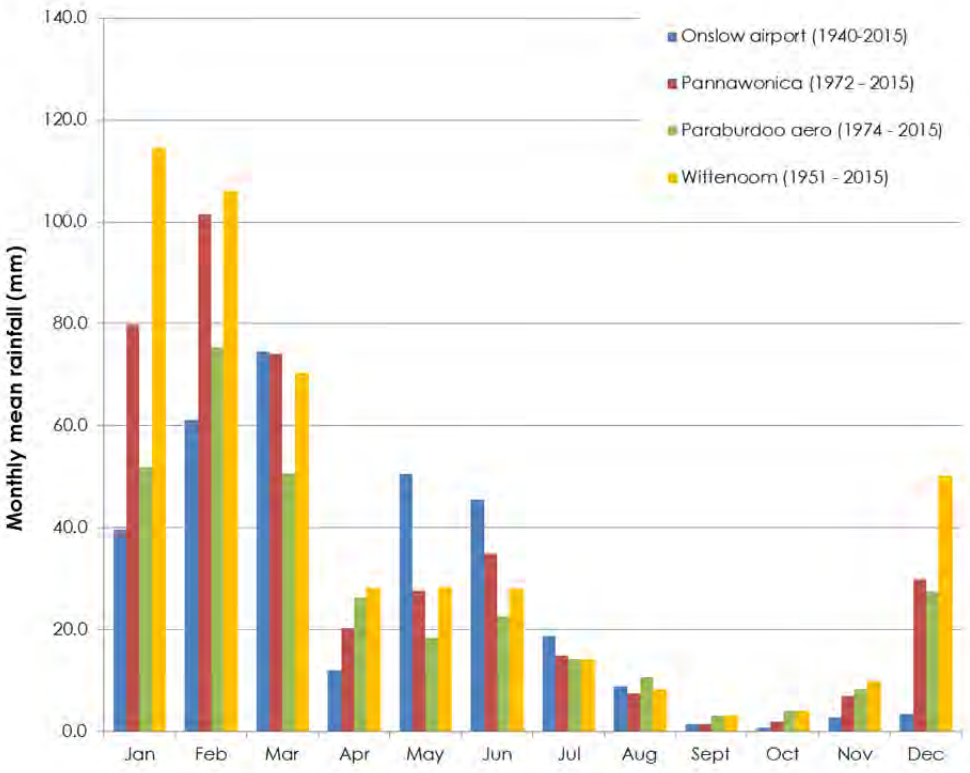


Chart 2: Shire of Ashburton mean monthly rainfall (BoM, 2016a)

Average annual rainfall recorded in the Shire varies from 317 mm at Onslow airport to 465 mm at Wittenoom. As shown in Chart 2, the majority of rainfall occurs in summer between December and March with the driest months being September and October. Chart 2 also demonstrates the variability in rainfall events across the Shire, with more northern, inland areas experiencing higher volume summer ('wet season') rains, while Onslow and nearby coastal areas are also subject to winter frontal systems.

BoM data indicates that while average annual rainfall has declined around Onslow in the last 20 years, in contrast it has increased in inland areas (Pannawonica, Paraburdoo and Wittenoom) (see During most of the cooler times of the year, winds tend to be easterly or south-easterly over most of the Pilbara, influenced by the passage of winter high pressure systems that move east across the mainland. In spring prevailing winds weaken as a semi-permanent heat low develops over the land. In coastal areas the wind direction becomes more variable, particularly in the warmer months, when the wind direction often reverses in the afternoon and sea breezes from the north and north-west dominate (*Van* Vreeswyk *et al.*, 2004).

Table 3). In particular, rainfall in inland areas of the Shire has increased between October-December and April, while decreasing during the winter months. This may be indicative of changing rainfall patterns bringing more frequent intense rainfall events over the summer 'wet season', with more dry periods in between.

During most of the cooler times of the year, winds tend to be easterly or south-easterly over most of the Pilbara, influenced by the passage of winter high pressure systems that move east across

the mainland. In spring prevailing winds weaken as a semi-permanent heat low develops over the land. In coastal areas the wind direction becomes more variable, particularly in the warmer months, when the wind direction often reverses in the afternoon and sea breezes from the north and north-west dominate (*Van* Vreeswyk *et al.*, 2004).

Table 3: Average annual rainfall at the Shire of Ashburton

BoM Station	Rainfall (1940-2015)	Rainfall (1998-2015)	Change in average rainfall
Onslow airport (BoM no. 5017)	317 mm	273 mm	-44 mm
BoM Station	**Rainfall (1972-2015)**	**Rainfall (1995-2015)**	**Change in average rainfall**
Pannawonica (BoM no. 5069)	404 mm	432 mm	28 mm
BoM Station	**Rainfall (1974-2015)**	**Rainfall (1995-2015)**	**Change in average rainfall**
Paraburdoo aero (BoM no. 7185)	324 mm	364 mm	40 mm
BoM Station	**Rainfall (1951-2015)**	**Rainfall (1995-2015)**	**Change in average rainfall**
Wittenoom (BoM no. 5026)	465 mm	587 mm	122 mm

2.1.1 Cyclones

Onslow is one of the most cyclone affected towns on the Western Australian coastline, averaging one cyclone with wind gusts in excess of 90 km/h every two years. Between 1953 and 1963 Onslow suffered five severe cyclone impacts having wind gusts exceeding 170 km/h and a further three cyclones causing damage, some flood related (Shire of Ashburton, 2010a). Cyclones are generally associated with flooding and have the potential to increase storm surges in coastal areas.

The Shire of Ashburton has acknowledged that the cyclone activity around Onslow increases the risk of the town being affected by flooding and storm surge. The Onslow Coastal Hazard Special Control Area provides for the Shire to require any planning application to be supported by an assessment, prepared to the satisfaction of the Shire, of the impact of potential flood and storm surge events on the proposed development.

2.1.2 Climate change

Reports from the International Panel on Climate Change (IPCC) provide limited detail on Australian climate change, particularly when it comes to regional climate change projections. *Climate Change in Australia* (CSIRO, 2015a) was developed by the Australian Greenhouse Office together with CSIRO and BoM. It is based upon international climate change research including conclusions from the IPCC's fifth assessment report. It also builds on a large body of climate research that has been undertaken for the Australian region in recent years.

The CSIRO has provided a number of projections based on the outputs of global climate models (named CMIP5) that estimate likely changes in regional climate for defined natural resource management clusters around 2030 (near future) and 2090 (late century). Regional clusters correspond to the broad-scale climate and biophysical regions of Australia. The majority of the

Shire of Ashburton is located in the Western Australian Rangelands North sub-cluster, and wholly within the Rangelands cluster (Watterson I. et al., 2015).

The CSIRO predicts that mean, maximum, and minimum temperatures in the Rangelands North sub-cluster will continue to substantially increase. In addition, the frequency of hot days and duration of warm spells is also predicted to increase, as are evaporation rates. Specifically, temperature is projected to increase by 0.6 to 1.5˚C above the climate of 1986-2005 by 2030, and up to 3.1-5.6˚C by 2090 (CSIRO, 2015a) (see Figure 2). This rise in temperature has the potential to impact on plants, animals and people, through increased heat stress and increased risk of bushfires.

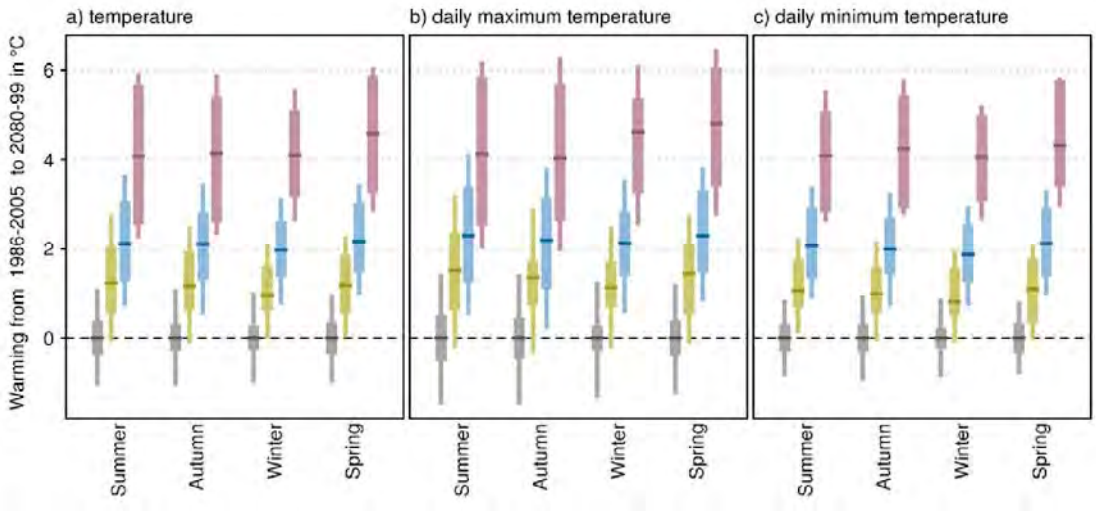


Figure 2: Projected seasonal surface air temperature changes for the Rangelands cluster to the mean (a), daily maximum (b) and daily minimum temperature (c). Temperature anomalies are given in °C relative to the 1986–2005 mean under RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (purple). Natural climate variability is represented by the grey bar (Watterson I. et al., 2015).

Decreases in spring rainfall in the Rangelands North sub-cluster has also been projected by the CSIRO as a result of climate change (Figure 3). This decrease in rainfall coupled with increases in evapotranspiration has also been linked to potential reductions in soil moisture, and possibly in runoff. Time spent in drought is also expected to increase by 2090 with medium confidence. However, the intensity in heavy rainfall events is highly likely to increase which will have implications for localised flooding in built up areas.

Bushfire risk is also linked to rainfall, as it drives vegetation growth. Thus when vegetation growth occurs after the end of the wet season and bushfires follow, the behaviour of these fires is expected to be more extreme in the future as a result of higher temperatures.

Sea levels will also continue to rise along coastal areas of the Rangelands, having implications for Onslow and other coastal settlements and infrastructure. Specifically, the intermediate emissions scenario gives a rise of 0.28-0.64 m and the high emissions scenario gives a rise of 0.4 to 0.84 m by 2090 (Watterson I. et al., 2015). Increases in sea surface temperature (up to 2.4-3.7ºC by 2090) and sea surface acidity (decrease of up to 0.3 pH units by 2090) are also highly likely as a result of climate change, which will in turn affect marine life and thus impact on the biodiversity of coastal and marine environments and local fisheries.

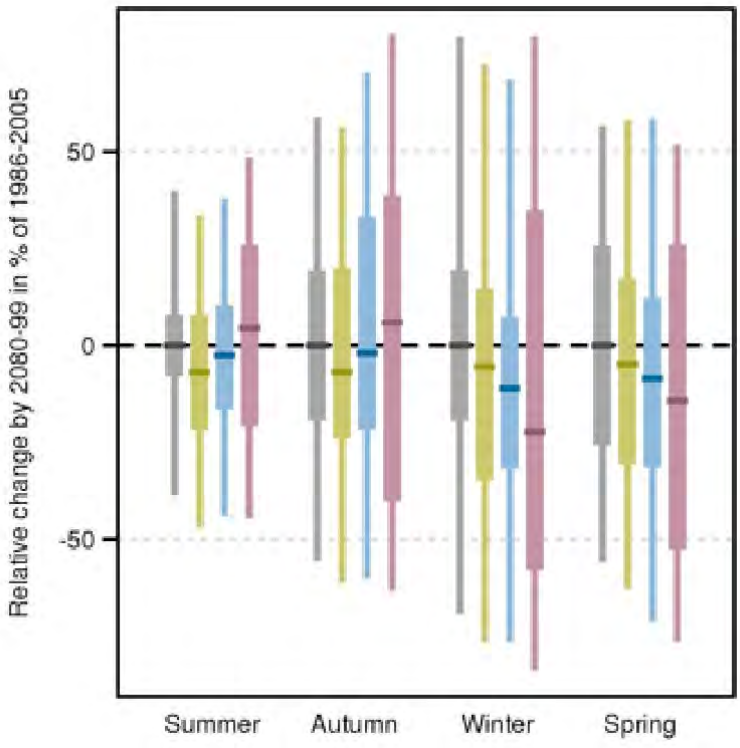


Figure 3: Projected seasonal rainfall changes for the Rangelands North sub-cluster for 2090. Rainfall anomalies are given in per cent with respect to the 1986–2005 mean under RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (purple). Natural variability is represented by the grey bar (Watterson I. et al., 2015).

2.1.3 Key considerations for strategic environmental planning

Key climate considerations for strategic planning are:

- **Temperature** – Increases in temperature are likely to result in increased needs for cooling and/or impacts on environmental and public health. Consideration should be given to heat island impacts in regional towns and the need for green infrastructure and shade in public and private places to mitigate heat increases in built environments. This may also result in an increase in water demands, and thus adequate water sources. Development should also incorporate passive solar design and breezeways.
- **Extreme weather** – Increases in extreme weather events, particularly bushfires as well as rainfall/tropical cyclones, may require development to be located away from areas of risk and/or improved emergency management responses and plans. Infrastructure adequate to manage extreme weather conditions will also require consideration.
- **Rainfall change** – Increases in rainfall event intensity may result in greater localised flooding and increased pressure on stormwater systems.

2.2 Air quality

Air quality can be affected by bushfires, mining, agriculture and industry. Key pollutants are dust from industrial and construction activities and particulates (measured as PM10 and PM25) from bushfires. Other pollutants of interest are oxides of nitrogen, ozone, lead, sulphur dioxide, and carbon monoxide. Pollutants are predominantly driven by wind patterns and topography and have the ability to affect the environment and landscape as well as human health in the region.

Air quality in the Shire of Ashburton is generally good. Dust can be a significant issue in the Pilbara, as it can impact on the health of both humans and the environment. No ports in the Shire of Ashburton currently export iron ore, often associated with dispersion of particulates into the local air space. The main source of dust in the local government area is from particulate matter generated by fire. Major bushfire events typically generate particulate concentrations well beyond the threshold National Environment Protection Measures level. Fires also burn off the cryptograms (microbial organisms that help maintain soil cohesion) holding soil together and leave behind a fine friable powder that can become airborne at low wind speeds.

Dust may also be generated from transport and industrial processing, and construction sites. This risk has been recognised by the Shire in the vicinity of Ashburton North Strategic Industrial Area (ANSIA) through the establishment of a special control area which requires consideration of off-site impacts and buffers.

The extraction and production of minerals can also result in air quality impacts such as dust, noise and light. However, impacts from these sources tend to be localised. Overspray of chemicals should also be considered in areas of intense agriculture.

Another potentially significant air quality issue is associated with the Wittenoom Town site, Wittenoom Airfield, Wittenoom Gorge, Yampire Gorge and the Joffre Creek flood plain between the Wittenoom Townsite and the Fortescue River. This area is a registered contaminated site due to the known presence of free asbestos fibre contamination within soils at the site. Transport of asbestos is dependent on disturbance activities such as vehicle traffic and cattle mustering, as well as activities that result in loss of vegetation and increase the potential for erosion by wind and/or water. Although waterborne migration of asbestos has been identified as a significant method of migration, windborne migration has been considered more significant in terms of health risk associated with respirable fibres (GHD and PB, 2006).

Wittenoom has been classified under the *Contaminated Sites Act 2003* as "Contaminated - Remediation Required" and its status as a town has been formally removed; however, no action has yet been undertaken to clean up the site. The Shire has also prohibited any future development within Wittenoom through the establishment of a special control area.

A study undertaken in 2006 examining the recent management of asbestos contamination in Wittenoom indicated that priority should be given to the stabilisation of the Colonial mine site, as well as to reducing the risk to human health by isolation or remediation of areas with high concentrations of asbestos that is in a form which can be subject to release to air (GHD and PB, 2006).

Noise has also been identified as a potential air quality issue, particularly noise generated at industrial sites in close proximity to townships. Advice on noise generation at industrial sites and separation distances from sensitive land uses is provided by the Environmental Protection Authority in their 'Guidance for the Assessment of Environmental Factors' report no. 3 (EPA, 2005) and the Department of Environment Regulation's draft *Guidance Statement: Separation Distances*, which was released for consultation on 21 August 2015.

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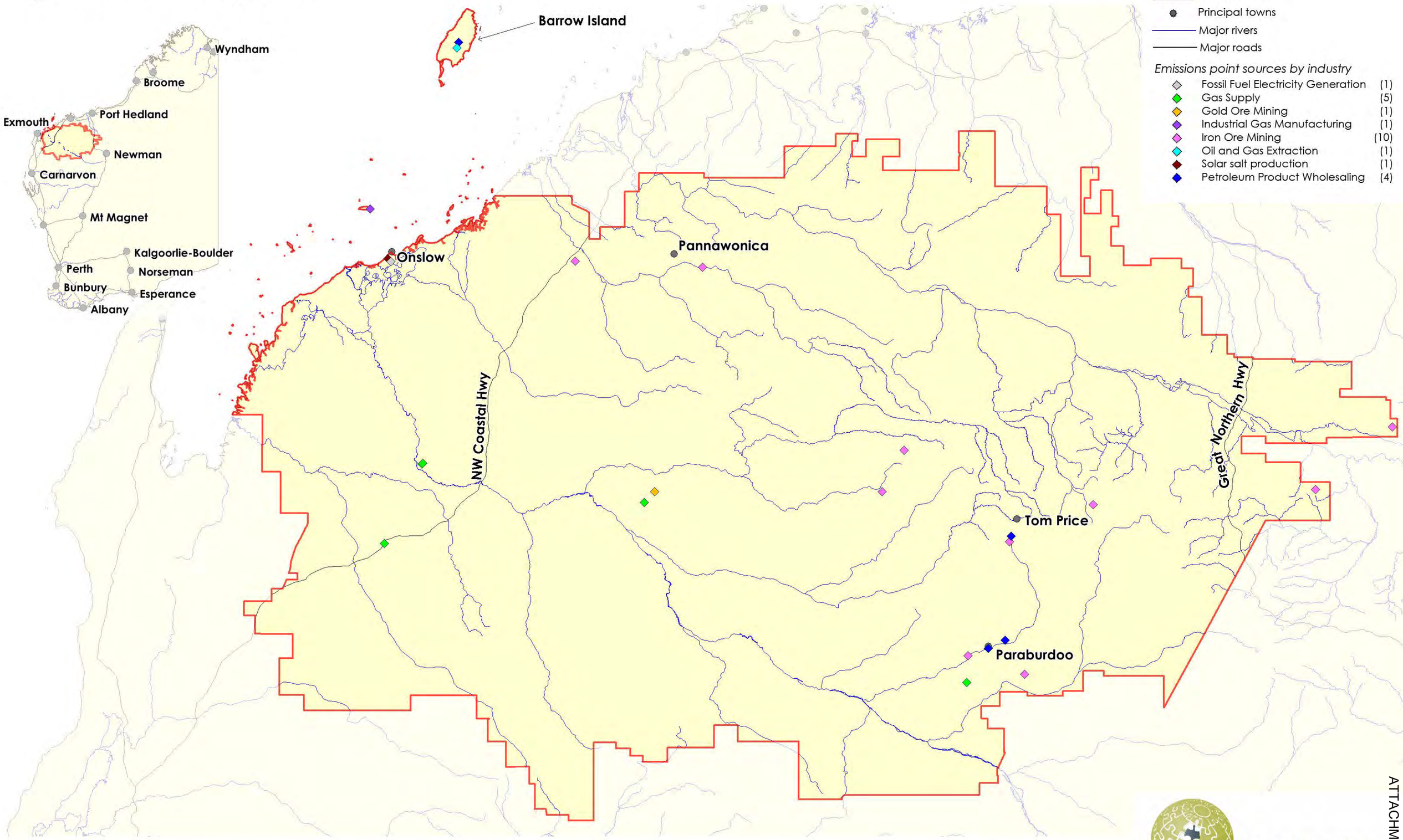
Figure 4: Air emissions



Data sources: Landgate, Geoscience Australia Created by: H Lamparski. Projection: MGA 50: zone 50.

Scale 1: 1,500,000 @ A3
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Odour from industrial processing and other uses including waste water treatment has the potential to impact on neighbouring uses. This is recognised by the Shire through a special control area in Town Planning Scheme No 7. The purpose of identifying the Waste Water Treatment Plant Odour Buffer is to avoid sensitive land uses being established within the odour buffer, and to protect the long term operation of the plant which provides an essential service to the community through the treatment, re-use and safe disposal of the town's wastewater.

2.2.1 Greenhouse gas emissions

The Shire of Ashburton has begun to actively reduce its greenhouse gas emissions through the installation of renewable energy sources to provide power for Shire buildings. This includes Onslow Airport which has installed a solar generation management system, however, it is not yet in operation. The Shire is also currently considering the heating of the Vic Hayton Memorial Swimming Pool in Tom Price using solar panels (Perera, 2016).

A new power station planned for Onslow near a proposed desalination plant is also expected to be partly operated using renewable energy via solar panels (pers. comm. Department of State Development, 21st June 2016).

The development of Australia's largest distributed energy resource microgrid, which aims to deliver more than 50% of Onslow's electricity needs with renewable energy, was announced in September 2016 (Government of WA, 2016). The new Onslow microgrid will include a mix of distributed solar energy generation and battery storage. The project includes essential electricity network infrastructure, a new transmission line and substation, and a 5.25 megawatt gas-fired modular power station, designed to efficiently contract in size as the renewable energy contribution expands to meet energy needs. Works on the power station are set to start in early 2017, with completion expected in early 2018.

2.2.2 Key considerations for strategic environmental planning

Key air quality considerations for strategic planning are:

- **Dust** – Dust generated from bushfires should be monitored and management responses developed to inform the public regarding health risks during bushfire events. Management of fuel loads without exceeding threshold air quality standards should also be considered through the development of an Air Quality Management Plan, and a program of regular fuel reduction which minimises air quality impacts on townsites and sensitive environments, on advice from the Bushfire and Natural Hazards Cooperative Research Centre (http://www.bnhcrc.com.au/). Further details regarding management of bushfire risk is presented in section 2.7.1.
  Dust from localised extraction and production of minerals, particularly near townsites, should be monitored and infringement notices issued where necessary, consistent with the *Extractive Industries Local Law 2013*.
- **Noise** – Guidance should be sought from environmental agencies with regards to appropriate separation distances to manage noise and dust for new industrial areas.
- **Odour** – from industries and waste water treatment plants should be considered as part the location of any new development.
- **Greenhouse gas emissions** – Emissions which result from Shire operations may be reduced through increased use of renewable energy and implementation of actions to improve energy efficiency.
- **Asbestos** – The Shire should maintain advice with regards to potential for health risks from the former mine sites and associated communities.

2.3 Land resources

2.3.1 Geography, topography and landforms

The Shire of Ashburton comprises two distinct landforms across its vast 100,000 km^2 area from east to west. The eastern half of the Shire is characterised by some of the oldest landforms in the world made up of rugged, deep and steep gorges separated by winding river systems, and reaching an elevation of up to 1,200 m AHD as shown in Figure 5. From east to west the landscape undulates through steep hills, flattening across a series of rivers to flood plains reaching the coast at a low elevation (Figure 5). The Ashburton, Cane, Robe and Fortescue rivers and associated tributaries run across the Shire from east to west, regularly flooding the surrounding landscape during the wet season and from tropical cyclones. They also form important catchments for surface water runoff and feed groundwater system throughout the Shire.

The Shire of Ashburton is also characterised by a series of islands along the length of its coastline, the largest (and second largest in Western Australia) and most iconic being Barrow Island (Figure 5). The island's main feature is its undulating limestone uplands surrounded by flat beaches, dunes and low cliffs.

2.3.2 Geology and soils

Figure 6 presents mapping from the Department of Mines and Petroleum's *1:2,500,000 Generalised geology of Western Australia 1999*. The soils of the Shire are generally reflective of the topography. The eastern half of the Shire typically has a surface geology of iron formation and shale, and basalt and sandstone, with a strip of alluvial deposit through the north. Small areas of metamorphosed and volcanic rock, and granite and gneiss are also located in the south around Tom Price and Paraburdoo. The western lower-lying, flat plains comprises a combination of alluvial deposits along the coast, and marine, metasedimentary, basic and intrusive rocks, sandstone, shale, and granite and gneiss further inland. Barrow Island is comprised completely of marine limestone, sandstone and valley-fill deposits, small pockets of which are also found throughout inland areas of the Shire. The lithographic description of surface geology is provided in Table 4.

Table 4: Surface geology of the Shire of Ashburton (source: DMP, 2010)

	Map symbol	Lithographic description
Eastern gorges & hills	Ab	metamorphosed basic and ultrabasic volcanic and intrusive rocks
	AP_b	basalt, dacite, and sandstone
	AP_i	iron-formation and shale
	Agn	granite and gneiss
	Asf	metamorphosed sedimentary and acid volcanic rocks
	Cza	alluvial, shoreline, and eolian deposits
Western plains	Cza	alluvial, shoreline, and eolian deposits
	Czsl	marine limestone, sandstone and valley-fill deposits (primarily at Barrow Island, however also scattered in small areas across the Shire)
	TRKs	marine and continental sedimentary rocks
	P-d	basic and ultrabasic intrusive rocks
	P_gn1	granite and gneiss
	P_s1	metasedimentary rocks
	P_st1	sandstone
	P_ss2	sandstone and shale

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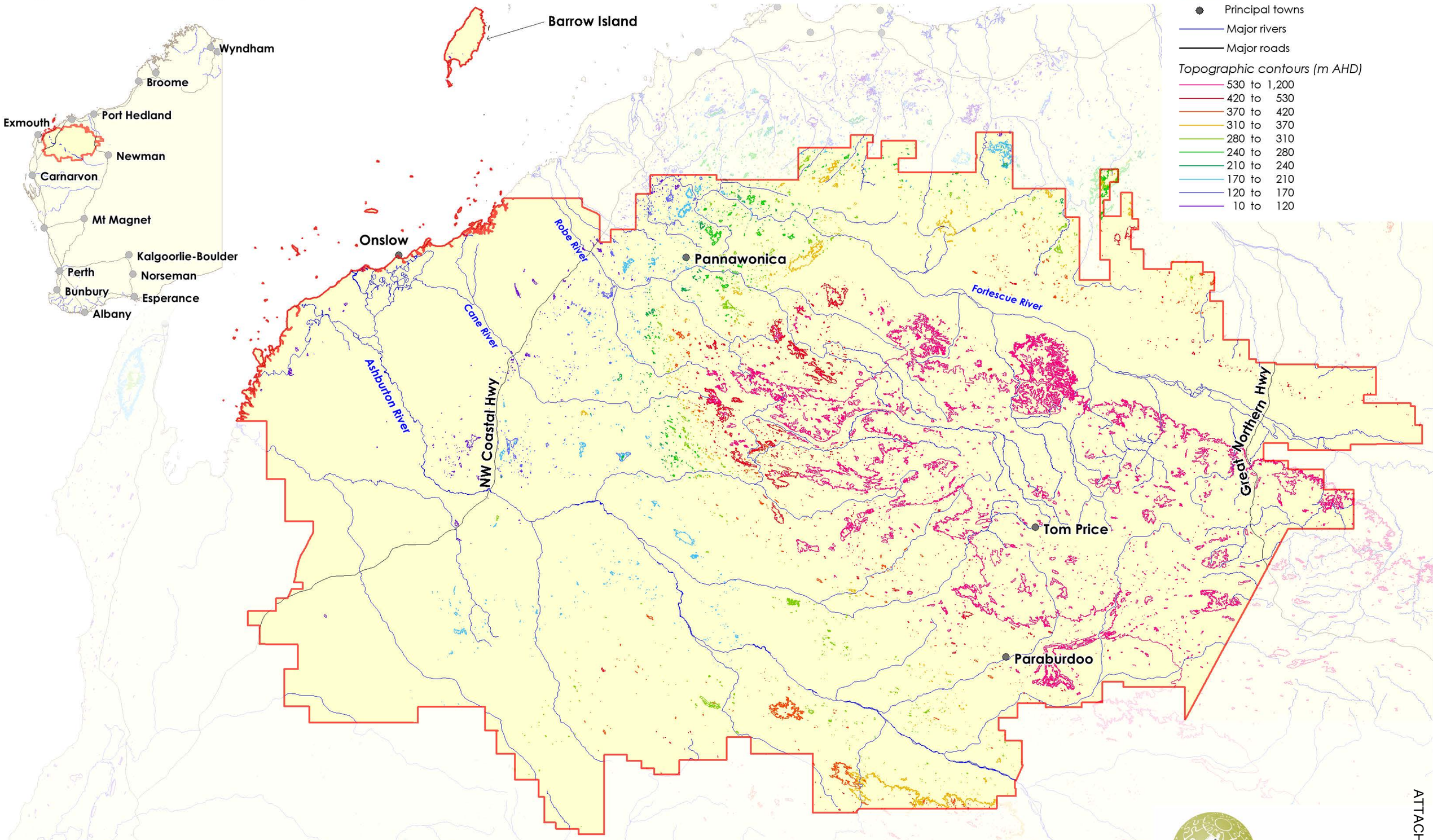
Figure 5: Topography



Data sources: Landgate Created by: H Lamparski. Projection: MGA50: zone 50.

Scale 1: 1,500,000 @ A3
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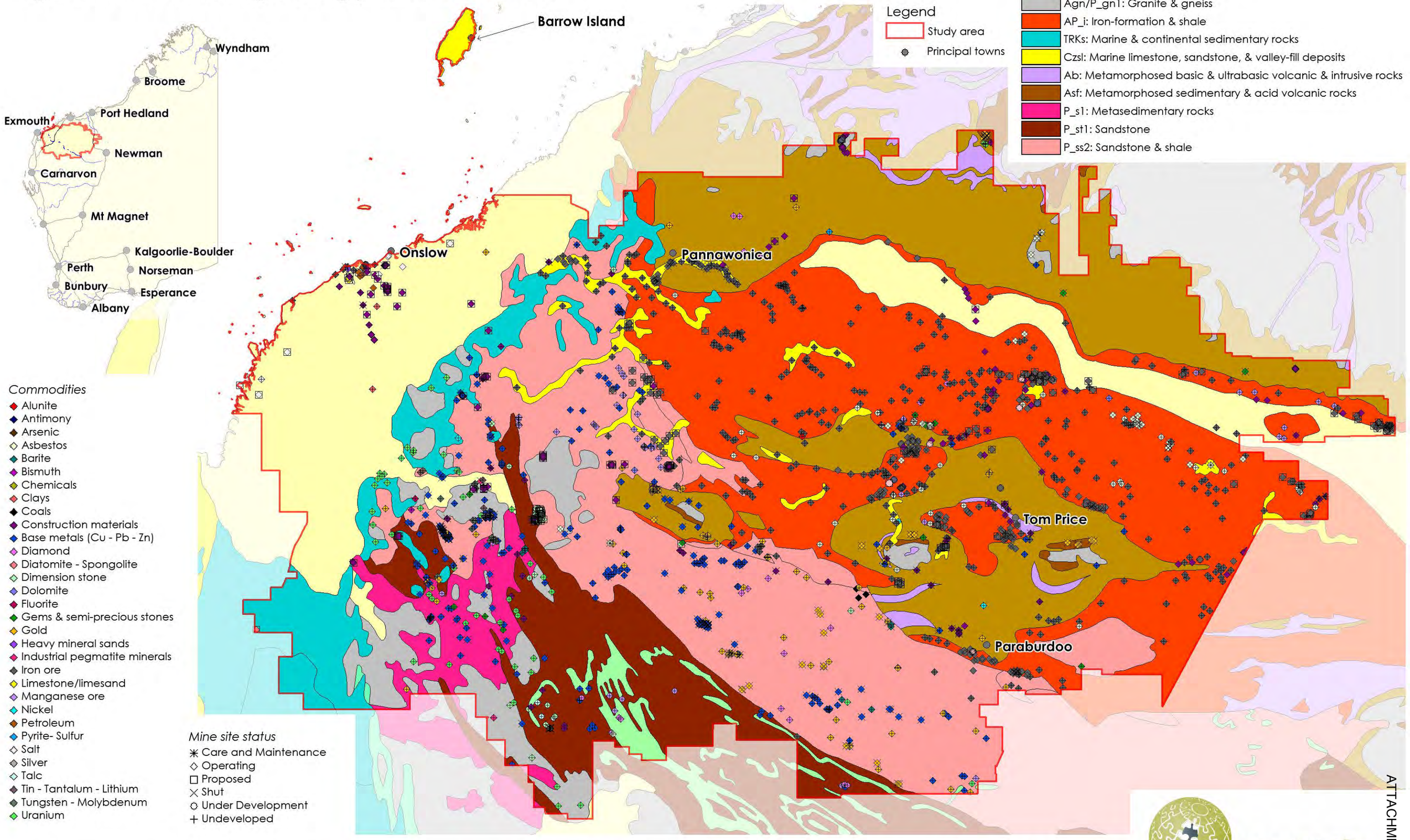
Figure 6: Surface geology and minerals



Data sources: Landgate, Dept. of Minerals & Petroleum, Created by: H Lamparski. Projection: MGA 50: zone 50.

Scale 1: 1,500,000 @ A3
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2.3.3 Minerals and basic raw materials

A substantial range of minerals have been identified by the Department of Mines and Petroleum across the Shire, the majority of which are undeveloped as shown in Figure 6. The primary commodity identified in the east of the Shire is iron ore, with a significant number of mines under development or in operation around Tom Price and Paraburdoo. Gold, manganese ore, and base metals are also significant commodities in the Shire, with deposits mainly located through the centre of the local government area. Uranium deposits have also been identified in the south west of the Shire. Salt and construction material deposits and operations infrastructure primarily comprise the commodity processing activity within coastal areas. Commodity deposits and mining activity status in the Shire is presented on Figure 6.

No significant resources of basic raw materials are considered to occur within the Shire (DMP, 2016a).

2.3.4 Acid sulfate soils

Acid sulfate soils are naturally occurring soils, sediments and peats that contain iron sulfides, predominantly in the form of pyrite materials (DER, 2015). These soils are commonly found in low-lying land bordering the coast or estuarine and saline wetlands and freshwater groundwater-dependent wetlands throughout Western Australia. They occur naturally in Western Australia and are harmless when left in an anoxic, waterlogged, and undisturbed environment.

Disturbing acid sulfate soils through excavation or drainage causes the iron sulfides in these soils to be exposed to and react with oxygen and water to produce iron compounds and sulfuric acid (DER, 2015). This acid can also release other substances, including heavy metals, from the soil and into the surrounding environment and waterways, thus potentially resulting in significant environmental and economic impacts including (DER, 2015):

- contamination of groundwater resources by acid, arsenic, heavy metals and other contaminants;
- fish kills and loss of biodiversity in wetlands and waterways;
- loss of agricultural productivity; and
- corrosion of concrete and steel infrastructure by acidic soil and water.

Much of Western Australia's acid sulfate soil material lies just below current water-tables. Changes in land use and increasing groundwater abstraction, as well as declining rainfall, will lead to lower water-tables resulting in possible acid sulfate soil oxidation (DEC, 2013b).

The WAPC released the *Acid Sulfate Soils Planning Guidelines* (WAPC, 2008) which outline a range of matters that need to be addressed at various stages of the planning process to ensure that the subdivision and development of land containing acid sulfate soils is planned, and managed, to avoid potential adverse effects on the natural and built environment.

Current mapping indicates areas within the Shire with a high probability of acid sulfate soils occur largely along coastal areas, both north and south of Onslow (see Figure 7). Small pockets of high probability areas also occur in the south along waterways, as well as in localised sites in the southwest, north and east.

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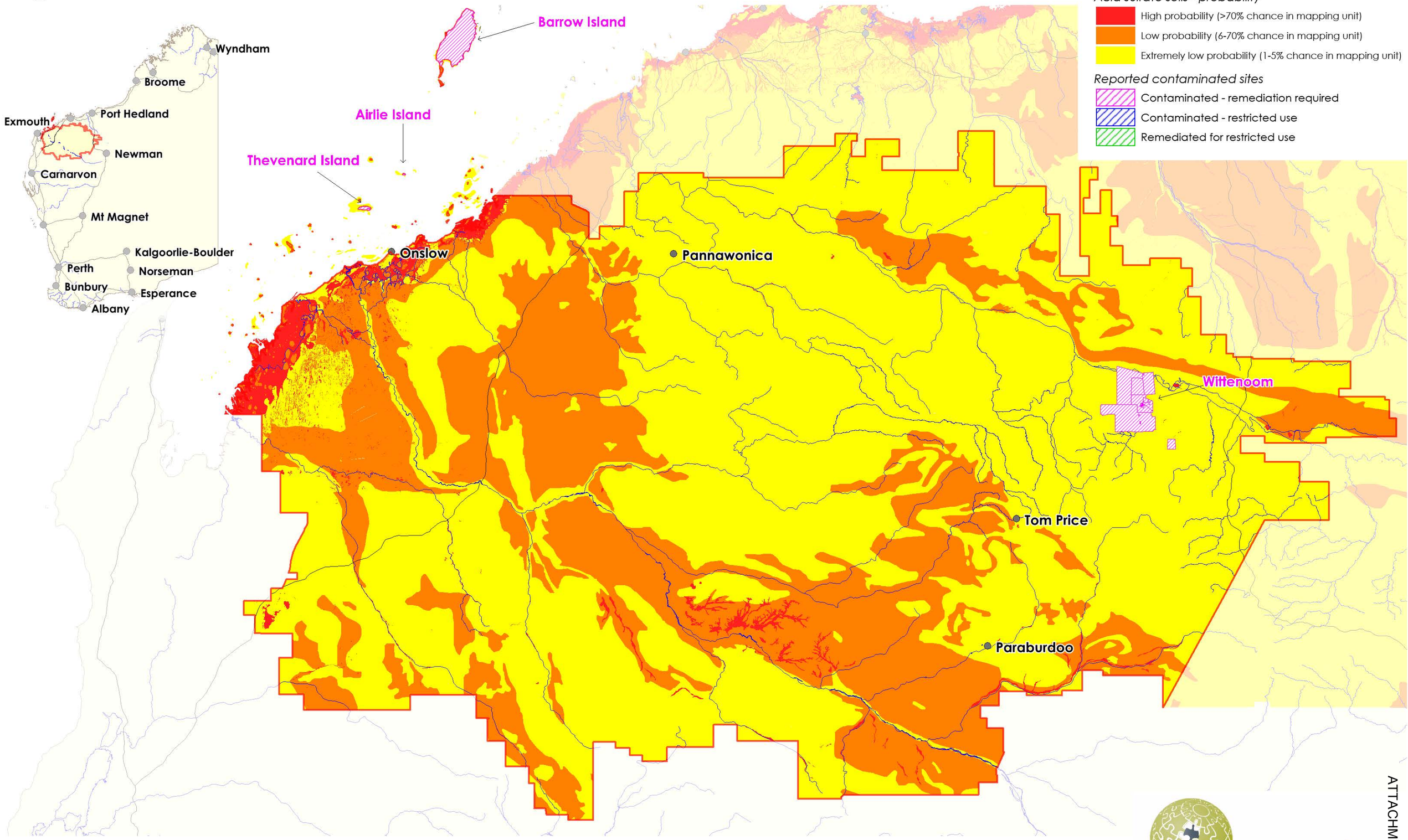
Figure 7: Acid sulfate soil risk and contaminated sites



Data sources: Landgate, Geoscience Australia Created by: H Lamparski. Projection: MGA 50: zone 50.

Scale 1: 1,500,000 @ A3
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2.3.5 Contaminated sites

Historical land uses have the potential to result in contamination of soil and groundwater. The contamination of land often renders the land unusable until it is remediated. It also has the potential to cause surface water or groundwater contamination through the transmission of contaminants where they come into contact with stormwater.

Western Australia has developed contaminated sites legislation to protect people's health and the environment from harm. Under the *Contaminated Sites Act 2003*, contaminated sites must be reported to the Department of Environment Regulation, investigated and, if necessary, remediated.

Land owners, occupiers and polluters are required to report all known or suspected contaminated sites to the Department of Environment Regulation. Reported sites are then classified, in consultation with the Department of Health, based on the risks posed to the community and environment.

Figure 7 indicates sites within the Shire currently registered on the Department of Environment Regulation's Contaminated Sites database. There are four main areas within the Shire containing registered contaminated sites; Wittenoom (ex-)townsite, Barrow Island, Thevenard Island and Airlie Island. All the contaminated sites within the Shire have been classified as 'Contaminated – remediation required'. The nature and extent of contamination on Barrow Island, Thevenard Island and Airlie Island is primarily hydrocarbons in both soil and groundwater associated with surrounding oilfield facilities, as well as heavy metals and other contaminants.

Oilfield operations off Thevenard Island ceased in 2014 and infrastructure is currently in care and maintenance mode. A decision was made by owners Chevron Corporation to decommission the Thevenard Island facilities, with the removal of all plant, road and footing expected to take two years (Wilkinson, 2015). Oilfield facilities at Airlie and Barrow Islands are still in operation.

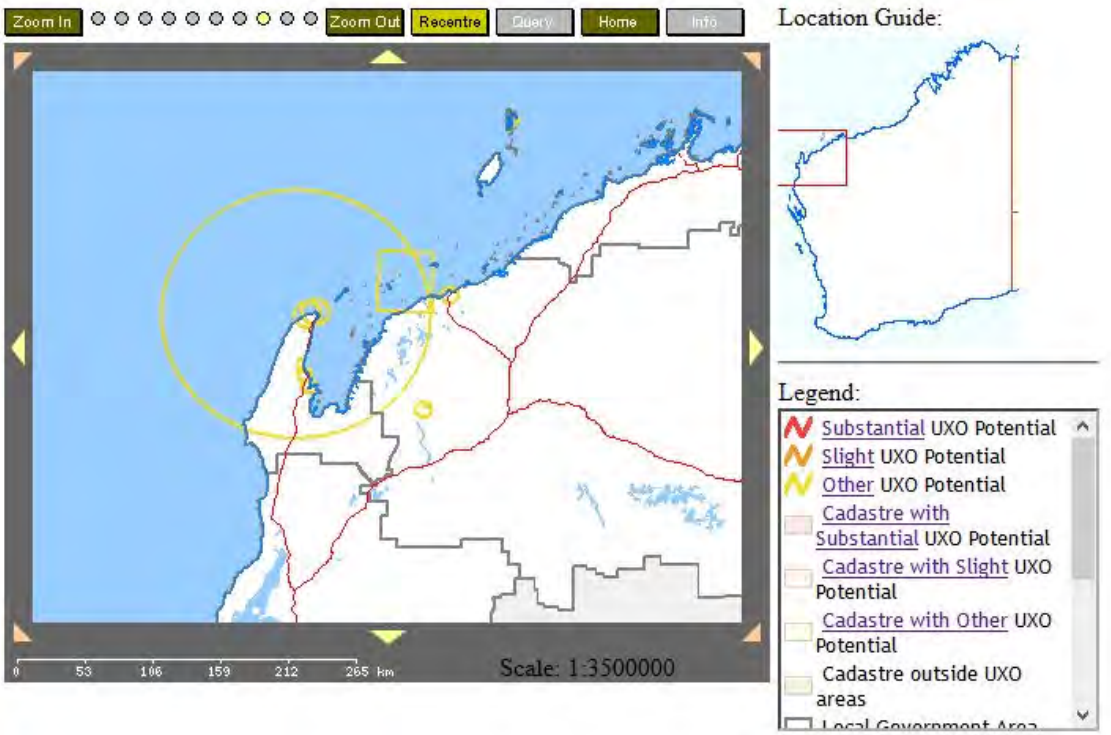
Buildings and materials found to contain asbestos at the old Onslow horse racing track (also known as the Onslow speedway), located approximately 17 km south of Onslow, have recently been removed by an approved asbestos removal contractor (pers. comm. Tahi Morton, Shire of Ashburton, 16th November 2016). However, soil at the site has not been tested for asbestos. The old horse racing track is expected to be turned into a motor cross track in the near future.

Soil testing for asbestos was undertaken at the Onslow rodeo grounds and marked as a future contaminated site. The Shire is currently working to finalise the assessment with the Department of Environment Regulation (pers. comm. Tahi Morton, Shire of Ashburton, 16th November 2016). An additional 0.5 m layer of topsoil has recently been laid over the asbestos-contaminated site at the rodeo grounds in order to use this area as a car park. The contaminated site has previously been covered by topsoil, however, an additional layer was required in order for it to be used safely and minimise risk.

Other sites reported to the Department of Environment Regulation, including sites awaiting classification, are recorded separately by the Department of Environment Regulation and have not been mapped.

A search of the Department of Defences's Unexploded Ordnance (UXO) online mapping indicates that a classification of 'Other' UXO potential exists in some coastal areas of the Shire and one inland area (see Plate 1 below). The areas classified as having 'Other' UXO potential indicates that they were used by the Department of Defence for military training, but use of live firing has not been confirmed, and UXO or explosive ordnance fragments / components have not been recovered from the site. Defence recommends that Local Government notify affected landowners if their property is in a 'Slight' or 'Substantial' potential UXO contamination area only.

However, the Shire is required to inform affected landowners, residents and those working in these areas that they were used for military activities and ensure that they receive the appropriate UXO warning and advice as issued by Defence (DoD, 2016).



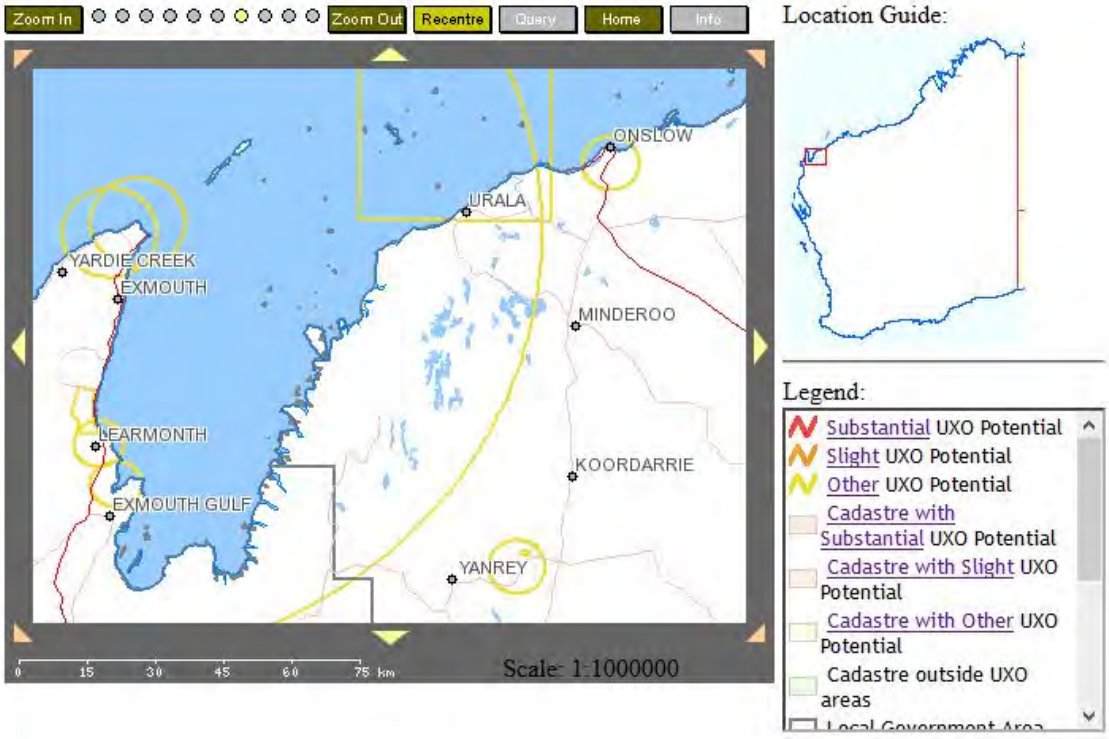


Plate 1: Potential for UXOs in the Shire (DoD, 2016)

Wittenoom

Wittenoom townsite and its surrounding areas is the most notable contaminated site in the Shire. It is now a degazetted town, the legacy of contamination due to crocidolite mining and milling between the 1940s and 1960s. The State Government began phasing down activity in Wittenoom in 1978 as a result of the widespread contamination of crocidolite. In 1993 the Government commissioned a feasibility study for cleaning up the townsite which found that there was still extensive contamination, after approximately fifteen years during which attempts were made to clean up the town. A proposed clean up involved the removal of 100 mm of contaminated top soil and replacement by gravel capping under strict guidelines at a cost of approximately $2.43 million. However, a systematic clean-up of the town was not undertaken. Members of the Interdepartmental Committee on Wittenoom believed it was unlikely the town could be satisfactorily cleaned up and the benefits of attempting to clean up the town were not in proportion to the costs, or the risks involved.

In 2006 GHD and Parsons Brinckerhoff undertook a study on behalf of the Department of Industry and Resources, and Department of Local Government and Regional Development, to develop a risk-based strategy for managing the health risks posed by asbestos tailings in Wittenoom. The objectives of the study were to undertake a field survey of the extent and nature of the asbestos contamination, develop a risk assessment process and identify and evaluate options for the management of any risk identified. The risk assessment indicated that the Wittenoom gorges posed a high or extreme risk to Aboriginal people, tourists and mining industry contractors. The floodplain, and contaminated creek beds in particular, used by Aboriginal people, pastoralists, residents and construction contractors was also considered of high to extreme risk to these groups. Waterborne migration of asbestos was identified as the most significant method of migration, although windborne migration was considered more significant in terms of health risk associated with respirable fibres. A major conclusion of the study was that priority should be given to the stabilisation of particular mine sites and tailings dumps (Colonial mine site) to reduce the risk to human health by isolation, or by remediation of areas with high concentrations of asbestos in a form which could be subjected to release to air (GHD and PB, 2006).

In addition, it was recommended that residents be removed from the townsite, and townsite buildings and infrastructure be demolished and removed. Recommendations were put forward to the Wittenoom Steering Committee, established by the Western Australian Government in 2002 (Government of Western Australia, 2016). Both the Department of Health and an accredited contaminated sites auditor also reviewed the report, with the latter finding that the detected presence of free asbestos fibres in surface soils from sampled locations presented an unacceptable public health risk. The auditor recommended that the former townsite and other impacted areas defined in the report be classified as "Contaminated - Remediation Required".

In December 2006, the Minister for the Pilbara and Regional Development announced that Wittenoom's status as a town would be removed, and in June 2007 the townsite status was officially removed (Government of Western Australia, 2016). The Department of Environment and Conservation subsequently classified Wittenoom as a contaminated site under the *Contaminated Sites Act 2003* on 28 January 2008.

Most recently, in 2013 the Department of Lands engaged environmental consultants to undertake feasibility studies on the preferred remediation options for the three highest risk sites at Wittenoom, including Wittenoom Mine, Colonial Mine and the Wittenoom Gorge. The Department of Lands also began working with relevant agencies and stakeholders to raise awareness of the risks posed by Wittenoom to the general public and local Aboriginal people, and assess long term solutions for the management of the area.

The Government of Western Australia also began drafting special legislation in December 2015 to allow the forcible removal of the last few remaining residents of Wittenoom (Perpitch, 2016).

2.3.6 Waste management

Effective waste management is essential to protect groundwater resources and wetlands, coastal zone areas and other areas with environmental values.

Waste in the Shire is generated from domestic land uses including building and construction, council works and commercial and industrial activities, including mining. Waste management facilities are generally operated by the Shire including in the townships of Onslow, Paraburdoo and Tom Price. However, some private facilities exist, such as at Pannawonica, which are operated by mining companies.

The predominant means of disposing waste in the Shire is by landfill, with limited recycling or reuse of materials. This is largely a factor of high transport costs and a lack of markets for recyclable materials; however, it is compounded by high levels of contamination, the costs of recovery, and the generally free access by households to dump trailer waste at landfills.

Waste management in remote communities is also difficult, due to low levels of community awareness and participation in recycling as well as inappropriate waste management practices that have the potential to impact on drinking water resources. Illegal dumping of waste is particularly an issue with reports of dumping occurring in Paraburdoo near the light industrial area.

Increased growth in the region will lead to increased amounts of waste that are generated. This is of concern primarily due to the low level of reuse and recycling that are currently occurring, suggesting that the majority of all new waste will end up in landfill.

Due to development in Onslow, continued residential growth and expansion of the resources industry, the old Onslow Landfill was officially closed and in a new, modern waste transfer station opened August 2015. Waste collected at the transfer station in Onslow is being transported to Tom Price. Another landfill site has also been identified for development 30 km south of Onslow, as a Class 4 facility for use by Chevron as part of its operations (OCCI, 2016). The land is currently vested to the Department of Parks and Wildlife for conservation and a feasibility study will be completed in 2016.

The landfill site in Tom Price has an estimated capacity of around fifteen years, with the capacity of the Paraburdoo landfill estimated at 9-10 years.

Long-term waste management planning is currently being undertaken by the Shire. A Landfill Strategic Waste Plan which includes an assessment of the lifecycle of landfills has recently been developed for the Shire of Ashburton and has been received by Council.

2.3.7 Land capability for agriculture

The Department of Agriculture and Food WA (DAFWA) undertook an assessment of soil capability and degradation hazards across Western Australia, however, the assessment did not extend to the Pilbara region (DAFWA, 2016a).

A Rangeland inventory and condition survey was undertaken for the Ashburton River catchment between 1976 and 1978 (Payne et al., 1988). A survey report was prepared providing a baseline record of the existence and condition of the natural resources within the catchment to assist with the planning and implementation of land management practices. The report identified and described the condition of soils, landforms, vegetation, habitat, ecosystems, and declared plants and animals. It also assessed the impact of pastoralism and made land management recommendations.

The area surveyed covers approximately 93,600km² and includes the catchment of the Ashburton River and part of the catchment of the Yannarie River. About 65% (61,130km²) of the area was then occupied by 30 pastoral leases grazing sheep and/or cattle. The remaining 35% (32,470km²) consisted of various reserves and vacant crown land unsuitable for pastoral purposes. Pasture and soil condition was assessed at a number of points throughout the survey area and found that:

- 9% of the points surveyed indicated that perennial vegetation was in poor to very poor condition;
- 27% indicated fair rangeland condition; and
- 64% indicated good or very good condition.

The worst areas of degradation and erosion were identified on the most valuable pasture lands. These areas are readily accessible, close to permanent water supplies and support attractive pastures. Therefore, they received preferential overuse in the early days of settlement, and sensitive parts of these areas are now seriously degraded.

Rangelands pastoral condition was also assessed by DAFWA in order to provide advice on the planning and management of grazing pressure on leases, and to report to the Pastoral Lands Board. Lessees and station managers can use these assessments to improve management and long-term condition of the rangeland resource. The Western Australian Rangeland Monitoring System (WARMS) has been the key assessment tool used by DAFWA to monitor change in vegetation condition and provide information on rangeland condition trends at a regional or district scale. This included grassland and shrubland assessments to indicate pasture condition and trends, and thus land capability. Grassland sites were assessed on a three-year cycle and shrubland sites assessed on a five-year cycle through the WARMS tool. Regular lease inspections were carried out by DAFWA until 2012, when responsibility was given to lessees and land manager to undertake these assessments (DAFWA, 2016b).

Reporting data from the most recent sampling period (2012 – epoch 7 for grasslands) for the Ashburton Land Conservation District (LCD) indicates that perennial grass coverage continued to decreased despite favourable climatic conditions, and a stock density below the estimated carrying capacity of the LCD in the previous two years (see Chart 3, Novelly and Thomas, 2013). Data on rangelands condition has not been reported since 2013 and the Annual Rangeland Condition and Data Input Application (ARCADIA) administered by the Pastoral Lands Board is no longer in operation.

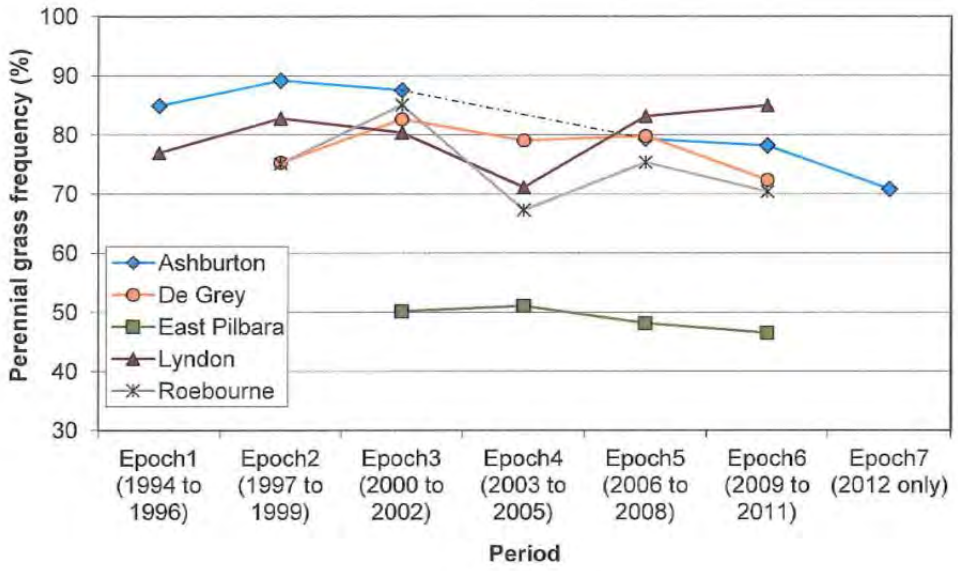


Chart 3: Reported grassland cover (frequency) (Novelly and Thomas, 2013)

The decline in vegetation and soil condition (particularly when exacerbated by drought) in the rangelands of the Shire of Ashburton has implications for the regional pastoral industry (Novelly and Thomas, 2013). As vegetation coverage decreases, the capacity for livestock to graze and be supported by the rangelands will also decrease. This pattern places pressure on pastoralists to increase stock density to make up for market shortfalls, which in turn has environmental implications.

Rangelands NRM has recently been working with the Federal Government to deliver Ecologically Sustainable Rangeland Management (ESRM) plans for land managers in the rangelands. Through the ESRM planning process, the land manager identifies land systems, notes their productive potential and degradation risks and prioritises them into action/response categories. Land systems with the greatest productive potential with the highest risks of on-going or future degradation are prioritised to ensure sustained productivity. Land managers can then use this knowledge to assess current management practices and develop appropriate interventions (Rangelands NRM, 2016). In particular, Rangelands NRM is working with pastoralists in the Fortescue catchment to assist in managing total grazing pressure and control livestock access to areas of high biodiversity value, by increasing ground cover and its condition on pastoral properties, and improving cattle management.

Although mining activities require environmental approval, the widespread exploration for resources and their associated extraction and transport has resulted in some impacts on the regional landscape. This includes a loss in land capability in areas that are actively mined, as well as utilised for associated infrastructure. Other localised landscape impacts are evident as a result of mining activities in coastal and marine areas, such as the construction of off-loading facilities, ports, pipelines and causeways.

2.3.8 Key considerations for strategic environmental planning

Key land resource considerations for strategic planning are:

- **Resource extraction** – Clearing of the land for resource extraction results in a loss of biodiversity and can lead to erosion. Mining activities impact on the visual landscape of the Shire; can result in off-site impacts on nearby land uses including dust, noise and light; and can also lead to the lowering of groundwater tables.

- **Acid sulfate soils** - Declining soil and land quality can occur as a result of activity where acid sulfate soils are disturbed. This leads to the release of acid and heavy metals which can cause significant harm to the environment and infrastructure. Appropriate management of acid sulfate soils, particularly in areas of high risk where changes in groundwater are likely or mining is proposed, is required, consistent with current best practice.
- **Contaminated sites** – Given that contaminated sites within the Shire are located within operational oilfield facilities, the Onslow townsite, and within the Wittenoom degazetted townsite, consideration should be given to processes established under the *Contaminated Sites Act 2003*, particularly in coordination with the Department of Lands with respect to Wittenoom. In addition, any unsewered residential and industrial areas within the Shire have the potential to lead to contamination of land and groundwater and alternative treatment units should be used in areas of high environmental risk.
- **Waste management** – Consideration should be given to opportunities to establish local or regional waste management and/or recycling facilities as population in the region increases, as well as opportunities to subsidise recycling schemes. This should include industries with multiple benefits such as waste to energy plants.
- **Soil and vegetation condition** – Vegetation retention assists in the maintenance of soil health. Soils and vegetation (grasslands and shrublands) in good condition are also associated with higher agricultural productivity. Supporting the development and planning process of Ecologically Sustainable Rangeland Management (ESRM) Plans for land managers in coordination with the Pastoral Lands Board and DAFWA should also be considered.

2.4 Water resources

2.4.1 Surface water – waterways, wetlands and flooding

Long, wide river systems drain the rocky outcrops of the inland region and flow over the coastal plains to discharge northwest into the Indian Ocean. These are a significant environmental feature of the Shire's landscape. River flowpaths are often wide and intertwining, and discharge points are usually a combination of direct ocean channels and dispersal through marshy flats.

As a direct response to irregular rainfall patterns and extreme climatic conditions, rivers in the Shire are subject to massive, seasonal variations in flow. These conditions result in a landscape with wide floodplains which allow the periodic passage of large volumes of water and sediment across the tablelands to the coastal areas and near-shore marine environment, particularly during cyclonic events. With the exception of some small but important, spring-fed sections, all waterways in the region are ephemeral, in that surface flow ceases for at least part of each year.

Major surface water basins within the Shire include the Onslow Coast and Cane River, Fortescue River, Robe River, Yannarie River, and Ashburton River (Figure 8). The Ashburton River Catchment covers over 75,000 km^2 and includes the Ashburton, Angelo, Hardey, Henry Rivers and Tunnel, Perry, Ethel, Turee, 7 Mile, Duck Creeks.

The largest rivers in the Shire, the Fortescue and Ashburton rivers, flow for significantly greater periods of time than the other rivers. However, in wetter years only the Fortescue River flows for more than half the year. The major rivers contribute significant recharge to groundwater resources such as the Millstream aquifer, while flowing over the coastal plains towards the Indian Ocean. However, streamflow has been estimated to exceed groundwater recharge volumes by five to six times, due to the very large flows resulting from cyclonic events and tropical depressions, which exceed the amount of water that can infiltrate during these events (CSIRO, 2015b).

Most runoff occurs during the period of January to March, largely as a result of cyclonic activities, with typically less runoff during December and April (WAPC, 2009). Mean annual runoff rates from the major rivers in the Pilbara region typically represent 2% to over 10% of the annual rainfall and between 8-30 mm of rainfall is required to make the rivers and streams flow (CSIRO, 2015b).

The Shire of Ashburton is located within the Pilbara Surface Water Area, which is proclaimed under the *Rights in Water and Irrigation Act 1914* for the purposes of regulating the taking of water from watercourses and wetlands.

Wetlands

While no Ramsar wetlands are located within the Shire, Millstream Pools and Fortescue Mashes are being considered as Ramsar sites (DoW, 2010b). A number of wetlands have been listed in the *Directory of Important Wetlands in Australia* (Environment Australia, 2001). These include; Millstream Pools, Karijini Gorges, Weeli Wolli Spring, Exmouth Gulf East, Fortescue Marshes, Kookhabinna Gorge, Mt. Bruce coolibah-lignum flats and Yadjiyugga Claypan. Nationally important wetlands are shown on Figure 8.

Due to the arid climate of the region, permanent and semipermanent pools are of high ecological value. These pools and wetlands sustain populations of terrestrial and aquatic flora and fauna during times of drought and are refuge areas from which biota expand during times of flood. Permanent pools with recognised significance include those associated with the Yule, Sherlock, Harding, and Fortescue coastal rivers (Kendrick and Stanley, 2001).

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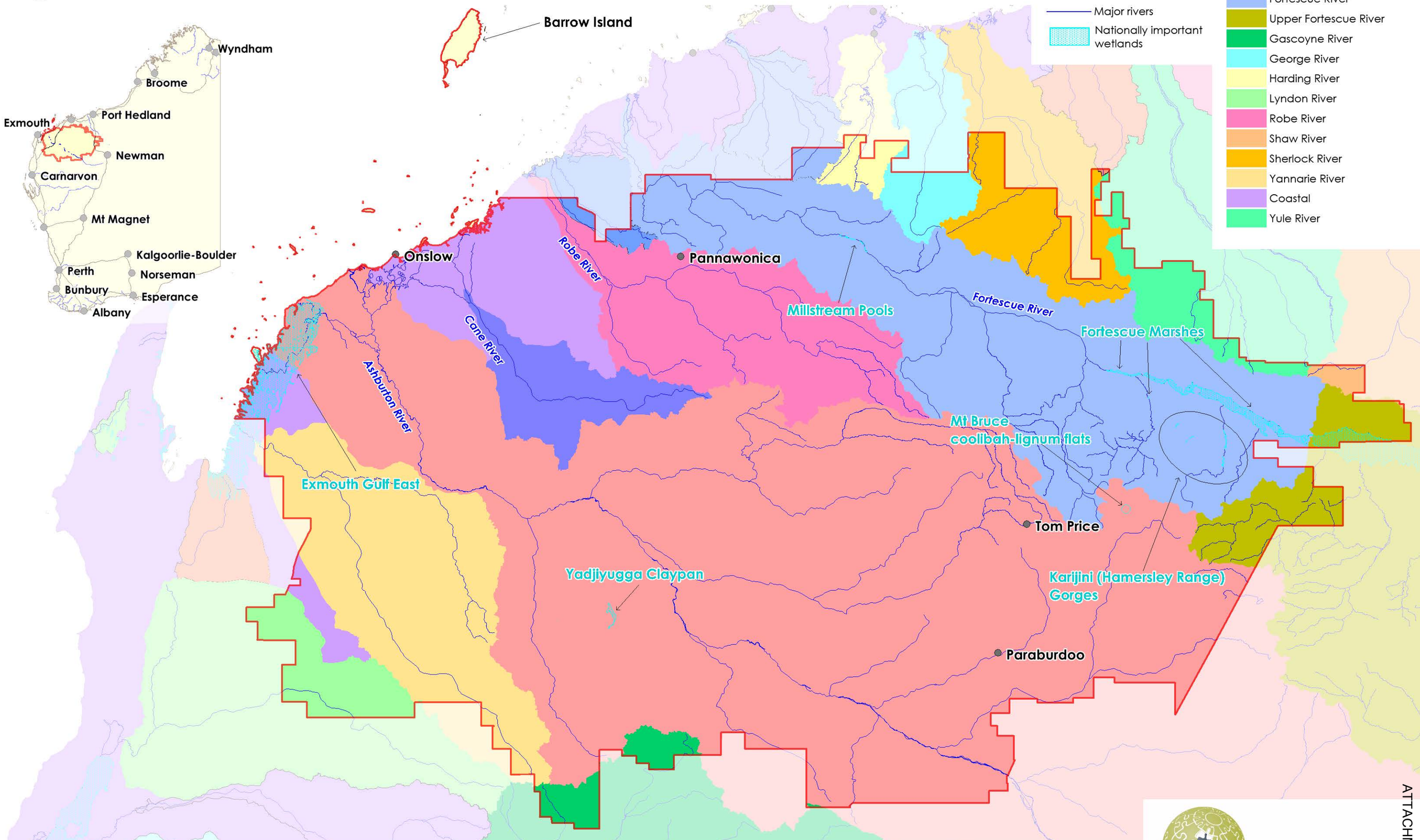
Figure 8: Surface water



Data sources: Landgate, Department of Water, Department of the Environment Created by: H Lamparski. Projection: MGA 50: zone 50.

Scale 1: 1,500,000 @ A3
0 60 km

essential environmental

Pools and wetlands also have significant cultural value to local Aboriginal people. For instance, stories of 'The Dreaming' from the Millstream area provide the basis for the cultural practices of the Yindjibarndi and Ngarluma people (WAPC, 2009).

Flooding

Episodic flooding is a natural hydrologic feature of the Shire and greater Pilbara region. Episodic flooding provides critical recharge of groundwater aquifers and inundation of waterways and wetlands that may have been dry for extended periods. Episodic flooding also results in explosive ecological responses, which are a remarkable feature of the region.

Heavy rainfall and associated river flooding is the main impact from most cyclone events, particularly in the inland region of the Shire. The highest rainfall is usually found along or just east of the cyclone track. The flood potential of a cyclone system is not directly related to its intensity but is associated with its track, speed, aerial extent and saturation of catchments from prior rainfall. Rainfall totals in excess of 100 mm are common with tropical lows that move over land. In February 1997, a slow moving low moving over the west Kimberley, Pilbara and Gascoyne caused rainfall in excess of 400 mm in parts, and one of the highest ever floods along the Ashburton River. Cyclone Joan in December 1975 caused over 400 mm of rain near its track, the highest fall being 591 mm at Marandoo (BoM 2016b).

Flooding is enhanced when multiple tropical lows occur within a few weeks of each other. During January and February 1961 rainfall totals exceeded 200 mm during two tropical cyclones. At Wittenoom it was described as the worst flood in memory as water levels rose to 23 m in sections of the Gorge. In both events Wittenoom was isolated. In 1980 cyclones Amy, Dean and Enid moved over the eastern Pilbara causing total rainfall to exceed 600 mm in some areas (BoM, 2016b).

Flood risk and stormwater in townsites requires management by the Shire. Key stormwater management issues associated with development in the Shire include the management of erosion, silt, sediment, water quality and weeds, particularly in sensitive environments. It is recognised that the red soils of the Pilbara region have a high capacity for erosion. This, coupled with the high volumes of stormwater which flow in the wet season, requires active and effective management to adequately control erosion and sediment transport.

The Shire is responsible for the management of flooding and drainage in the major townsites of Onslow, Tom Price and Paraburdoo. This includes routine maintenance of systems and approval of new systems for new areas of development. Rio Tinto Iron Ore is responsible for the provision of services in Pannawonica.

Anecdotal evidence suggests that there are no significant issues with regards to major event flooding in Tom Price and Paraburdoo; however, some impacts may result from blocked infrastructure. Maintenance typically involves semi-regular removal of vegetation from drains, replacement of old infrastructure (end of life, e.g. rusted corrugated iron pipes), and removal of sediment after big events.

Flood risk is also addressed in section 2.7.2.

2.4.2 Groundwater – resources, availability and use

Groundwater is the major source of water in the greater Pilbara region and thus particularly important to the Shire. Due to the arid climate of the region, highly seasonal and variable rainfall and very high evaporation rates, surface water is not a reliable water resource for users.

The main groundwater resources in the region are contained within karstic dolomites, channel-iron deposits, and mineralised zones in the Hamersley Range, fractured rock aquifers, in channel-iron deposits at Bungaroo Creek and potentially other paleochannels, and in alluvium along the lower river systems along the coast. Alluvial groundwater is generally fresh close to riverbeds and saline further away where they are less well flushed of salts (CSIRO, 2015b).

Groundwater aquifers in the Pilbara region are recharged by direct infiltration of rainwater and from streamflow leaks through riverbeds during surface water flows. The quantity, quality and reliability of groundwater resources depends on the different aquifer types, thus impacts of abstraction from aquifers also vary.

Groundwater is most easily located and accessed near surface water drainage lines or alluvial channels. Aquifers in coastal areas of the Pilbara are considered small, receiving a typical annual recharge of less than 10 GL/year (DoW, 2010b).

Groundwater is critical to biodiversity in the region. It is the source of many small, spring-fed systems and sustains riparian areas along the ephemeral rivers, as well as many significant groundwater dependent ecosystems which have important environmental, social and cultural values. In particular, aquifers provide important habitat for stygofauna and troglofauna. The presence of stygofauna in the Pilbara has been well documented in groundwater dependent ecosystems. The Fortescue System, particularly the Millstream Aquifer, has many identified global stygofauna "hot spots" (Rangelands NRM Coordinating Group, 2005).

The Shire contains a number of important aquifers, including Carnarvon – Birdrong, Hamersley – Millstream, Lower Robe alluvial, Lower Cane alluvial and Lower Bungaroo Valley (Table 5). The Shire is located entirely within the Pilbara Groundwater Management Area, and Ashburton Groundwater Management Subarea, which is proclaimed under the *Rights in Water and Irrigation Act 1914.*

Public drinking water supply

Public drinking water is supplied predominantly from groundwater and the Shire's Public Drinking Water Source Areas include the Cane River Water Reserve, Millstream Water Reserve, the Harding Dam Catchment Area and Bungaroo Creek Water Reserve, as well as a number of smaller areas as indicated in Table 5 and shown on Figure 9.

Table 5: Public drinking water sources areas in the Shire

PDWSA	Source	Priority	Management Plan	Included in TPS No. 7 Reserve
Bungaroo Creek Water Reserve	Groundwater	P1	Bungaroo Creek Water Reserve Drinking water source protection plan (West Pilbara water supply scheme) (2012)	No
Cane River Water Reserve	Groundwater	P1	Cane River Water Reserve water source protection plan (Onslow Town Water Supply) (1999)	Yes – Cane River water reserve area SCA
Harding Dam Catchment Area	Surface water	P1	Harding Dam water source protection plan (West Pilbara water supply scheme) (1999)	Yes - Public purposes: water & drainage; Millstream Chichester National Park
Millstream Water Reserve	Groundwater	P1 & P2	Millstream Water Reserve Drinking water source protection plan (West Pilbara integrated water supply	P1: Yes - Public purposes: water & drainage; Millstream Chichester National

PDWSA	Source	Priority	Management Plan	Included in TPS No. 7 Reserve
			scheme) (2010)	Park P2: No
Marandoo Water Reserve	Groundwater	P1	Southern Fortescue & Marandoo Water Reserves Drinking water source protection plan (Tom Price town water supply) (2011)	Yes – Other purposes: infrastructure
Pannawonica Water Reserve	Groundwater	Not assigned	-	No
Paraburdoo Water Reserve	Groundwater	P1 & P3	Paraburdoo Water Reserve Drinking water source protection plan (Paraburdoo town water supply) (2013)	P1: Partial – Public purposes: water & drainage P3: No
Southern Fortescue Water Reserve	Groundwater	P1	Southern Fortescue & Marandoo Water Reserves Drinking water source protection plan (Tom Price town water supply) (2011)	Yes – Borefield SCA

All water reserves are covered by water source protection plans, with the exception of the Panawonica water reserve which is not yet assigned a category (see Table 5). These water source protection plans provide guidance on the management of risks to the water source and are managed by the Department of Water.

Water for the main towns (Onslow, Tom Price, Paraburdoo, and Pannawonica) comes from a variety of groundwater sources near the towns and is provided by the Water Corporation or mine operators (DoW, 2013), as shown in Table 6.

Table 6: Major water supplies and their sources for the Shire of Ashburton

Water Supply Scheme	Local government area	Water source	Water service provider
Onslow	Shire of Ashburton	Cane River alluvial aquifer	Water Corporation
Tom Price	Shire of Ashburton	Southern Fortescue borefield& Marandoo mine aquifer dewater	Rio Tinto
Paraburdoo	Shire of Ashburton	Paraburdoo wellfield	Rio Tinto
Pannawonica	Shire of Ashburton	Robe River alluvial aquifer	Rio Tinto

The Water Corporation currently hold an allocation license for 15 GL from the Millstream aquifer (DoW, 2013). This is nearly three times the long-term sustainable yield of this resource which is estimated at 5.2 GL/year (DoW, 2010d). Although the licence conditions for Millstream and Harding Dam require the dam to be used as the primary water source for the West Pilbara water supply scheme (supplying Karratha, Dampier, Roebourne, Wickham, Point Samson and Cape Lambert), water supply issues in the dam have required the use of the Millstream aquifer to supplement supply during peak demand periods (see Figure 9, DoW, 2013).

The State Government reached an agreement with Rio Tinto to develop an extra 10 GL/year groundwater source from the Lower Bungaroo Valley. This water is used to supplement the Water Corporation's West Pilbara Water Supply Scheme and reduce the reliance on Millstream aquifer.

At present the Lower Cane alluvial aquifer supplies water via a pipeline to Onslow. While plans had recently been developed to treat saline groundwater in the coastal Carnarvon – Birdrong.

aquifer via desalination to provide additional drinking water for Onslow, and for gas processing, (CSIRO, 2015a), these have recently been placed on hold due to higher than expected freshwater production from the Lower Cane alluvial aquifer.

Rio Tinto Utilities owns and operates the water supply schemes for Tom Price, Paraburdoo and Pannawonica. The company is licensed under the *Water Services Licensing Act (*1995) to supply potable and wastewater services to these towns, as well as Dampier in the Shire of Roebourne. Tom Price, Pannawonica and Paraburdoo are supplied with water from bore fields in shallow alluvial aquifers and supply is not currently considered to be at capacity. Groundwater management is administered by Rio Tinto through Groundwater Operating Strategies which are agreements between the Department of Water and Rio Tinto detailing abstraction and monitoring requirements and reporting by both parties.

Groundwater availability

Information on groundwater availability for some aquifers within the Shire is presented in the Department of Water's Pilbara groundwater allocation plan (DoW, 2013).

Table 7 provides information on the committed allocation and remaining volume of groundwater resources within the Shire in the Ashburton groundwater subarea (data requested from DoW 22nd June 2016). Groundwater used for stock and domestic purposes at pastoral stations is exempt from groundwater licensing.

Table 7: Groundwater resource and allocation limits (source: DoW, June 2016)

Aquifer	Allocation Limit	Allocated Volume	Committed Volume	Remaining Volume	% Allocated and Committed	Additional Requested
Carnarvon - Birdrong	100,00	2,400	0	**97,600**	**2.40 %**	10,000
Carnarvon – Birdrong.	1,500,000	1,220,000	0	**280,000**	**81.33 %**	0
Carnarvon - Surficial	2,000,000	1,858,570	0	**141,430**	**92.93 %**	12,000,000
Hamersley – Fortescue	Not set	127,544,000	0	-	**0 %**	0
Pilbara – Fractured Rock	Not set	15,994,320	0	-	**0 %**	0
Wittenoom – Wittenoom	19,980,000	10,155,500	0	**9,824,500**	**50.83 %**	0
Hamersley – Fractured Rock	Not set	334,356,615	0	-	**0 %**	15,922,000
Combined – Fractured Rock	Not set	3,303,270	0	-	**0 %**	20,000
Hamersley - Millstream	682,500*	585,500	0	**97,000**	**85.79 %**	0
Lower Robe Alluvial	3,000,000	0	0	**3,000,000**	**0 %**	0
Lower Cane Alluvial	92,5000	0	0	**92,5000**	**0 %**	0
Lower Bungaroo Valley	0	95,000	0	**-95,000**	**0 %**	0

*15 GL/yr is the maximum amount that can be taken from Water Corporation's borefield, provided management conditions are met and Harding Dam cannot be used. The long-term reliable allocation is an average of 5.2 GL/yr.

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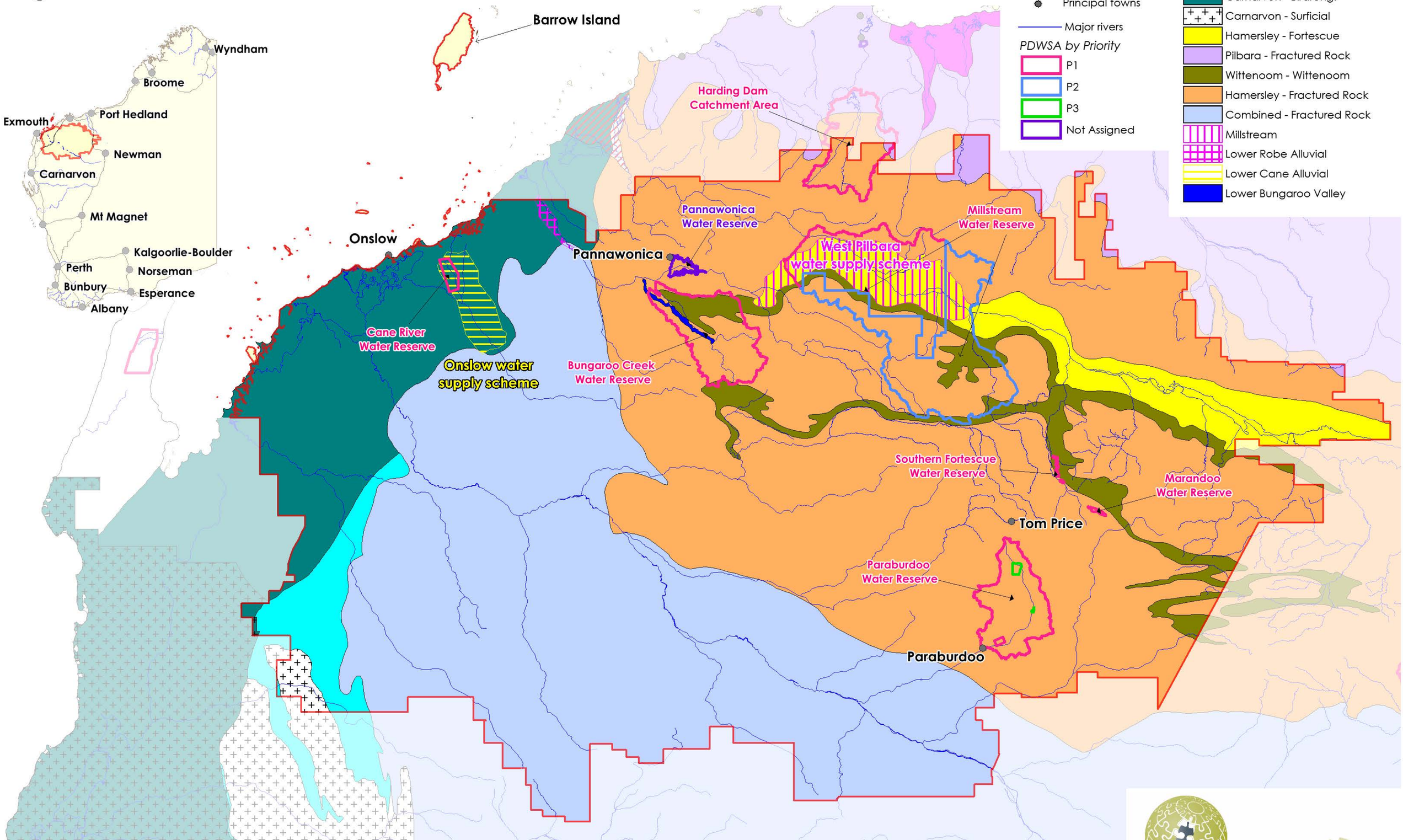
Figure 9: Groundwater



Data sources: Landgate, Department of Water, Department of the Environment Created by: H Lamparski. Projection: MGA 50: zone 50.

Scale 1: 1,500,000 @ A3
0 60 km

essential environmental

Mining and irrigated agriculture

The mining industry is the dominant water user in the region with mining operations, mine dewatering and other related water uses (including minesite and exploration camp irrigation and residential water uses) accounting for over 80% of total water licenced for use in the region compared with just 9% used for public drinking water supply and other industries respectively (Chart 4) (DoW Water Register, 2013).

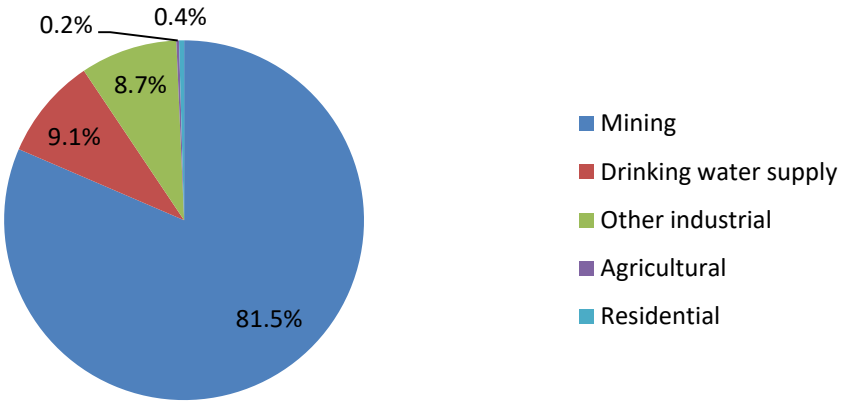


Chart 4: Breakdown of water licensing in the Pilbara (Source: DoW Water Register, 2013)

It is estimated that 'mining related uses' such as transportation, infrastructure projects and residential water use on minesites and exploration camps collectively accounts for around 30% of total mining water licensing, whilst mine dewatering is the biggest single water use accounting for approximately 40% of licensed water use alone (Chart 4) (DoW Water Register, 2013).

Mine dewatering is managed under the *Rights in Water and Irrigation Act 1914* to minimise adverse impacts of the abstraction and release of water. Part V of the *Environmental Protection Act 1986* also manages the discharge of mine dewater to ensure receiving water bodies are not degraded.

A number of studies have been undertaken throughout the Pilbara to assess long-term use and security of groundwater resources for potential expansion of irrigated agriculture in the region.

The Pilbara Water Discovery project, funded by the Royalties for Regions program, is a four year study involving electromagnetic surveys to determine the viability of agricultural expansion in the region, as part of the Department of Water's Water for Food program. Collection of survey data and associated test drilling will be completed in 2016.

In addition, the *Pilbara surplus mine dewater options and feasibility study,* also funded through Royalties for Regions, was completed to assess the availability and possible use of surplus mine dewater to supply irrigated agricultural enterprises in the Pilbara. The Department of Water has confirmed the availability of surplus mine dewater in relation to prospective irrigation precincts in nearby locations where viable soils are concentrated, particularly in the central and eastern Pilbara, and potentially in the very east of the Shire in the Harmersley Range (DoW, 2015).

Surplus water from below water table mining at Rio Tinto's Marandoo mine is currently being used in an irrigated agriculture scheme known as the Hamersley Agricultural Project 45 km north east of Tom Price. Water from the Marandoo below water table expansion is being used to irrigate areas of Hamersley station and produce hay to feed cattle across six stations (Rio Tinto, 2012). However, some concern regarding the production of the non-native grass using recycled water from Marandoo exists.

2.4.3 Alternative water supply and water efficiency

While water recycling schemes are not widespread in the Shire, a number of schemes are being implemented in the region in recognition of the need to facilitate growth in townships whilst conserving existing town drinking water supplies.

The Shire of Ashburton was declared a Waterwise Council in 2014 and maintained its status 2015, with the aim of continuing to work towards improving water efficiency in Onslow in particular. The Shire has developed a Waterwise demonstration garden in Onslow and a 'Waterwise Garden Guidelines' information pack for the Onslow community to promote water efficiency.

A wastewater recycling scheme is also being investigated in Onslow to provide a fit-for-purpose alternative water source for irrigation of public open space and parks, and potentially drought-proofing Onslow's landscape. In addition, wastewater from Onslow Airport will be treated and recycled to irrigate the airport's waterwise garden.

Surplus water from below water table mining at Rio Tinto's Marandoo mine is also to be reinjected to the Southern Fortescue borefield to replenish the aquifer which supplies the Tom Price township (DoW, 2011). Similarly, surplus water from the nearby Nammuldi mine (60 km north west of Tom Price) is also being used for irrigated agriculture projects at nearby stations. Seeding of Rhodes grass for the Nammuldi Agricultural Project began in April 2014.

2.4.4 Key strategic environmental planning issues for consideration

Key water resource considerations for strategic planning, consistent with *State Planning Policy 2.9: Water Resources* are:

- **Flooding from stormwater** - Adequately manage the risk of flooding, and consequences particularly associated with sediment transport management, in townsites and industrial areas through application of *State Planning Policy 2.9: Water Resources.* The Shire may also need to review existing townsite drainage systems and ensure appropriate levels of service will be maintained as development occurs (such as at Onslow Airport).
- **Public drinking water sources** – There are a number of important water sources which provide water for public supply within the region. Although most of these public drinking water sources are protected in the existing planning scheme, consideration should be given to the reservation and/or use of a special control area to improve their level of protection in future, particularly in relation to Bungaroo Creek water reserve. Planning decision-making should be consistent with the DoW's *Water Quality Protection Note: Land Use Compatibility within Public Drinking Water Source Areas* (2016) in the vicinity of any drinking water borefields, including the requirements for well-head protection zones.
- **Groundwater availability** – although allocation currently remains in some aquifers and investigations into available groundwater supplies are continuing, declining rainfall in coastal areas may result in reduced recharge and consequently availability in these areas in the future, particularly as population and industry expands. Dewatering/over-abstraction have also impacted local groundwater levels, potentially affecting groundwater-dependent pool ecosystems and wetlands through drying up and loss of habitat. This in turn can impact wildlife and cultural and social values. This is especially critical given the presence of nationally important wetlands in the Shire. Therefore groundwater allocations and availability require consideration of these values when planning for residential and industrial expansion.
- **Water use efficiency-** It is recognised that the Shire is a Waterwise Council. It should continue to investigate and expand water efficiency opportunities, such as irrigation of public open space and sports ovals where practical.

- **Water reuse** – Due to increasing demand for water associated with residential growth and industrial expansion, it is considered that water recycling and reuse to provide fit-for-purpose sources of water should continue to be investigated in Onslow and other townsites where practical, as an alternative to groundwater use. This will require cooperation with the Water Corporation and Rio Tinto. In addition, reuse of mine dewater for irrigation of agricultural projects should continue to be investigated where practical.
- **Contamination of water resources** - Landfill sites are a potential source of pollutants to ground and surface waters. These land uses, and others with the potential to pollute ground and surface waters must be carefully located, designed, managed and monitored to avoid impacts.

2.5 Biodiversity

The Shire is characterised by a diverse range of terrestrial, aquatic and coastal landscapes, flora and fauna. In order to better understand the terrestrial and aquatic biodiversity, a bioregional framework was developed by the Commonwealth and State governments, which divides the country into Interim Biogeographical Regions and bio-subregions.

The Shire contains eight Interim Biogeographic Regionalisation for Australia (IBRA) subregions: Cape Range, Ashburton, Hamersley, Chichester, Fortescue and Roebourne, with small portions of Augustus and Wooramel. Vegetation types in these regions are predominantly scrub, shrub-, low tree-, and grass-steppe, and grassland, with small amounts of samphire, tidal mudflats and mangroves located in coastal region (see Figure 10). A more detailed description of the bio sub-regions in the Shire is found in section 3.2 of the *Pilbara Framework: Regional Profile* (WAPC, 2009) and in the DPaW's *Biodiversity Audit* (CALM, 2003).

Western Australia's conservation reserve system plays a pivotal role in conserving WA's biodiversity, which is both rich and exhibits a high degree of endemism (i.e. plants and animals occurring nowhere else (CALM, 2003). *Australia's Biodiversity Conservation Strategy 2010-2030* (DSEWPaC, 2010) contains objectives to 'maintain the extent of habitat' and 'create nature reserves or conservation management agreements on public and private land'. Conservation reserves account for approximately 17 per cent of land tenure in the Shire of Ashburton and include Barlee Range Nature Reserve, Cane River Conservation Park, Karijini National Park, Millstream-Chichester National Park, and Mungaroona Nature Reserve, as well as a number of offshore island nature reserves including Barrow Island and Thevenard Island (Table 8, Figure 11).

Table 8: Terrestrial conservation reserves in the Shire of Ashburton (Source: DPaW, 2016)

Type of reserve	Name of reserve	Area (km²)
National parks	Karijini National Park	6,683
	Millstream-Chichester National Park	2,413
Conservation parks	Cane River Conservation Park	3,334
Proposed Conservation Parks	West Hamersley Range Conservation Park	-
	Mulgalands Conservation Park	-
Nature reserves	Mungaroona Range Nature Reserve	1,061
	Barlee Range Nature Reserve	1,072
	Barrow Island Nature Reserve	253
	Tent Island Nature Reserve	19
	Thevenard Island Nature Reserve	6.2
	Boodie, Double Middle Islands Nature Reserve	5.5
	Serrurier Island Nature Reserve	3.1
	Little Rocky Island Nature Reserve	3.1
	Burnside & Simpson Island Nature Reserve	1.3
	Bessieres Island Nature Reserve	0.5
	Y Island Nature Reserve	0.4
	Locker Island Nature Reserve	0.3
	Airlie Island Nature Reserve	0.3
	Great Sandy Island Nature Reserve	0.2
	Victor Island Nature Reserve	0.2
	Gnandaroo Island Nature Reserve	0.05
	Round Island Nature Reserve	0.03
	Rocky Island Nature Reserve	0.02
	Whalebone Island Nature Reserve	0.007
Former leasehold	Reserve Ex. Wanna Station	1,446
TPS No. 7 conservation reserves		992
Total conservation areas		**17,295**

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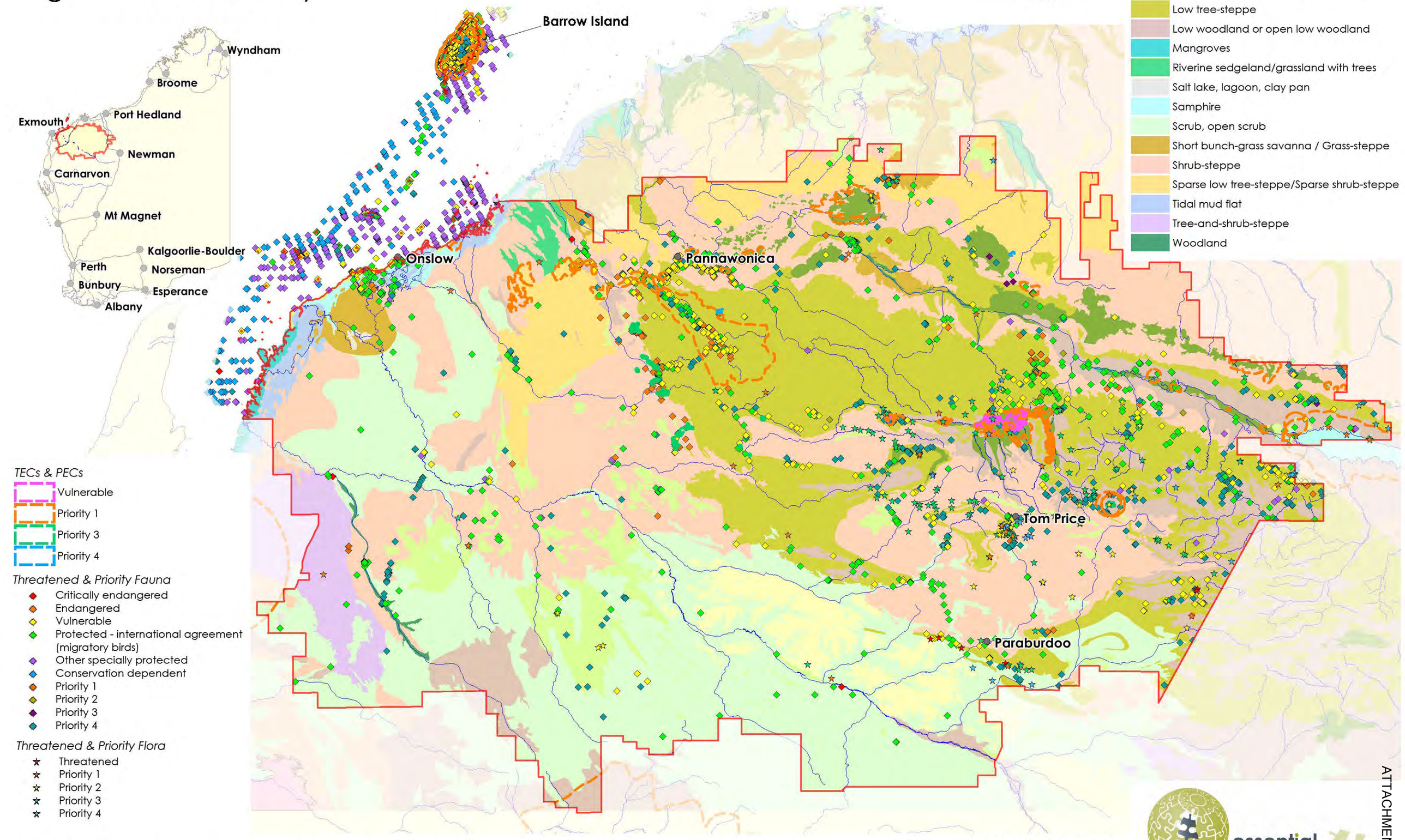
Figure 10: Biodiversity



Datasources: Landgate, Dept. of Water, Dept. of Parks & Wildlife, Dept. of the Environment Created by: H Lamparski. Projection: MGA 50: zone 50.

Scale 1: 1,500,000 @ A3
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essential environmental

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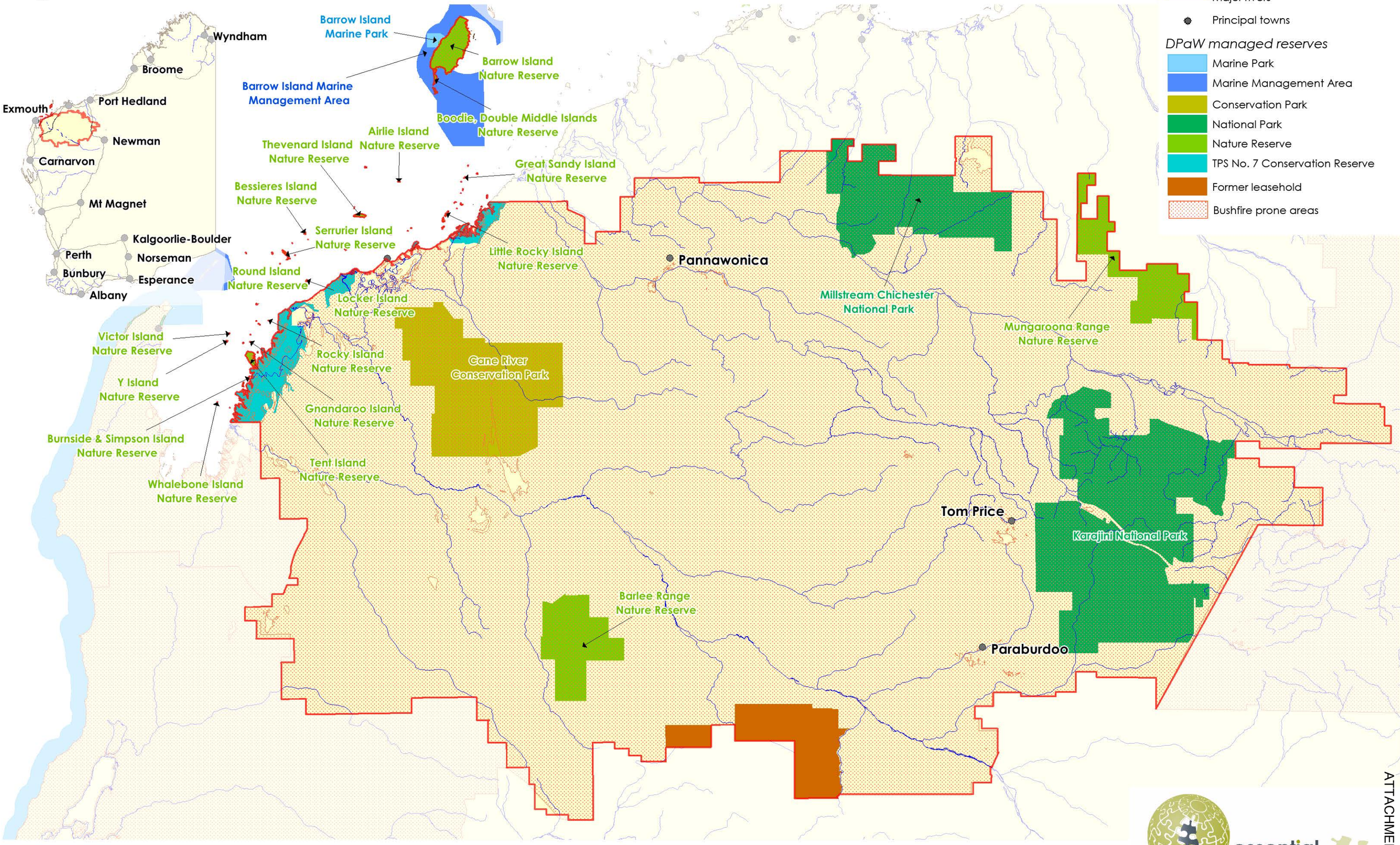
Figure 11: Conservation



Datasources: Landgate, Dept. of Water, Dept. of Aboriginal Affairs, Dept. of the Environment Created by: H Lamparski. Projection: MGA 50: zone 50.

Scale 1: 1,500,000 @ A3
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essential environmental

It is noted that the Shire has reserved a number of areas along the coast for conservation in the local planning scheme, primarily in the intertidal area, which contain environmentally sensitive mangrove communities.

The state government has purchased a number of former leaseholds throughout the southern rangelands to expand the state's conservation system. In the Shire this included Ex. Wanna Station (DPaW, 2013a). A new terrestrial conservation reserve has also been planned for the Shire of Ashburton, the proposed West Hamersley Range Conservation Park. A small portion of the proposed Mulgalands Conservation Park, most of which is situated in the Shire of East Pilbara, is also located in the very east of the Shire of Ashburton.

The Hamersley Ranges are a nationally recognised Biodiversity hotspot. They contain numerous endemic mammals, reptiles and plants, and their gorges have been described as 'valuable refuge for plant species', as their topographical location generally protects them from fire (Rangelands NRM, 2010).

The Pilbara Corridors' Conservation Action Planning (CAP) process is now underway and will identify priorities and establish working groups to implement management actions. The CAP process aims to develop and maintain a collaborative, long-term conservation strategy for the Pilbara Bioregion.

2.5.1 Remnant vegetation

Removal of native vegetation is a major process threatening biodiversity in the region. The loss of habitat area through clearing is currently the primary cause of declines in species and populations worldwide (EPA, 2007). Forms of degradation include burning, over grazing, fragmentation, and draining/flooding of land, which can result in the removal of native vegetation and degradation or loss of ecosystems.

Fragmentation of the landscape occurs as a result of removal of large areas of native vegetation, leaving behind small and unconnected remnant bushland. Fragmentation of landscapes also occurs as a result of the construction of large linear infrastructure such as railways and pipelines. Many flora, fauna and communities become threatened as a result of fragmentation, often resulting in diminished biodiversity and extinctions in some areas.

Change in tree cover across the Shire reflects overall removal of remnant vegetation by processes including bushfire, land clearing and other degradation (although bushfire is recognised as having the most significant impact). Data provided in 'Australia's Environment in 2015' (ANU. 2016) indicates that tree cover was approximately 0.5% in 1972, and has fluctuated between 0.2 and 0.5% between 1972 and 2015, with a decrease of approximately half of the area of tree cover since 2012, as shown in Chart 5 below. This is equivalent to a loss of approximately 252 km^2 of tree cover in the Shire. It is noted, however, that the native vegetation of the majority of the Shire comprises grassland, shrubland, and low tree steppe and thus the low percentage of tree cover reflects this.

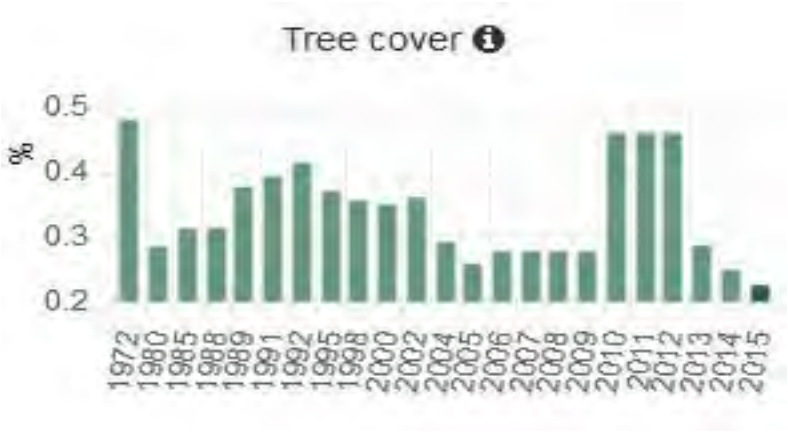


Chart 5: Tree cover (%) in the Shire of Ashburton (Source: ANU, 2016)

2.5.2 Protected flora, fauna and ecological communities

At the Commonwealth level, flora, fauna and ecological communities may be recognised as matters of national environmental significance and are protected under the *Environment Protection and Biodiversity Conservation Act (*EPBC Act), *1999*, administered by the Department of the Environment. The categories of threatened flora and fauna protected under the EPBC Act are (i) extinct in the wild (ii) critically endangered, (iii) endangered and (iv) vulnerable. An additional category of "conservation dependent" exists, which requires special consideration but is not protected under the EPBC Act.

The Commonwealth lists a number of matters of national environmental significance in the Shire including 37 threatened species and 36 migratory species. The threatened species listed under the EPBC Act include the critically endangered bar-tailed godwit (*Limosa lapponica baueri*), and short-nosed seasnake (*Aipysurus apraefrontalis*) (see Appendix 2 for the full listing).

A search of the Department of Parks and Wildlife (DPaW) Threatened Species data base revealed 48 species of rare fauna, including the night parrot, short-nosed seasnake, leaf-scaled seasnake, the loggerhead turtle, and the northern quoll; six specially protected fauna species (including the dugong and whale shark), 30 Species protected under international agreements and 27 species of priority fauna which are known to occur in the Shire (Figure 10).

The DEC Threatened Species data base also contained two listings of declared rare flora (*Aluta quadrata* and *Thryptomene wittweri*) as well as 122 species of priority flora. The Shire of Ashburton contains 20 Priority Ecological Communities and one Threatened Ecological Community, the Themeda grasslands which is dominated by the perennial Themeda (kangaroo grass and many annual herbs and grasses) and exists to the north west of Tom Price. In addition, Beadon Creek near Onslow and other coastal mudflat areas are likely to support mangrove and samphire communities which are of interest to the Environmental Protection Authority (EPA) as benthic primary producer habitat as well as nursery, feeding and breeding grounds for marine fauna. See *EPA Guidance Statement No. 1 – Tropical Arid Zone Mangroves along the Pilbara coastline*, April 2001, for further information.

Flora and fauna is also protected at the State level under the *Wildlife Conservation Act 1950*, administered by DPaW. The *Wildlife Conservation (Specially Protected Fauna) Notice, 2010* recognises four categories of Rare and Endangered fauna taxa, and the *Wildlife Conservation (Rare Flora) Notice 2012* recognises two categories of rare flora. In addition, DPaW also classifies flora and fauna under five different Priority codes, with different management requirements.

DPaW have recorded a number of threatened species in the Shire which are summarised in Table 9 and listed in Appendix 2.

Table 9: Threatened and priority flora and fauna in the Shire of Ashburton (DPaW, 2016)

Conservation Status (*Wildlife Conservation Act, 1950*)	No. fauna species	No. flora species
Threatened – Critically endangered	3	-
Threatened – Endangered	4	1
Threatened – Vulnerable	41	1
Protected under international agreement	30	-
Other specially protected fauna	6	-
Priority 1	4	29
Priority 2	6	24
Priority 3	3	58
Priority 4	14	11
Total	**111**	**124**

2.5.3 Offshore islands

The Shire of Ashburton also contains a number of offshore islands, which are part of the chain of Mackerel Islands that provide important marine habitat and marine resources including petroleum. Barrow Island is the second largest island in Western Australia with an area of 202 km^2. It is a Class A nature reserve designated for the "Conservation of Flora and Fauna" and is surrounded by the Barrow Island Marine Park and Barrow Island Marine Management Area (Figure 12). The Barrow Island nature reserve is considered one of the most important conservation reserves in the State due to its importance as a biological refuge. The island is home to 22 endemic species of mammal, reptile, bird and subterranean fauna (DPaW, 2015), many of which are considered threatened fauna (20 taxa) because they are not found on the mainland (EPA, 2007). Both Barrow Island and Thevenard islands are subject to mining activity associated with Chevron's Gorgon LNG project.

2.5.4 Aquatic ecosystems

Stygofauna are animals that live permanently in groundwater systems, in habitats ranging from minute spaces between sand grains to pools and streams in caves (DPaW, 2016). Troglofauna occur in humid air chambers in underground caves or other smaller voids (EPA, 2003). Most stygal and troglobitic species in Western Australia are invertebrates, although stygal fish and troglobitic snakes do occur in subterranean caves. Crustaceans form the richest group of stygofaunal invertebrates, with the greatest biogeographic significance (EPA, 2003).

Many of these animals have been shown to be endemic to the Pilbara region with highly restricted short range distributions, with some stygofauna even limited to single aquifers. In addition to being endemic, many species have considerable scientific importance and conservation significance because they appear to represent links to the time when Australia was part of Gondwanaland (EPA, 2003). Some studies suggests that stygofauna have important ecosystem service functions, such as the maintenance of water quality in groundwater aquifers (EPA, 2003), which provide the majority of the Pilbara's water supply.

Members of two amphipod stygofauna families, the Melitidae and Paramelitidae, have been extensively collected and documented in the Pilbara mainland as well as Barrow Island (King, 2011). The biology and habitation of stygofauna was also a major focus of the seven year *Pilbara Region Biological Survey 2002-2012* (DPaW, 2013) (Plate 2). As part of this survey, stygofauna found in over 500 bore sites and 20 wetland springs in the Pilbara region were documented from sites representing a cross section of the Pilbara's major geological features and groundwater types (DPaW, 2016). Results from the survey indicate that the region is incredibly rich in aquatic invertebrates and over 300 new species of stygofauna were recorded. The permanent pools and streams of Millstream Chichester National Park are considered a particular hotspot for stygofauna and as a result, are recognised as containing a Priority Ecological Community (Science Network WA, 2012).

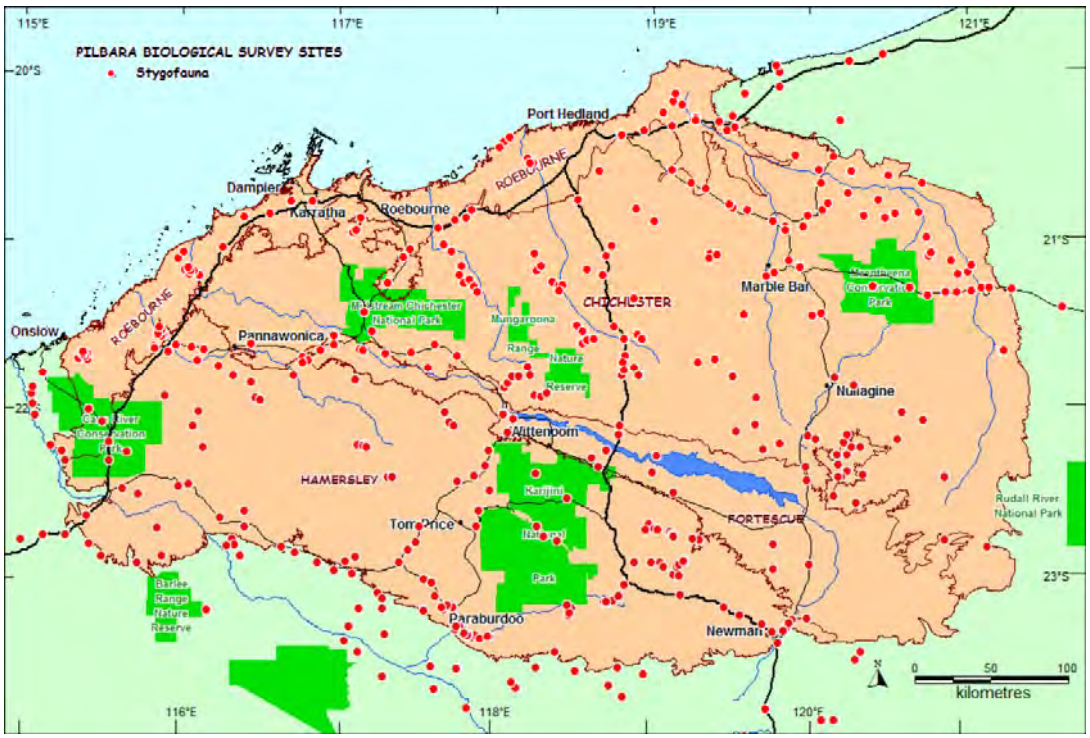


Plate 2: Location of bores sampled for stygofauna during the DEC's Pilbara biological survey in the Pilbara and adjacent IBRA regions

2.5.5 Key strategic environmental planning issues for consideration

Key biodiversity considerations for strategic planning are:

- **Biodiversity** – the Shire is well known for its impressive terrestrial, marine and aquatic biodiversity. A significant proportion of the Shire's biodiversity is protected in a number of conservation areas. No Biodiversity strategy has been prepared for the Shire.
- **Management of conservation areas** – While conservation reserves are managed by the Department of Parks and Wildlife, the Shire may consider active management of the following issues to assist in conservation and protection of biodiversity:
    - **Uncontrolled access** – which leads to direct loss of biodiversity as well as impacts from rubbish dumping, weeds and bushfires.
    - **Weeds -** many Shire reserves with high biodiversity values have aggressive weeds such as parkinsonia and mesquite, which require management, particularly in highly disturbed areas.
    - **Feral animals** - feral animals, especially goats, camels, rabbits and foxes, have a major impact on the native flora and fauna.

2.6 Coastal environment

The coastal environment of the Shire of Ashburton contains a variety of landscapes and land forms, including deltas (such as the Ashburton River delta), wide intertidal mudflats, mangroves, dunes, and long stretches of sandy beach (Figure 12). This variety of coastal habitat types is due to the changing depositional and erosional coastal processes operating along the Pilbara coast. These land and seascapes support a wide variety of marine and terrestrial biodiversity, much of which is recognised at a national level. Seagrass meadows are also prevalent along the Shire coast, and provide habitat and breeding grounds for many forms of marine life.

Intertidal mudflats are a key feature of the mainland shores of the region. As the coast is largely low-lying with extreme tidal ranges, the extensive mud flats are usually exposed at low tide (Nayton, 2011). The flats are well recognised as supporting rich and diverse invertebrate communities and shorebirds including samphire. The mudflats in most cases are bordered by tropical arid-zone mangroves that are of international scientific importance, providing nursery and habitat for commercial fish species, increased inshore productivity, marine nutrient resources, sediment trapping and protection from coastal erosion. Sandy beaches also provide nesting sites for sea turtles and sea birds.

The major activities that occur within the coastal and marine environment of the Shire include recreational activities such as camping, boating, fishing, swimming, diving and 4WDing, as well as commercial fishing and activities associated port facilities.

2.6.1 Offshore islands

The environmental values of the Pilbara coastline and offshore and barrier islands are well known and some of these areas are considered to be the most biologically diverse in the state. Some of the key environmental assets in the coastal and marine areas of the Shire include:

- seagrasses & algal beds that support a diverse fauna of herbivorous fish, marine turtles and dugong (benthic primary producer habitat);
- well established and species-rich coral reefs;
- important and protected marine species including sea turtles, dugong, marine mammals (whales and dolphins), colourful invertebrate communities, seabirds and waders/ shorebirds and marine reptiles;
- important nesting sites for turtles and migratory seabirds; and
- faunal refuges from mainland impacts.

In particular, Barrow and Thevenard Island groups and surrounding marine areas are particularly significant due to their unique biodiversity and the external pressures presented from expansion of the off-shore petroleum industry. They have significant value to the resource industries as locations for port and processing facilities and these can clash with the environmental values of the region.

Barrow Island is one of Australia's leading producers of oil after it was discovered in commercial quantities in 1964 and has supported ongoing production of crude oil from oil fields located on the island since 1967. Oil tankers are filled by a submarine pipeline that extends 10 km offshore. Approval for construction of the Gorgon gas processing hub in 2009 has seen Barrow Island further influenced by development pressures. The gas processing plant on the island is currently facilitating development of the Greater Gorgon gas field approximately 40-110 km to its north. The Port of Barrow Island (Figure 12), controlled by the Department of Transport, is the major site for vessels to import and export resources and supplies to Barrow Island, the Gorgon gas field and surrounding operations.

Taylor Burrell Barnett - Shire of Ashburton Environmental Profile
Figure 12: Coastal environment

Barrow Island Nature Reserve
Port of Barrow Island
Boodie, Double Middle Islands Nature Reserve
Port of Onslow
Airlie Island Nature Reserve
Great Sandy Island Nature Reserve
Thevenard Island Nature Reserve
Port of Ashburton
Little Rocky Island Nature Reserve
Bessieres Island Nature Reserve
Serrurier Island Nature Reserve
Onslow
Pannawonica
Round Island Nature Reserve
Rocky Island Nature Reserve
Locker Island Nature Reserve
Victor Island Nature Reserve
Y Island Nature Reserve
Tent Island Nature Reserve
Gnandaroo Island Nature Reserve
Burnside & Simpson Island Nature Reserve
Whalebone Island Nature Reserve

Legend
- Study area
- Principal towns
- Major rivers
- Boat ramps
- Coastal infrastructure
- Petroleum & gas pipelines

DPaW managed reserves
- Marine Management Area
- Marine Park
- Nature Reserve
- TPS No. 7 Conservation Reserve
- Port authority controlled waters
- Department of Transport controlled waters
- Seagrass distribution
- Aquaculture pearling sites

Coastal landform
- Beach Ridges
- Intertidal Surfaces
- Sand Mantles
- Small Parabolic Dunes (<1km long)
- Transverse Dunes

Datasources: Landgate, Dept. of Transport, DPaW, Pilbara Ports Authority, Geoscience Australia, Dept. of the Environment Created by: H Lamparski. Projection: MGA50: zone 50.

Scale 1: 750,000 @ A3
0 30 km

Wheatstone is a liquefied natural gas (LNG) plant under construction in the Ashburton North Strategic Industrial Area (ANSIA), being developed by Chevron on the Shire coast approximately 11 km south-west of Onslow. The first LNG is expected to be processed by mid-2017. ANSIA and the Port of Ashburton (managed by the Pilbara Ports Authority) provide the industrial land and transportation facilities to export gas for both the Wheatstone LNG and nearby Macedon domestic gas project (developed by BHP Biliton). The Port of Onslow (managed by the Department of Transport) at Beadon Creek is used more generally as a maritime facility for the resources sector, fishing and charter vessels.

The Mackerel Islands is another group of islands, located approximately 20 km off the coast of Onslow that abound with tropical marine life and habitat. Two of the major islands, Thevenard and Direction Island, have been leased for tourist accommodation facilities since 1968. Thevenard Island (classified as a Nature Reserve) has also been the hub from which crude oil from Chevron-operated offshore petroleum reservoirs is processed and readied for shipment by ocean tankers to Australian refineries since the late 1980s.

In addition, oil and gas processing facilities have been operational on Airlie Island (managed by Apache) since the late 1980s. Oil and gas facilities on and offshore Thevenard Island are currently in care and maintenance mode, and are expected to be decommissioned from 2016. Onshore decommissioning and remedial work is expected to take two years.

Projected increases in shipping demand for port facilities is expected as large scale oil and gas projects increase their production and export. This means that effective management of dredging activities, construction of land based infrastructure, and installation of subsea infrastructure, will become critical in the near future in order to ensure that impacts on coastal and marine values in the Shire are minimised.

Dredging often results in the loss of benthic primary producer habitat such as mangroves, seagrasses and algal beds. Degradation of the marine environment may also occur as a result of industrial discharge or accidents (oil spills) from adjacent industrial and mine processing sites, wastewater treatment plants or vessel traffic. Potential threats are also thought to occur from acoustic pollution, excessive lighting (to which nesting and hatching turtles are very sensitive), and aquaculture, which may restrict feeding grounds and interfere with preferred travel routes of marine life. There are major implications for the coastal and marine environment if degradation pressures continue. Marine ecosystems will become more fragmented and less equipped to adapt to changing conditions, such as the effects of climate change (EPA, 2007).

The *Barrow Island Act 2003* was ratified to authorise the implementation of an agreement between the State government and the Gorgon joint venturers to undertake offshore production of natural gas on Barrow Island. The agreement regards the need to minimise environmental disturbance on Barrow Island and provide support for conservation programs relating to Barrow Island and other areas. As part of the environmental approvals process, the Gorgon Joint Venture participants agreed to fund a series of conservation initiatives. Draft Environmental Assessment guidelines for Protecting the Quality of Western Australia's Marine Environment were developed by the EPA in 2014, and provide a basis for management of marine environmental quality in WA, including discharge regulation, the environmental management of ports and marinas, and environmental quality management in marine parks and reserves.

2.6.2 Fishing

Commercial fishing is an important industry in the Shire, with the major regional fisheries including: Onslow Prawn Managed Fishery, Pilbara Trap Managed Fishery and the Pilbara Trawl Managed Fishery. A small pearling industry is also based in the waters around Onslow.

Substantial closures of trawling fisheries in coastal and offshore waters were introduced to manage impacts of finfish trawling by Australian vessels (subject to Ecologically Sustainable Development requirements under the EPBC Act 1999). However, trawling is still permitted in a small number of limited locations. Spanish mackerel fishing occurs from vessels around reefs shoals and headlands. The catch has more than doubled since 2009 in the bioregion. The Department of Fisheries *State of the Fisheries Report 2014/15* notes that stock levels of Pearl Oysters and Onslow/Nickol Bay Prawns are currently adequate.

Pearl Oyster industry was classified by the Department of Fisheries as having a 'low' ecological risk, while prawning and finfish (Spanish Mackerel) were classified as 'moderate' in 2014/2015. Introduced pests and species were classified as a 'high' current risk status of impacting the Bioregion, while Climate and Oil & Gas Development Activity were both classified as 'low' risk.

The only fisheries in the region that have reported any interactions with Endangered, threatened and protected species (cetaceans, dugongs, marine turtles, sea snakes, elasmobranchs, seahorses and pipefish, crocodiles, seabirds and migratory shorebirds) are the two trawl fisheries, the Onslow Prawn Managed Fishery (OPMF) and the Nickol Bay Prawn Managed Fishery (NBPMF) (as well as Gillnet Barramundi Fishery). However, interactions are few due to use of bycatch reduction devices and separation of trawling activities from most protected species' primary habitat.

Aquaculture development is dominated by pearling. Establishment of an aquaculture zone is being considered by the Department of Fisheries. The establishment of an aquaculture zone would streamline the processes for commercial projects, leading to the development of further aquaculture operations in the region. Marine production of barramundi is also in development.

Recreational fishing experienced significant growth in 2014/2015, with a seasonal peak occurring in winter when tourists swell the local population. Angling fishing is boat-based, and small boat fishing occurs in creeks, mangroves, rivers and ocean beaches.

Recreational fishing is managed through size and catch limits based on risk categories for various species. In addition, the Department of Fisheries is able to monitor the intensity of recreational fishing through the recent change to licensing of recreational boat users. A large proportion of the Pilbara community own or have access to a boat and undertake recreational fishing. Although recreational fishing activities are likely to continue as population increases, the overall population of the Pilbara is still fairly low and their impact on fish stocks is considered to be manageable (*State of the Fisheries Report 2014/15,* DoF,2015).

2.6.3 Ports

The Port of Ashburton in ANSIA is a relatively recent addition to the Pilbara region, only formally vested to the Pilbara Ports Authority in December 2011. The Port of Ashburton is a multi-user port with common infrastructure to support the export of LNG and downstream hydrocarbon products. The coastal area and port remain Crown Land with a Reserve for Port purposes. Chevron Australia is using the port facilities at ANSIA as part of their Wheatstone LNG Project.

The main boat harbour in the Shire is at Beadon Creek near Onslow, with plans to expand in the near future. A number of boat launching ramps are also located around Onslow for use by the community. While there is significant commercial and recreational activity around Onslow, the remainder of the Shire's coastal zone is sparsely settled and is generally used for pastoral activities.

2.6.4 Tourism and coastal camping

There are currently no designated sites for coastal camping in the Shire of Ashburton. However, some camping is known to currently occur at the mouth of the Ashburton River and along other areas of the coast. Impacts from recreational use of the coast are increasing, with greater numbers of people having access to the coast, seeking off road experiences, camping, boating and fishing.

Concerns identified by the community and managers of the coastal and marine environment in the Shire include:

- the sustainability of consumptive recreational activities (largely around Beadon Creek), particularly by fly-in-fly-out workers. In particular, management of coastal camping to ensure social, economic and environmental values are protected and enhanced;
- the suitability and enforcement of recreational fishing regulations; and
- the suitability and maintenance of boat ramps and associated facilities (Rangelands NRM, 2009).

The *Onslow Business Investment Guide* (OCCI, 2016) indicates that tourism, aquaculture and commercial fishing provide opportunities to further develop the town of Onslow. In particular, access to offshore islands from Beadon Creek Harbour and Sunset, Sunrise and Four Mile beaches have been considered as coastal environment which will attract visitors as part of tourism experiences. Commercial fishing out of Beadon Creek Harbour and aquaculture are also considered industries with opportunities for growth (OCCI, 2016).

In September 2008, the Federal Court of Australia determined that native title claimed by the Thalanyji existed in large parts of Ashburton's coastal area. Consultation and engagement with traditional owners will therefore be necessary when considering the planning of activities and uses along the coast.

2.6.5 Sea level rise

The coastal town of Onslow contains a significant proportion of the Shire's population and has been under pressure to support the growth of the region, particularly around the oil and gas and mining industries. Current and planned development in Onslow and adjacent to the coast may be vulnerable to the effects of sea level rise and storm surges. This includes the town itself, ports, marinas, boat ramps and other infrastructure, and recreational areas.

The key sea level processes affecting Onslow include tides, cyclonic surges, seasonal variation and inter-annual mean sea level variations. The spring tide range in Onslow is 1.9 m. Cyclonic storm surges of up to 0.8 m have been recorded in Beadon Creek, with anecdotal or inferred evidence of much higher events, particularly on the exposed coast. The most extreme elevated water levels are generally associated with onshore wind events caused by tropical cyclones passing to the west of Onslow.

CSIRO modelling indicates that the continued increase in sea level for both the west and south coasts of the Rangelands are projected with a very high confidence. In Port Hedland (the closest town to be modelled) the projected range of sea level rise is 0.07-0.17m by 2030, and 0.28-0.64 m by 2090. This will have significant implication for existing environments and built infrastructure, particularly at Onslow, and will require management and planning to ensure that the coastal environment is protected.

A coastal vulnerability study was undertaken for Onslow in 2011. The *Onslow Townsite Planning Coastal Setbacks & Development Levels* report (M P Rogers and Associates PL, 2011) focusses on the effects of 100 year ARI storm inundation for current day and 2110, on current infrastructure and future development of Onslow, with recommendations for finished floor levels.

The study recommended setbacks to allow for the action of physical coastal processes. The recommended setbacks in Onslow were calculated to range from 30 m for the area protected by a seawall up to 372 m from the coast. These setbacks could be reduced if low-lying areas were raised prior to development, to allow development of land that would otherwise be unused. The study also noted through cyclone inundation modelling that large areas of Onslow and its surrounds are vulnerable to coastal inundation, and that care must be taken to ensure that any future development is located safely above these inundation levels.

A Draft Coastal Hazard Risk Management and Adaption Plan (CHRMAP) was prepared by Cardno for the town of Onslow, including ANSIA, in August 2016 (Appendix 3). Physical assets and areas with economic, social/cultural and environmental value potentially at risk within the study area were identified. The risk level of thirteen (13) assets or areas of importance were then determined in relation to the impact of coastal erosion and inundation, or fluvial (riverine) inundation hazards, as presented in Table 10 and Table 11 below. Based on the risk level analysis, management and adaption options were recommended for specific assets with the aim of mitigating risk and vulnerability through one or more of the following actions:

- Avoiding the risk;
- Removing the risk;
- Changing the likelihood;
- Changing the consequences;
- Increasing adaptability; and
- Transferring or accepting the risk.

'Avoid' and 'managed retreat' options are the preferred options for new and existing developments. 'Accommodate' options aim to re-design existing infrastructure to mitigate potential impacts as they occur. 'Accommodate' options may also be employed for new developments, when there is no practical option to avoid or retreat from coastal hazards. 'Protect' options are often considered the last line of defence and are the least favourable options. A number of protection options are recommended for each of the thirteen assets including physical maintenance and management, as well as planning actions. These are detailed in Table 5-2 of the Draft CHRMAP for Onslow, as shown in Appendix 3.

The CHRMAP recognises that planning timeframes need to be considered when determining adaptation options. The report also recommends that assets are monitored over time and that potentially no action may be taken until the risk level becomes intolerable. It identifies that relocation can occur as part of future town planning schemes.

Recognition of the need for consideration of storm surge is provided within Town Planning Scheme No 7 through the establishment of the Onslow Coastal Hazard special control area.

Table 10: Risk levels for assets predicted to be under impact from coastal erosion and inundation at Onslow

Assets	Values	Risk Level[1]			
		Present day	2040	2070	2110
On-ground infrastructure at Onslow Jetty	Commercial Aboriginal Public infrastructure Recreational Environmental	Low	High	Extreme	Extreme
Onslow Back Beach picnic area (low risk)		Low	High	Extreme	Extreme
Front Beach / Sunrise Beach		Low	High	Extreme	Extreme
Seawall (the setback allowed for in this section mainly consists of the uncertainty factor required as per SPP2.6)		Low	High	Extreme	Extreme
Seaview Drive near 12 Mile Creek / 4 Mile Beach	Public infrastructure Recreational Commercial Aboriginal	High	High	High	Extreme
Assets adjacent to crest of seawall (bins, shade structures, benches)		Low	Low	Medium	High
Shire of Ashburton Offices at the intersection of Second Ave and McGrath Rd		High	High	Extreme	Extreme
Aboriginal community on Second Ave		Medium	Medium	Extreme	Extreme
Western half of Ian Donald Blair Memorial Walkway	Recreational Public infrastructure	Low	Low	High	High
Intersection of Seaview Drive and Back Beach Road	Public infrastructure Recreational Residential	Medium	Medium	High	High
Eastern end of Ian Donald Blair Memorial Walkway		Low	Medium	High	High
Lot 381 (at the top of the hill at Beadon Point)		Medium	Medium	Medium	High
Second Ave		Medium	Medium	Medium	High

[1]Risk evaluation and ranking based on likelihood and consequence analysis, as per Table 12 and Table 13 below

Table 11: Risk levels for assets predicted to be under impact from fluvial inundation in Onslow under the 2015 timeframe

ARI event	Assets type	Planning timeframe[2]			
		Present day	2040	2070	2110
100 year	Housing, buildings & property	High	High	Extreme	Extreme
	Parks & recreation grounds	Low	Low	Medium	High
	Public infrastructure (fencing, light poles, playgrounds etc.)	Low	Low	Medium	High
	Car parks	Low	Low	Medium	High
	Roads / footpaths	Medium	Medium	High	High
	Sheds	Low	Low	Medium	High
500 year	Housing, buildings & property	High	High	Extreme	Extreme
	Parks & recreation grounds	Medium	Medium	High	High
	Public infrastructure (fencing, light poles, playgrounds etc.)	Medium	Medium	High	High
	Car parks	Medium	Medium	High	High
	Roads / footpaths	High	High	High	Extreme
	Sheds	Medium	Medium	High	Extreme

[1]Risk evaluation and ranking based on likelihood and consequence analysis, as per Table 12 and Table 13 below

Table 12: Risk priority matrix (adapted from CHRMAP guidelines (WAPC, 2014))

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	High	High	Extreme	Extreme	Extreme
Likely	Medium	High	High	Extreme	Extreme
Possible	Low	Medium	High	Extreme	Extreme
Unlikely	Low	Low	Medium	High	Extreme
Rare	Low	Low	Medium	High	High

Table 13: Risk levels and tolerances (example from CHRMAP guidelines (WAPC, 2014))

Risk level	Action required	Acceptance / tolerance
Extreme	Immediate action required to eliminate or reduce risk to acceptable levels	Unacceptable
High	Immediate to short-term action required to eliminate or reduce risk to acceptable levels	Tolerable / unacceptable
Medium	Short to medium term action to reduce risk to acceptable levels, or accept risk	Tolerable
Low	Accept risk	Acceptable

2.6.6 Tides

Although the tidal range in the Shire is moderate, the Shire has recognised an area of tidal influence within a town planning scheme special control area. The key purpose of this area is to consider the impact of any proposed development on the natural environment, in particular the mangrove ecosystem and the potential for storm surge impacts.

Three tidal creeks and coastal lagoons are present within the study area; the Ashburton Eastern Delta Entrance and lagoon, Hooley Creek and Four Mile Creek. Hooley Creek and the Ashburton Delta eastern lagoon are recognised as valuable mangrove and tidal creek habitats which support a variety of marine fauna, including protected species such as sawfish and juvenile turtles.

2.6.7 Key strategic environmental planning issues for consideration

Key coastal considerations for strategic planning are:

- **Sea level rise** – consideration of sea level rise, vertical allowances and setback distances will be required when managing existing infrastructure and planning future development, as per IPCC and CSIRO modelling and coastal vulnerability studies. Ensure that any substantial future development is supported by a current storm surge and flood inundation study consistent with the most current predictions for sea level rise and coastal processes, consistent with State Planning Policy 2.6: State Coastal Planning Policy (2014).
- **Commercial activity** – Planning for and management of activities associated with the resources industry, commercial fishing and aquaculture must consider impacts on sensitive coastal environments which provide habitat for coastal and marine life. Consideration should be given to the location of supporting industrial areas, which adequately manage any potential off-site or environmental impacts. In addition, coastal spaces which are shared with recreational activity should be planned to ensure multiple, cumulative impacts on sensitive environments are considered and impacts are appropriately managed.
- **Tourism** – management and planning of sustainable tourism activity such as camping, boating, swimming, fishing, and 4WDing, and development around sensitive coastal environments such as beaches, river mouths (Beadon Creek), and seagrass meadows, will be critical with population and industry growth, development of tourism, and townsite expansion.
- **Traditional owners** - engagement with traditional owners should be considered to ensure that cultural heritage values are not lost, particularly within the native title area for the Thalanyji community.

2.7 Hazards and natural disasters

2.7.1 Bushfire risk

Fire plays an important part in maintaining the landscape of the Pilbara region. Fire helps shape the diversity of plants and animals (EPA, 2007). Many native plants have evolved fire-related adaptations over time, such as fire-induced flowering or smoke-induced germination. Fires are most often naturally started by lightning strokes. Electrical storms are common in the Pilbara particularly in some remote desert areas, and can result in the ignition of multiple fires across a vast area at the same time. These fires are particularly difficult to control due to the vast areas of land and their inaccessibility (EPA, 2007). Fire in the rangelands has been used as a land management technique, first by the Aboriginal inhabitants and later by the pastoral industry.

Natural regimes have been altered significantly with the settlement of humans in the region. Altered fire regimes, particularly those that occur late in the dry season in the Pilbara, have the ability to significantly impact on the land and biodiversity values of the area. They have the potential to change ecosystems and the composition of species within (EPA, 2007). In addition to electrical storms, fires are also started by human error in remote areas and have the ability to cause widespread damage, burning out of control in the hot, Pilbara climate. Problems occur when ecosystems are burnt too often and can lead to loss of biodiversity through inadequate recovery and reproduction times for many plants and animals (EPA, 2007). This can result in a simplification of ecosystems. Animals can be adversely impacted upon if they have limited capacity to escape fire or to find alternative food sources and shelter if fire temporarily removes habitat.

Fires can also exacerbate or cause additional threatening processes to occur such as soil erosion, release of particulates to the atmosphere and weed invasion. Fires can also result in the release of greenhouse gases. Very intense fires which destroy mature native vegetation can contribute to long-term ecosystem change by removing adults and leaving new seedlings vulnerable to drought (EPA, 2007).

The frequency of fires in the Shire has varied considerably between 2002 and 2015 (no data was available in 2000 or 2001), as shown in Chart 6. Chart 6 demonstrates the approximate geographic area of the Shire which experienced fire during each year. For example, in 2015 a frequency of 0.08 may be interpreted as approximately 8% of the Shire experienced fire during that year.

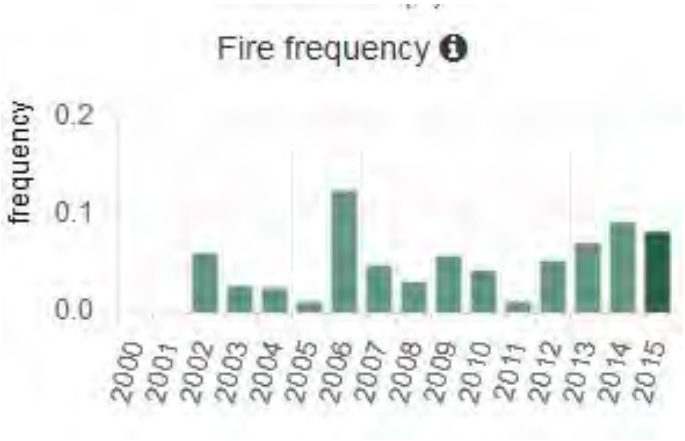


Chart 6: Fire frequency in the Shire of Ashburton (no. of fires per 2.5 km grid cell) (ANU, 2016)

Data recorded for the overall Pilbara bioregion also varied considerably between 1997 and 2005, as indicated in Table 14, with relatively large areas burnt in 1997 and 2000 (DSEWPaC, 2008). The majority of fires occurred during the hotter August to December period and were presumed to produce hotter, more intense burns than fires in other months (DSEWPaC, 2008). This confirms the strong link between climate and fire intensity.

Table 14: Percentage of areas burnt as a result of bushfires in the Pilbara bioregion 1999-2005 (DSEWPaC, 2008)

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
% area burnt	20.1	2.5	9.7	25.8	9.4	11.8	3.1	3.1	1.1

In accordance with the Map of Bush Fire Prone Areas gazetted by the Department of Fire and Emergency Services, the overwhelming majority of the Shire is designated as a Bush Fire Prone Area (see Figure 14), with the exception of relatively small areas cleared for urban development or agriculture, water bodies, and areas affected by mining.

Future planning and development within Bush Fire Prone areas will need to meet the requirements of *State Planning Policy 3.7: Planning in Bushfire Prone Areas* (SPP 3.7) (2015) and the *Guidelines for Planning in Bushfire Prone Areas* (WAPC, 2015).

2.7.2 Flood risk

Many rivers and creek pass through or near to the townships and communities of the Shire, flowing inland from the Hamersley Ranges, west across the plains towards the Indian Ocean. Severe flooding of these waterways is a well-known risk to towns and communities in the region during the wet season, particularly during extreme cyclonic events when flood waters travel fast and wide.

Historically, major flooding in Onslow has been typically associated with storm surge rather than heavy rainfall, though localised flooding will occur in low-lying areas adjacent to Beadon Creek.

A review of the Onslow townsite drainage system was undertaken in 2010 and assessed the condition of the existing drainage infrastructure. It identified a number of drainage issues in the townsite as follows (GHD, 2010):

- The hydraulic gradient of the drainage system is limited by sea level and existing natural surface levels. The surface levels through the town are low lying, generally varying between 2 and 4 m AHD.
- Undrained low points were observed along the intersections of Simpson Street, Third Street and Third Avenue which are subject to localised ponding. Similarly inconsistent and flat grades of the stormwater pipes on Third Avenue do not allow stormwater to flow effectively.
- Unkerbed roads within the town prevent the containment of runoff within the road corridor, allowing adjacent lots to be potentially flooded during major storm events.
- Three stormwater basins (in Second and Third Ave) fill periodically and provide an environment that promotes mosquito breeding, posing a health risk.

The Onslow Townsite Development Local Water Management Strategy (LWMS)(Hyd2o, 2012) addresses flood protection for Onslow by defining an approach based on safe conveyance of flood flows to receiving water bodies rather than attenuation. One of the recommendations of

the LWMS is to extend the existing watercourse/drain which flows to the Beadon Creek harbour and grade it appropriately to enable drainage from the townsite to access this outlet. The LWMS also specifies that overland flow paths should occur in road reserves and linear public open space corridors for the safe conveyance of 100 year flows off site; that habitable building floor levels are set at 0.5m above 100 year flooded stormwater levels; and that habitable building floor levels are set at 100 year storm surge levels allowing for 100 year climate change.

Any future development in proximity to waterways within the Shire will be required to be consistent with *State Planning Policy 2.9: Water Resources* to minimise risk of flooding, and manage the safety or lives and property when flood events do occur.

2.7.3 Key strategic environmental planning issues for consideration

Key hazards and natural disasters considerations for strategic planning are:

- **Bushfire risk** – the majority of the Shire is identified as being Bush Fire Prone. Future planning and development within Bush Fire Prone areas will need to meet the requirements of *State Planning Policy 3.7: Planning in Bushfire Prone Areas* (SPP 3.7) (2015) and the *Guidelines for Planning in Bushfire Prone Areas* (WAPC, 2015). Consideration also should be given to the location of firebreaks in semi-rural areas around townsites and emergency management including access routes; and
- **Flood risk** – Townships and communities associated with waterways in the Shire may be subject to risk of flooding. Any proposed development should be consistent with *State Planning Policy 2.9: Water Resources* and in Onslow, consistent with the Local Water Management Strategy, and address flood risk appropriately.

It is not considered necessary to include a special control area in a local planning future scheme to highlight either bushfire risk or flood risk, as these issues are adequately addressed through existing policy.

2.8 Heritage

Heritage is important in understanding the history, identity and people of a region, and exists in many forms both tangible and intangible, such as places, objects, landscapes, languages and customs. The value of heritage places in the Pilbara may be recognised by the natural and cultural values that are significant for aesthetic, historic, scientific, or social reasons (*Environment and Heritage Legislation Amendment Act (No. 1) 2003*).

The Pilbara is well known for its rich Aboriginal history, modern European history and unique and diverse natural heritage. The numbers of national and state heritage sites identified on various heritage lists is presented for the Shire in Table 15 and Figure 13. It should be recognised that a search of the Department of Aboriginal Affairs (DAA) database does not comprise a full assessment of existing Aboriginal sites under the *Aboriginal Heritage Act 1972*.

Table 15: Number of heritage sites within the Shire of Ashburton (Source: Australian Heritage Database, DAA Aboriginal Heritage Inquiry System* and inHerit - State Heritage Office^)

Local Government Area	No. heritage sites
RNE – Historic	4
RNE – Indigenous	3
RNE – Natural	17
DAA Registered Aboriginal Sites*	1,655
Municipal Inventory^	28

2.8.1 Aboriginal Heritage

The Pilbara region is home to a great variety of traditional landowner language groups, many of which have a strong spiritual, physical and cultural connection to their region and landscape. Aboriginal people are thought to have inhabited the region for up to 40,000 years. As such a rich cultural and historical indigenous heritage exists in the region, particularly in natural features such as rivers, hills and rock formations where people, animals and characters left traces of their journey across the landscape. These places may be valuable because of mythological lore (The Dreaming); because of past use as meeting places for special ceremonies; as burial grounds for ancestors; or as places where culture and history was recorded through rock art. The location of these important cultural sites within the natural landscape means there is considerable overlap between Aboriginal and natural heritage in the region.

Aboriginal heritage is an integral part of Aboriginal culture, customary law, and spirituality. Therefore, its conservation is critical in ensuring that the unique indigenous culture in the Shire is not lost. The protection of Aboriginal heritage also requires consideration of the 31 individual languages identified in the Pilbara, many of which have between two and five dialects (Wangka Maya Pilbara Aboriginal Language Centre, 2016) and their ability to access sites of cultural significance, as well as the heritage sites themselves.

The original inhabitants of the Ashburton area are the Yamatji people of the Murchison, Gascoyne and Pilbara regions. The main Aboriginal groups living within the Shire include (but are not limited to) (DAA, 2015; AIATSIS, 2016 and NNT, 2016):

- Nhuwala;
- Jadira;

- Kuruma;
- Marduthunera;
- Banjima;
- Inawongga;
- Jurruru;
- Pinikura;
- Thalanyji;
- Tenma;
- Djiwal;
- Yindjibarndi;
- Budina;
- Gnulli;
- Palyuku;

Given the historically fluid nature and often forced movement of Aboriginal people, this list should not be considered complete nor final, but gives an indication of the diversity of people, culture and language within the Shire.

The local Traditional Owners in the Onslow area are the Thalanyji people. The Thalanyji cultural tradition is associated with the rainbow serpent Burra Balanyji that created underground tunnels in the area which link all of the water bodies around Onslow – the rivers, the creeks and all the fresh water soaks (Shire of Ashburton, 2010).

Over 1,600 indigenous heritage sites have been identified in the Shire and are protected under the *Aboriginal Heritage Act 1972*. The geographical spread of places in the Aboriginal Heritage Sites Register largely reflects where Aboriginal heritage surveys have been conducted (EPA, 2007). As heritage surveys are normally undertaken in response to development proposals, large areas of the region have not been surveyed. Therefore site identification is biased towards areas subject to recent development.

The DAA maintains a register of known Aboriginal sites, which records the places and objects of significance that the *Aboriginal Heritage Act 1972 (WA)* applies to. The presence of an Aboriginal site places restrictions on what can be done to the land. Anyone proposing to undertake activity upon land on which an Aboriginal heritage site is located will require permission through engagement and consultation with the region's traditional owners and may be required to first apply for consent from the Minister for Aboriginal Affairs under section 18 of the *Aboriginal Heritage Act 1972*. The Aboriginal Heritage Due Diligence Guidelines (DAA & DPC, 2013) describes the list of land use activities and associated risk of disturbance to an Aboriginal heritage site to determine whether a Section 18 application may be required. Data from the DAA presented in Table 16 indicates that the number of Section 18 applications lodged for the Shire increased between 2008 and 2012. This reflects the increase in activity in the Shire, where the number of applications has doubled in 2011-2012.

Table 16: Number of lodged Section 18 applications in the Shire of Ashburton (Source: DAA, 2013)

Year	No. applications
2008	10
2009	8
2010	8
2011	19
2012	22

There have been 44 Indigenous Land Use Agreements (ILUAs) registered within the Shire of Ashburton since 2001. An ILUA is a voluntary agreement between a native title group and others about the use of land and waters. These agreements allow people to negotiate flexible, pragmatic agreements to suit their particular circumstances. An ILUA can be:

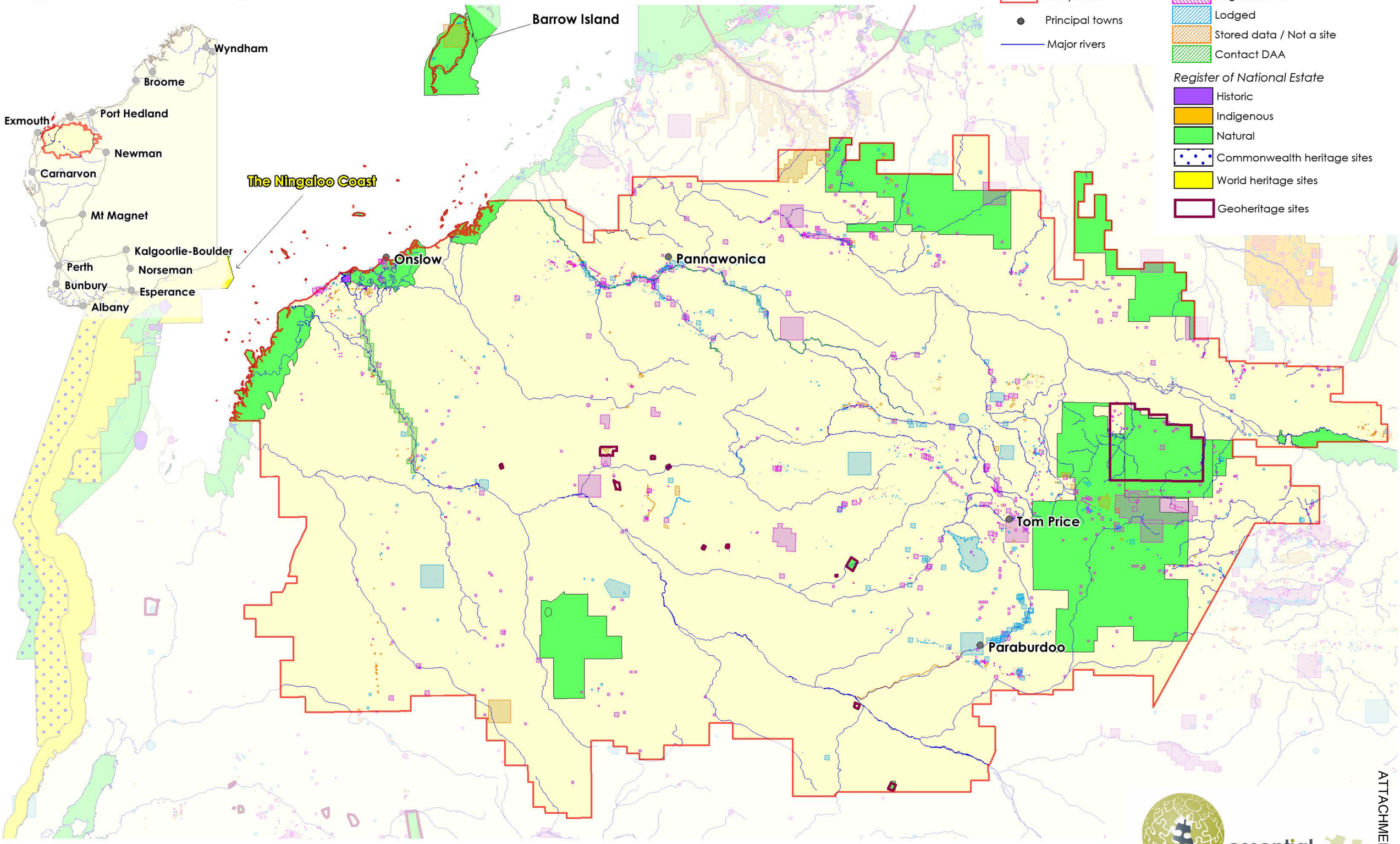
- over areas where native title has, or has not yet, been determined;
- entered into regardless of whether there is a native title claim over the area or not;
- part of a native title determination or settled separately from a native title claim.

ILUAs can cover topics such as:

- native title holders agreeing to a future development;
- how native title rights coexist with the rights of other people;
- access to an area;
- extinguishment of native title;
- compensation;
- employment and economic opportunities for native title groups;
- cultural heritage; and
- mining.

When registered, ILUAs bind all parties and all native title holders to the terms of the agreement.

Taylor Burrell Barnett - Shire of Ashburton Environmental Profile
Figure 13: Heritage



Data sources: Landgate, Dept. of Water, Dept. of Aboriginal Affairs, Dept. of the Environment, DMP Created by: H Lamparski. Projection: MGA50: zone 50.

Scale 1: 1,500,000 @ A3
0 60 km

essential environmental

2.8.2 European Settlement Heritage

The original town of Onslow was gazetted as a townsite on 26 October 1885 and named after Sir Alexander Onslow, the Chief Justice of Western Australia at the time (SoA, 2016). It supported the nearby stations that had been established along the Ashburton River and the gold mines that had developed in the hinterland. One of the first recorded stations was Minderoo which was established in 1882. By 1890 all land along the Ashburton River had been taken up, running mainly sheep, but also a few cattle (SoA, 2016).

In the early days of settlement, pearls were found in the Exmouth Gulf and Onslow and pearling became home port to a fleet of pearling luggers. By 1925, the port facilities at the mouth of the Ashburton were affected by the silting up of the river causing more and more problems in the loading and unloading of visiting ships (SoA, 2016). Today pearling is a small industry with the shells farmed for blister and culture pearls.

Mining of the now infamous blue asbestos began in the region in 1937 in Wittenoom Gorge (Rom and Markowitz, 2007), and following the discovery of iron ore in the Hamersley Ranges in the 1960s, mining became the dominant driver of the region and state's economy with towns built to accommodate the mining boom.

Onslow was actively involved in World War II with the Navy refuelling at the jetty and the town becoming the furthest town south to be bombed by the Japanese. Onslow was also used as a base by the Royal Navy between 1952 and 1956 to conduct tests on the nearby Monte Bello Islands. On 3rd October 1952 the British conducted their first atomic bomb tests on the Monte Bello Islands as part of Operation Hurricane (DEC, 2009).

Surveys proved that there was deep water at Beadon Point and so the town was moved some eighteen kilometres to the east to where it is today (SoA, 2016).

Evidence of the region's colonial European past remains in the form of a number of preserved heritage sites, of which four are recognised on the Register of National Estate (Table 15).

A large number of historic heritage sites are located within the Shire, and registered with both the Heritage Council of WA and the Shire of Ashburton Municipal Inventory (State Heritage Office, 2016). A small number of key sites, including the Old Onslow Townsite, Bessieres Island Lighthouse, and Tambrey Station Homestead (ruins) and Surrounds are also part of the Register of National Estate and the National Trust.

A large number of historic shipwrecks have also been identified off the Pilbara coast, associated with the region's European history. Sixteen wrecks have been identified in the Onslow area on the Australian National Shipwreck Database, dating back to 1868 (DSEWPaC, 2016).

Like in many areas of Australia, European settlement resulted in the introduction of disease, alcohol, indentured labour and the forced removal of Aboriginal children from their families by government agencies of the time.

In contrast to the historical settlement of Onslow, Pannawonica and Paraburdoo were gazetted as 'closed towns' in 1972, meaning that the towns were purpose-built and were managed by a mining company (in this case Rio Tinto). Facilities at the towns were limited for visitors and accommodation is reserved for mining staff. Tom Price was also founded as a mining town and was gazetted in 1964. It is still primarily serves to support the local mining activity. All but Pannawonica have been naturalised and are now managed by the Shire.

2.8.3 Natural Heritage

The natural heritage of the region is renowned because of its unique and diverse collection of marine and terrestrial landscapes and habitats. Twenty natural heritage sites within the Shire are listed on the Register of National Estate (Table 15). In addition, the region's unique natural heritage is largely preserved and managed through the conservation reserve system and the identification of numerous national parks and nature reserves, including Karijini National Park, Millstream-Chichester National Park, and Barrow Islands National Park.

The Shire also contains a number of sites of important world geoheritage, some of which contain the oldest known examples of fossil stromatolites (3.5 billion years old) (DMP, 2016b). These fossils are identified and managed through the Geological Survey of Western Australia, twelve of which are located within the Shire (shown in Figure 13). They are considered the best preserved and oldest indicators of early life on Earth.

2.8.4 Key strategic environmental planning issues for consideration

Key heritage considerations for strategic planning are:

- **Protection of heritage sites and values** – While heritage is primarily managed through State and Commonwealth legislation, opportunities exist to protect and promote both Aboriginal and European cultural heritage through joint management arrangements with traditional owners and optimise opportunities for Indigenous training, employment and businesses. Consideration should also be made to Native Title and ILUAs when considering any planning or development proposals, in discussion with appropriate Traditional Owners.
- **Engagement with Traditional Owners** – is required to meet legislative requirements of Native Title. Increased benefits may be observed through an elevated level of involvement of the Traditional Owners within the Shire in terms of land and cultural heritage management.

3 SUMMARY

The Shire of Ashburton ('the Shire') is the southern most local government area in the Pilbara region. It is located approximately 1,000 km north of Perth and comprises over 100,000 km^2. The Shire is best known for mining, agriculture and fishing, and for its rugged, ancient landscape supporting tourism in the region. It is home to some of the world's largest open cut mines, immense pastoral leases and cattle stations, and thriving prawn, pearl and mackerel fishing industries.

The Community mission for the Shire is

'working together, enhancing lifestyle and economic vitality'

The Shire's Community Strategic Plan defines key environmental outcomes to be delivered in the Shire of Ashburton as *maintaining the integrity and quality of the Shire's natural environments, together with celebrating and valuing the Aboriginal and European history and heritage, with the aim of being a recognised leader in sustainability practices.*

The Shire of Ashburton has commenced the process of preparing a Local Planning Strategy (LPS) to guide future growth and development. In order for these outcomes to be achieved in the future, it is critical that the natural and environmental assets of the Shire are recognised, and any environmental opportunities and constraints are considered as part of the LPS process. This report provides a snapshot of the Shire's environmental context and highlights opportunities and constraints for consideration.

The key environmental context and considerations are summarised as follows:

- Increases in temperature and extreme weather events as a result of climate change have the potential to impact on the health of the environment and the community, as well as the maintenance of public lands and capacity of infrastructure systems including those managed by the Shire;
- The broad and diverse landforms of the Shire, from the Hamersley Ranges in the inland east, to the flood plains and coast in the west, underpin the soil, water and vegetation characteristics. The great river systems that flow across the Shire, through the steep gorges and hills and across the scrubby steppe regularly flood the surrounding landscape during the wet season and tropical cyclones and form important catchments for surface water runoff and feed groundwater systems;
- Minerals extraction and processing will continue to occur throughout the Shire. Clearing of the land for resource extraction results in a loss of biodiversity and can lead to erosion. Mining activities can also lead to the lowering of groundwater tables, and can also impact on the visual landscape of the Shire and can result in off-site impacts on nearby land uses including dust, noise and light;
- Flooding occurs semi-regularly in the Shire, particularly during the wet season and extreme tropical cyclones. Adequate management of flood risk, and associated sediment transport in townsites and industrial areas requires consideration consistent with *State Planning Policy 2.9: Water Resources*. The Shire may need to review existing townsite drainage systems and ensure appropriate levels of service will be maintained as development occurs (such as at Onslow Airport) and water quality including sediments in stormwater is addressed.
- Groundwater is available for allocation in many aquifers, however, declining rainfall in coastal areas may result in reduced recharge and consequently availability in these areas in the future, particularly as population and industry expands. Dewatering/over-abstraction have also impacted local groundwater levels and thereby potentially affecting groundwater-dependent pool ecosystems and wetlands through drying up

and loss of habitat, affecting vegetation and wildlife dependent on them as well as groundwater-dependent cultural and social values. This is especially critical given the presence of proposed Ramsar sites, and nationally important wetlands in the Shire.

- The Shire contains a number of important water resources which supply drinking water to the region. These areas should be protected and managed in accordance with relevant water source protection plans, DoW's Water Quality Protection Note 25 and State Planning Policy 2.7: *Public Drinking Water Sources*.
- It is recognised that the Shire is a Waterwise Council, and it should continue to investigate and expand water efficiency opportunities, such as irrigation of public open space and sports ovals where practical. The Shire could also investigate partnerships to establish water recycling and reuse schemes to provide fit-for-purpose sources of water where practical, as an alternative to groundwater use to support future development.
- The Shire is recognised as having significant terrestrial, marine and aquatic biodiversity. The level of reservation of land for conservation purposes in the Shire of Ashburton is much greater than the rest of the Pilbara and greater than the internationally recognised standard of reservation of between 10% and 15% of each bioregion.
- The Shire contains a number of areas which have been reserved for conservation. While many conservation reserves are managed by the Department of Parks and Wildlife, the Shire could consider active management of weeds, uncontrolled access, and feral animals to assist with vegetation retention, which in turn assists in the maintenance of soil health. Soils and vegetation (grasslands and shrublands) in good condition are also associated with higher agricultural productivity.
- Sea level rise and coastal vulnerability will increase along the rangelands coastline in the near future. Management of existing infrastructure and planning future development will require consideration of vertical allowances and setback distances.
- Expansion of tourism, commercial fishing, aquaculture and resource industry activity will increase pressure on sensitive and productive coastal marine environments which provide habitats and breeding grounds (seagrass meadows, turtle nestings on beaches, river mouths/intertidal mud flats) for marine life. Recreational activity (camping, coating, fishing, swimming and 4WDing) around sensitive coastal environments associated with population growth and industry development will also impact upon local biodiversity and environmental values.
- Coastal spaces which support recreational activity should consider cumulative impacts on sensitive environments and minimise impacts through appropriate management.
- The majority of the Shire is indicated as being located within a Bush Fire Prone Area of Western Australia as designated by the Fire and Emergency Services (FES) Commissioner. Any future planning and development within a designated Bush Fire Prone area should be consistent with the requirements of *State Planning Policy 3.7 Planning in Bushfire Prone Areas*.
- While heritage is primarily managed through State and Commonwealth legislation, opportunities exist to protect and promote both aboriginal and European cultural heritage through joint management arrangements and tourism opportunities with traditional owners, and optimise opportunities for Indigenous training, employment and businesses. This should include effective engagement with the appropriate traditional owners depending on the location of heritage sites and business opportunities, to support protection of cultural values

The above considerations and the implications for management and planning are broadly summarised in Table 17, with supporting mapping presented on Figure 14.

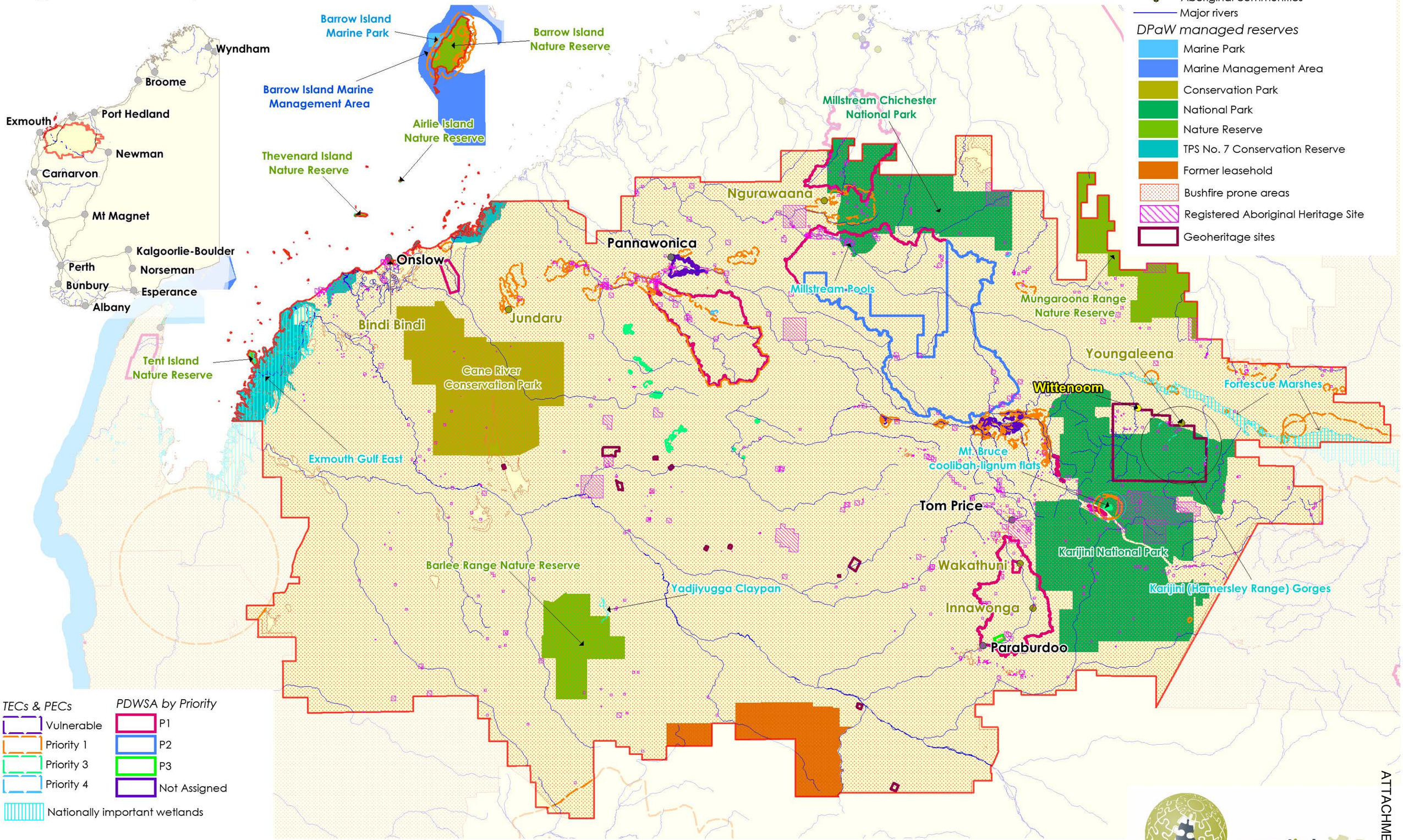
Within this local environmental context, consideration should also be given to emerging global, national and regional environmental priorities. These include:

- Climate change leading, in addition to the issues raised above, to global (land and ocean) temperature rise, sea level rise, ocean acidification and increases in extreme weather;
- Reducing greenhouse gas emissions and energy use through improved energy efficiency and increased use of renewable energy;
- Reducing resource consumption and a move towards community acceptance of smaller environmental footprints;
- Innovation leading to the creation of new ways to address sustaining problems including poorly functioning communities, and water scarcity, which result in improved built form and optimised delivery of services and infrastructure; and
- Enhanced liveability of communities which are adaptive and able to respond to changing environments and community priorities.

It is recognised that the Shire of Ashburton desires a sustainable, connected and thriving community into the future. This supports many opportunities for environmental innovations. Key areas of focus may include:

- Provision of wastewater recycling facilities and renewable energy schemes to reduce reliance on groundwater (and support green infrastructure to manage a hotter climate) and traditional energy sources, as well as decentralised waste-management strategies which optimise reuse and recycling of waste materials, or schemes to transform waste into energy.
- Eco and heritage tourism opportunities which celebrate the unique natural beauty, biodiversity and cultural of the Shire. This may include accommodation, entertainment and artistic opportunities as well as adventure and recreational activities. This could be extended to educational opportunities associated with practical and on-ground environmental and cultural heritage learning.

Taylor Burrell Barnett - Shire of Ashburton Environmental Profile
Figure 14: Key environmental attributes



Scale 1: 1,500,000 @ A3
0 60 km

essential environmental

The following table provides broad generalisations only. Specific solutions for individual locations should be determined through more detailed planning and assessment as part of the planning and development approvals process.

Table 17: Summary of strategic environmental planning considerations

Key environmental value	Impacts from and on land use	Red – high	Orange - medium	Green - low	Shire's role in managing the impact	Recommendations for planning control
	Residential /town/ village /commercial	Industrial	Rural residential	Rural/agriculture		
Air quality	Haze and smog Light overspill Dust (construction sand)	Noise, dust, light, odour	Haze	Overspray, noise, dust	Manage impacts through enforcement of by-laws and Environmental Health regulations	Provide buffers and management of off-site impacts consistent with SPP 4.1: State Industrial Buffer Policy and DER/EPA buffer guidelines.
	Health risks to residents	Health risks to employees	Health risks to residents	Health risks to residents & livestock		
Soils	Erosion, nutrient export and acidification	Erosion, and contamination	Erosion, nutrient export and acidification	Erosion, nutrient export, contamination and acidification	Ensure land clearing and site management practices are implemented which are appropriate to the land use and capability of the soils.	Ensure land use is appropriate to the capability of the land to sustain the land use. This is particularly important for intensive agriculture proposals
	Structural impacts including subsidence and erosion	Structural impacts including subsidence and erosion	Structural impacts including subsidence and erosion	Productivity and structural impacts including subsidence and erosion		
Minerals and basic raw material	Sterilisation of resource	Sterilisation of resource	Sterilisation of resource	Sterilisation of resource	Enforce conditions of development approval with regards to the management of of-site impacts	Ensure planning approvals are consistent with the protection of significant values and that potential off-site impacts are managed.
	Not permitted within this land use however may be affected by off-site impacts including noise, light and dust	Noise, light and dust	Not permitted within this land use however may be affected by off-site impacts including noise, light and dust	Noise, light and dust		
Groundwater for drinking water purposes	Nutrient pollution of recharge areas	Contamination of recharge areas	Contamination of recharge areas	Contamination of recharge areas	Planning approvals should restrict land use in PDWSAs	Ensure land use is consistent with SPP 2.7 and DoW's water quality protection notes
	Land use is restricted based on WQPN 25	Land use is restricted based on WQPN 25	Land use is restricted based on WQPN 25	Land use is restricted based on WQPN 25		

Key environmental value	Impacts from and on land use	Red – high	Orange - medium	Green - low	Shire's role in managing the impact	Recommendations for planning control
	Residential /town/ village /commercial	Industrial	Rural residential	Rural/agriculture		
Waterways and wetlands	Direct impacts from filling, draining, clearing, contamination and erosion	Direct impacts from filling, draining, clearing, erosion, contamination,	Direct impacts from clearing, erosion, contamination, and/or uncontrolled access by stock	Direct impacts from clearing, erosion contamination, and/or uncontrolled access by stock	Avoid development which results in direct impacts on values and address flood risk and management of stormwater.	Identify waterways and wetlands with significant values and ensure future development is not proposed in these locations or is managed appropriately Protect development from flood risk. and manage the water cycle consistent with State Planning Policy 2.9: *Water Resources*.
	Mosquitoes, flooding	Mosquitoes, flooding	Mosquitoes, flooding	Mosquitoes, flooding		
Remnant vegetation, biodiversity and fauna habitat	Direct impacts from clearing and bushfires and indirect impacts from rubbish, uncontrolled access, weeds, pests and feral animals	Direct impacts from clearing and bushfires and indirect impacts from rubbish, uncontrolled access, weeds, pests and feral animals	Direct impacts from clearing and bushfires and indirect impacts from rubbish, uncontrolled access, weeds, pests and feral animals	Direct impacts from clearing and bushfires and indirect impacts from agricultural practices, rubbish, uncontrolled access, weeds, pests and feral animals	Identify areas of remnant vegetation with significant values and aim to limit the location of high risk land uses	Protect as appropriate through reservation or use of a special control area.
	Bushfires, Snakes	Bushfires, Snakes	Bushfires, Snakes	Bushfires, Snakes		
Coastal environments	Loss of environmental, cultural and recreational values from clearing for development and unmanaged use	Loss of environmental, cultural and recreational values from clearing for development, and/or commercial activities	Loss of environmental, cultural and recreational values from clearing for development and unmanaged use	Loss of environmental, cultural and recreational values from clearing for agricultural activities	Planning approvals should avoid environmentally sensitive areas and consider risks from storm surge and sea level rise.	Demonstrate compliance with State Planning Policy 2.6: *State Coastal Planning Policy* and protect (reserve) areas of significant environmental value.
	Inundation from sea level rise and storm surge	Inundation from sea level rise and storm surge	Inundation from sea level rise and storm surge	Inundation from sea level rise and storm surge		

Key environmental value	Impacts from and on land use	Red – high	Orange - medium	Green - low	Shire's role in managing the impact	Recommendations for planning control
	Residential /town/ village /commercial	Industrial	Rural residential	Rural/agriculture		
Aboriginal and European heritage	Direct impacts from disturbance or reduced access to sites	Direct impacts from disturbance or reduced access to sites	Direct impacts from disturbance or reduced access to sites	Direct impacts from disturbance or reduced access to sites	Identify significant sites should be identified in the Scheme	Decision making should be consistent with the *Heritage Act* and *Aboriginal Heritage Act*
	Potential to limit scope of development	Potential to limit scope of development				

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APPENDIX 1: POLICY AND REGUILATORY FRAMEWORK

4.1 Guiding legislation

The management of the environment and natural resources in an urban and regional context is governed by a substantial number of acts and regulations, the most relevant of which are considered to be:

- Aboriginal Heritage Act 1972
- Biosecurity and Agriculture Management Act 2007
- Conservation and Land Management Act 1984
- Contaminated Sites Act 2003
- Country Areas Water Supply Act 1947
- Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
- Environmental Protection Act 1986
- Health Act 1911
- Heritage of Western Australia Act 1990
- Local Government Act 1995;
- Native Title (State Provisions) Act 1999
- Native Title Act 1993 (Commonwealth)
- Planning and Development Act 2005
- Rights in Water and Irrigation Act 1914
- Soil and Land Conservation Act 1945
- Waste Avoidance and Resource Recovery Act 2007
- Water Agencies (Powers) Act 1984
- Water Resources Legislation Amendment Act 2007
- Water Services Act 2012
- Waterways Conservation Act 1976
- Wildlife Conservation Act 1950

4.2 State policy context

Strategic guidance for the management of our environment is also provided by a number of State-level policies, strategies and guidelines. These include:

4.2.1 Relevant State Planning Policies

State Planning Policy 2: Environment and Natural Resources (2003)

The environment and natural resources policy defines the principles and considerations that represent good and responsible planning in terms of environment and natural resource issues within the framework of the State Planning Strategy.

The policy will be supplemented by more detailed planning policies on particular natural resources matters that require additional information and guidance. These supplementary policies may also be state planning policies and should be implemented in conjunction with this policy.

State Planning Policy 2.6: State Coastal Planning Policy (2013)

State Coastal Planning Policy provides an approach to the consideration of often competing needs and desires in coastal areas in a way that takes into account the values of the coastal zone. The policy ensures that current and future generations of Western Australians can benefit from opportunities presented by the values and resources of the Western Australian coast.

Guidance is provided for land use and development decision-making within the coastal zone including managing development and land use change; establishment of coastal foreshore reserves; and to protect, conserve and enhance coastal values. The policy recognises and responds to regional diversity in coastal types; requires that coastal hazard risk management and adaptation is appropriately planned for; encourages innovative approaches to managing coastal hazard risk; and provides for public ownership of coastal foreshore reserves.

State Planning Policy No 2.7: Public Drinking Water Source (2003)

This policy applies to proclaimed Public Drinking Water Source Areas (PDWSAs) throughout Western Australia. The objective of this policy is to ensure that land use and development within PDWSAs is compatible with the protection and long-term management of water resources for public water supply.

The policy specifies to regions outside the metropolitan region that all priority (P1, P2, and P3) source protection areas should be shown as special control areas in region schemes and local government schemes. This will be in accordance with the recommendations of any relevant land use, water management strategy, or water source protection plan. Furthermore, land uses and developments in all priority source protection areas that have the potential to impact detrimentally on the quality and quantity of public drinking water supplies should not be permitted unless it can be demonstrated, having regard to advice from the Water and Rivers Commission (now Department of Water), that such impacts can be satisfactorily managed.

Planning schemes and decisions on land use and development should have regard for any adopted region scheme policy or relevant environmental protection policy on public drinking water supply.

State Planning Policy 2.9: Water Resources (2006)

The *State Planning Policy 2.9: Water Resources* pledges Western Australia to pursuing sustainability through an integration of environmental protection, social advancement and economic prosperity. This vision is encapsulated in A State Water Strategy for Western Australia (2003), which seeks to develop and protect water resources in an economically and environmentally responsible way by providing a whole government framework for setting strategies and plans for water resources.

This policy is directly related to the overarching sector policy State Planning Policy 2 Environment and Natural Resources Policy and provides clarification and additional guidance to planning decision-makers for consideration of water resources in land use planning strategies, proposals and applications, for example local and regional planning strategies, structure plans, town planning schemes and amendments, subdivisions and development applications, and other town planning mechanisms.

State Planning Policy 3.7 - Planning in Bushfire Prone Areas (2015)

This policy seeks to guide the implementation of effective risk-based land use planning and development to preserve life and reduce the impact of bushfire on property and infrastructure.

It applies to all higher order strategic planning documents, strategic planning proposals, subdivision and development applications located in designated bushfire prone areas (unless exemptions apply). This policy also applies where an area is not yet designated as bushfire prone but the proposed development is planned in a way that introduces a bushfire hazard (e.g. revegetation)

4.2.2 State-level guidelines

There are a number of State-level guidelines which assist local governments to meet their regulatory requirements. Those that provide guidance for improved environmental management, protection and natural resource use are summarised in Appendix 1 and listed in Table 18 below. It should be noted that these documents are not statutory and provide guidance only.

Table 18: Relevant State-level guidelines

Environment area	Report
General	• Directions Paper on the Integration of NRM into Land Use Planning, (Western Australian Planning Commission, 2013). • Guidance for the Assessment of Environmental Factors No 33: Environmental Guidance for Planning and Development (EPA, 2008) • Western Australian State Sustainability Strategy (Government of WA, 2003)
Built form	• Building Code of Australia • State Planning Strategy (Western Australian Planning Commission, 2013) • Guidelines for Planning in Bushfire Prone Areas
Air quality and emissions	• Working together — WA Health Strategic Intent 2010-2015 (Department of Health, 2010)
Water	• Australian Guidelines for Water Recycling • Better Urban Water Management (WAPC, 2008) • Government Sewerage Policy- Draft Country Sewerage Policy (Government of WA, 2011) • Guidelines for the approval of non-drinking water systems in Western Australia - urban developments (Department of Water, 2013) • Pilbara regional water plan 2010-2030 (Department of Water, 2010) • River restoration manual, (Department of Environment and Conservation, 2004) • State Water Plan (Department of Water, 2007) • Stormwater management manual for Western Australia, (Department of Water, 2004-2007)
Waste	• Western Australian Waste Strategy (WA Waste Authority, 2012)

4.3 Local regulatory context

The Shire is in the process of developing a local planning strategy. Planning guidance is currently provided by Shire of Ashburton Town Planning Scheme No. 7 and local planning policies. Some strategic direction is also provided by the Community Strategic Plan.

The strategies and reports that are most relevant to the management of the environment and natural resources across the Shire are outlined below.

4.3.1 Shire of Ashburton Town Planning Scheme No. 7

Originally gazetted in 2004, the Shire of Ashburton Town Planning Scheme No. 7 (the Scheme) provides the statutory basis for land use and development in the Shire. The following Scheme objectives are considered to assist in the achievement of environmental outcomes

1.6(a) To facilitate development that responds to the character and amenity, geographical context and environmental constraints of the Shire and its urban and rural areas

1.6(i) To identify areas for conservation, recreation and natural landscapes which are important for ecological, heritage and amenity purposes in addition to the major tourist assets of the Shire.

1.6(j) To facilitate development that takes account of the heritage value of places, buildings and objects.

1.6(k) To acknowledge the health risks within the Wittenoom townsite.

1.6(l) To facilitate development that has regard for the long term protection of natural resources, such as clean air, water, soil and biological diversity.

Provisions that are relevant to the protection and management of the environment include:

5.6 Additional Heritage Information

In addition to the requirements of other provisions of the Scheme, the Local Government may require an application for planning approval, where the proposed development may affect a place of cultural heritage significance or an entry on the Inventory, to include additional information to assist the Local Government in its determination.

6.20 Flood and Storm Surge Prone Land

6.20.1 When considering applications for planning approval Council shall have regard to the requirements for the Onslow Coastal Hazard Special Control Area in clause 7.3.

6.20.2 In areas not subject to Onslow Coastal Hazard Area provisions contained in Clause 7.3 of the Scheme but where the Local Government considers development to be potentially incompatible with land prone to flood and storm surge events, it must be satisfied that approval of such planning applications has regard to flood and storm surge events and may approve, with or without conditions, or refuse proposals at its discretion.

The Scheme also contains a number of special control areas which address environmental issues. These generally require that consideration is given to the key issue and that the application is supported by sufficient information to assist decision making.

The following special control areas address a range of environmental issues:

7.2 Tidal Inundation Areas

7.3 Onslow Coastal Hazard Area

7.4 Onslow Strategic Industrial Buffer

7.6 Cane River Water Reserve Area

7.7 Turee Creek, Mt Lionel and Mt Stevenson Borefields

7.8 Wittenoom

7.10 Waste Water Treatment Plant Odour Buffer Special Control Area

4.3.2 *Shire of Ashburton Community Strategic Plan 2013-2023*

Setting out goals and plans to achieve them with focus on job creation, sustainable development, water management and resource management.

4.3.3 *Local environmental policy context*

The local policies which provide guidance for environmental management include:

- LPP25 Onslow Coastal Hazard Area – Scheme Control Area;
- ELM21 Tree Management Overview Policy;
- ENG08 Bushfire Policy; and
- ENG10 Guidelines for Urban Development.

4.4 Other guiding documents

4.4.1 *State Water Plan (2007)*

The S*tate Water Plan* provides a strategic framework manage water resources in Western Australia, highlights and builds upon the *State Water Strategy.* The Plan details priority actions identified in the Strategy, with a larger focus on water policy and planning. Priority actions included developing regional water plans, statutory water management plans, and further study to demand management and supply options including regional areas.

4.4.2 *Better Urban Water Management (2008)*

Better Urban Water Management (WAPC, 2008) provides guidance on the implementation of *State Planning Policy 2.9 Water Resources* (2006). It outlines the requirements for integrating land and water planning and improving the achievement of total water cycle outcomes and water sensitive urban design as part of land use planning and development.

Better Urban Water Management is designed to facilitate better management and use of water resources by ensuring an appropriate level of consideration is given to the total water cycle at each stage of the planning system. The document provides guidance for regional, district and local land use planning, as well as subdivision phases of the planning process. *Better Urban Water Management* is to be used by all stakeholders and decision makers and has statewide application for new urban, commercial, industrial and rural-residential developments.

APPENDIX 2: THREATENED FLORA AND FAUNA LISTS – STATE & COMMONWEALTH

Australian Government

Department of the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

LGA SHIRE OF ASHBURTON, WA

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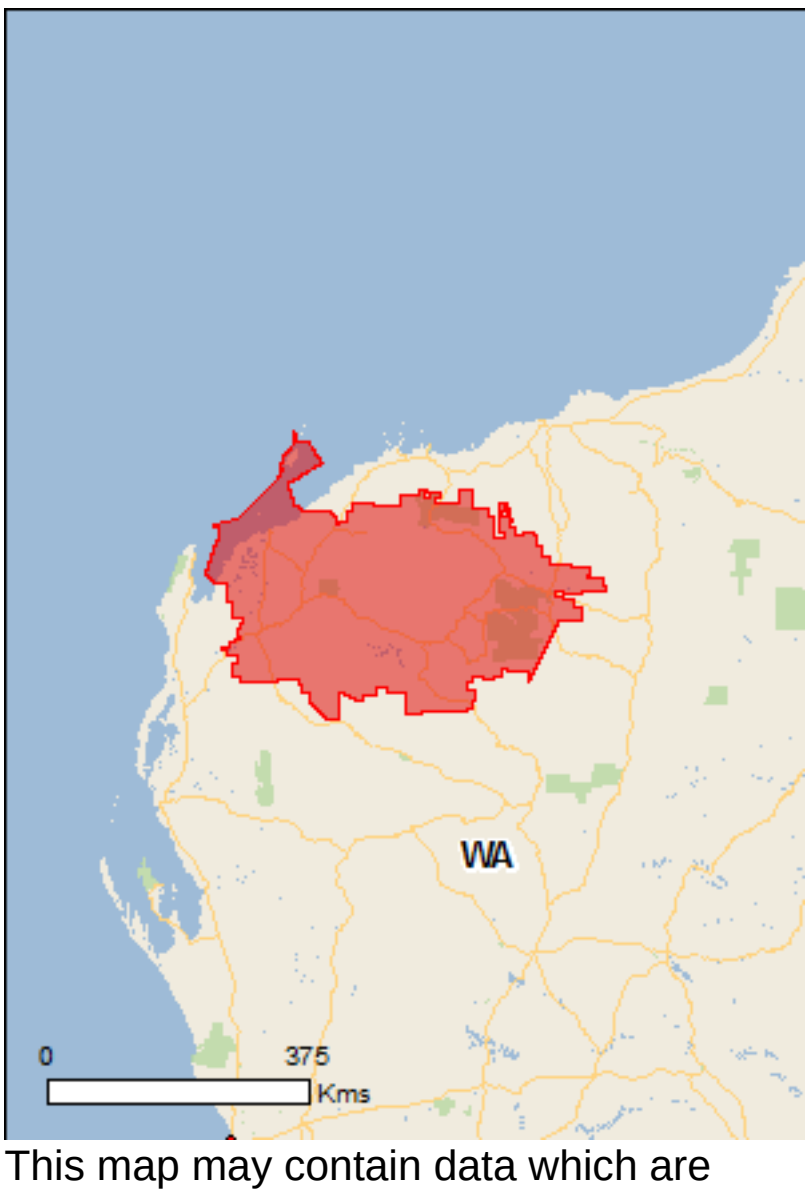

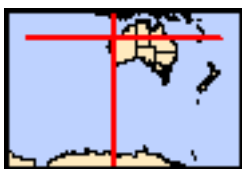

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://environment.gov.au/protection/environment-assessments

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Significance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Threatened Ecological Communities:	None
Threatened Species:	37
Migratory Species:	36

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits-and-application-forms

Commonwealth Lands:	2
Commonwealth Heritage Places:	None
Listed Marine Species:	79
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	1

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	28
Regional Forest Agreements:	None
Invasive Species:	16
Nationally Important Wetlands:	7

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
The Ningaloo Coast	WA	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Name
EEZ and Territorial Sea

Threatened Species [Resource Information]

Name	Status	Type of Presence
BIRDS		
Limosa lapponica baueri		
Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri		
Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Malurus leucopterus edouardi		
White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren [26194]	Vulnerable	Species or species habitat likely to occur within area
Pezoporus occidentalis		
Night Parrot [59350]	Endangered	Species or species habitat likely to occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis		
Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
FISH		
Milyeringa veritas		
Blind Gudgeon [66676]	Vulnerable	Species or species habitat may occur within area
MAMMALS		
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Bettongia lesueur Barrow and Boodie Islands subspecies		
Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021]	Vulnerable	Species or species habitat known to occur within area
Dasyurus hallucatus		
Northern Quoll, Digul [331]	Endangered	Species or species habitat known to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat may occur within area
Isoodon auratus barrowensis		
Golden Bandicoot (Barrow Island) [66666]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes conspicillatus conspicillatus		
Spectacled Hare-wallaby (Barrow Island) [66661]	Vulnerable	Species or species habitat known to occur within area
Macroderma gigas		
Ghost Bat [174]	Vulnerable	Breeding known to occur within area
Macropus robustus isabellinus		
Barrow Island Wallaroo, Barrow Island Euro [26196]	Vulnerable	Species or species habitat likely to occur within area
Macrotis lagotis		
Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Petrogale lateralis lateralis		
Black-flanked Rock-wallaby [66647]	Vulnerable	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form)		
Pilbara Leaf-nosed Bat [82790]	Vulnerable	Roosting known to occur within area
PLANTS		
Lepidium catapycnon		
Hamersley Lepidium, Hamersley Catapycnon [9397]	Vulnerable	Species or species habitat known to occur within area
Pityrodia augustensis		
Mt Augustus Foxglove [4962]	Vulnerable	Species or species habitat likely to occur within area
Thryptomene wittweri		
Mountain Thryptomene [16645]	Vulnerable	Species or species habitat likely to occur within area
REPTILES		
Aipysurus apraefrontalis		
Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Ctenotus angusticeps		
Airlie Island Ctenotus [25937]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area

Name	Status	Type of Presence
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Liasis olivaceus barroni		
Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
SHARKS		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias		
Great White Shark [64470]	Vulnerable	Species or species habitat likely to occur within area
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Puffinus carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat may occur within area
Puffinus pacificus		
Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Sterna anaethetus		
Bridled Tern [814]		Breeding known to occur within area
Sterna caspia		
Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii		
Roseate Tern [817]		Breeding known to occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Balaenoptera edeni		
Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Carcharodon carcharias Great White Shark [64470]	Vulnerable	Species or species habitat likely to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Migratory Wetlands Species		
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands	[Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Defence - TOM PRICE TRAINING DEPOT

Listed Marine Species	[Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur

Name	Threatened	Type of Presence within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat may occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
[Hippocampus kuda](#) Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
[Hippocampus planifrons](#) Flat-face Seahorse [66238]		Species or species habitat may occur within area
[Hippocampus trimaculatus](#) Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
[Micrognathus micronotopterus](#) Tidepool Pipefish [66255]		Species or species habitat may occur within area
[Phoxocampus belcheri](#) Black Rock Pipefish [66719]		Species or species habitat may occur within area
[Solegnathus hardwickii](#) Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
[Solegnathus lettiensis](#) Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
[Solenostomus cyanopterus](#) Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
[Solenostomus paegnius](#) Rough-snout Ghost Pipefish [68425]		Species or species habitat may occur within area
[Syngnathoides biaculeatus](#) Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
[Trachyrhamphus bicoarctatus](#) Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
[Trachyrhamphus longirostris](#) Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
[Dugong dugon](#) Dugong [28]		Breeding known to occur within area
Reptiles		
[Acalyptophis peronii](#) Horned Seasnake [1114]		Species or species habitat may occur within area
[Aipysurus apraefrontalis](#) Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
[Aipysurus duboisii](#) Dubois' Seasnake [1116]		Species or species habitat may occur within area
[Aipysurus eydouxii](#) Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
[Aipysurus laevis](#) Olive Seasnake [1120]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area

Name	Status	Type of Presence
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Commonwealth Reserves Marine	[Resource Information]
Name	Label
Montebello	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Airlie Island	WA
Barlee Range	WA
Barrow Island	WA
Bessieres Island	WA
Boodie, Double Middle Islands	WA
Burnside And Simpson Island	WA
Cane River	WA
Cane River (Mount Minnie and Nanutarra)	WA
Giralia	WA
Gnandaroo Island	WA
Karijini	WA
Little Rocky Island	WA
Locker Island	WA
Lowendal Islands	WA
Millstream Chichester	WA
Mungaroona Range	WA
Rocky Island	WA
Round Island	WA
Serrurier Island	WA
Tent Island	WA
Thevenard Island	WA
Unnamed WA40322	WA

Name	State
Unnamed WA41696	WA
Unnamed WA44665	WA
Victor Island	WA
Wanna	WA
Whalebone Island	WA
Y Island	WA

Invasive Species

[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit,

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Cylindropuntia spp. Prickly Pears [85131]		Species or species habitat likely to occur

Name	Status	Type of Presence within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area

Nationally Important Wetlands

[Resource Information]

Name	State
Exmouth Gulf East	WA
Fortescue Marshes	WA
Karijini (Hamersley Range) Gorges	WA
Kookhabinna Gorge	WA
Millstream Pools	WA
Mt. Bruce coolibah-lignum flats	WA
Yadjiyugga Claypan	WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining oigations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Parks and Wildlife Commission NT, Northern Territory Government
-Department of Environment and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-Forestry Corporation, NSW
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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APPENDIX 3: DRAFT RISK ASSESSMENT CHRMAP FOR THE ONSLOW COAST (CARDNO, 5TH AUGUST 2016)

Risk Assessment

CHRMAP for the Onslow Coast

59916801

Prepared for
Shire of Ashburton

5 August 2016

Cardno
Shaping the Future

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V1	5/08/2016	Draft - for discussion	DRS/JB	DvS

Executive Summary

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Study Terminology

Abbreviation	Description
AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
ANSIA	Ashburton North Strategic Industrial Area
AS	Australian Standard
CHRMAP	Coastal Hazard Risk Mitigation and Adaption Plan
MCA	Multi-criteria analysis
MS	Microsoft
WAPC	Western Australian Planning Commission
SPP2.6	State Planning Policy No 2.6
GIS	Geographical information Systems

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Tables

Figures

1 Introduction

The Shire of Ashburton (herein referred to as 'the Shire') is undertaking a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for the Town of Onslow (herein referred to as 'the Town') and immediate surrounds, in accordance with the State Coastal Planning Policy No 2.6 (SPP2.6, WAPC 2013). The Ashburton North Strategic Industrial Area (ANSIA) is located around 13 km to the west of the Town. This industrial area and the Town are two of the Shire's important coastal development zones. Their proposed and potential future development is the key driver for the undertaking of a CHRMAP for the area. This report presents the Risk Analysis and Evaluation component of the study (Elements 4 & 5, Figure 1-1).

The study area is subject to a range of natural hazards associated with coastal erosion, storm surge inundation, fluvial runoff inundation and various combinations of the events. Element 1 of the CHRMAP process investigated coastal processes, combined with future sea level rise, for the study area and used computer modelling to predict likely future inundation and erosion hazards (Cardno 2016a). The results of the hazard mapping were used to undertake the risk identification, which is detailed in the Key Issues Paper (Cardno 2016b). The Risk Identification is also summarised in Section 2.

The risk analysis presented here (Element 4 in Figure 1-1) further develops an understanding of the identified risks by assessing the likelihood of the risk occurring and the likely consequences if it does.

Risk evaluation and ranking utilises the outcomes of the risk analysis process and is applied to the risk priority level matrix (SPP2.6, WAPC 2013). Following the evaluation, each risk is ranked, and then assigned a risk prioritisation level. This will help identify risks to be treated, and how important or urgent that treatment is. It will also provide a mechanism to compare the level of risk after a preferred adaptation option has been theoretically implemented.

To assess the level of risk, or potential impact, posed to the assets by the identified coastal hazards this CHRMAP has employed risk analysis techniques outlined in AS 5334-2013 (Australian Standards Ltd, 2013), with some modifications.

This also report provides preliminary details of risk management and adaptation options (Elements 6 in Figure 1-1) which will be undertaken as part of the next phase of work.

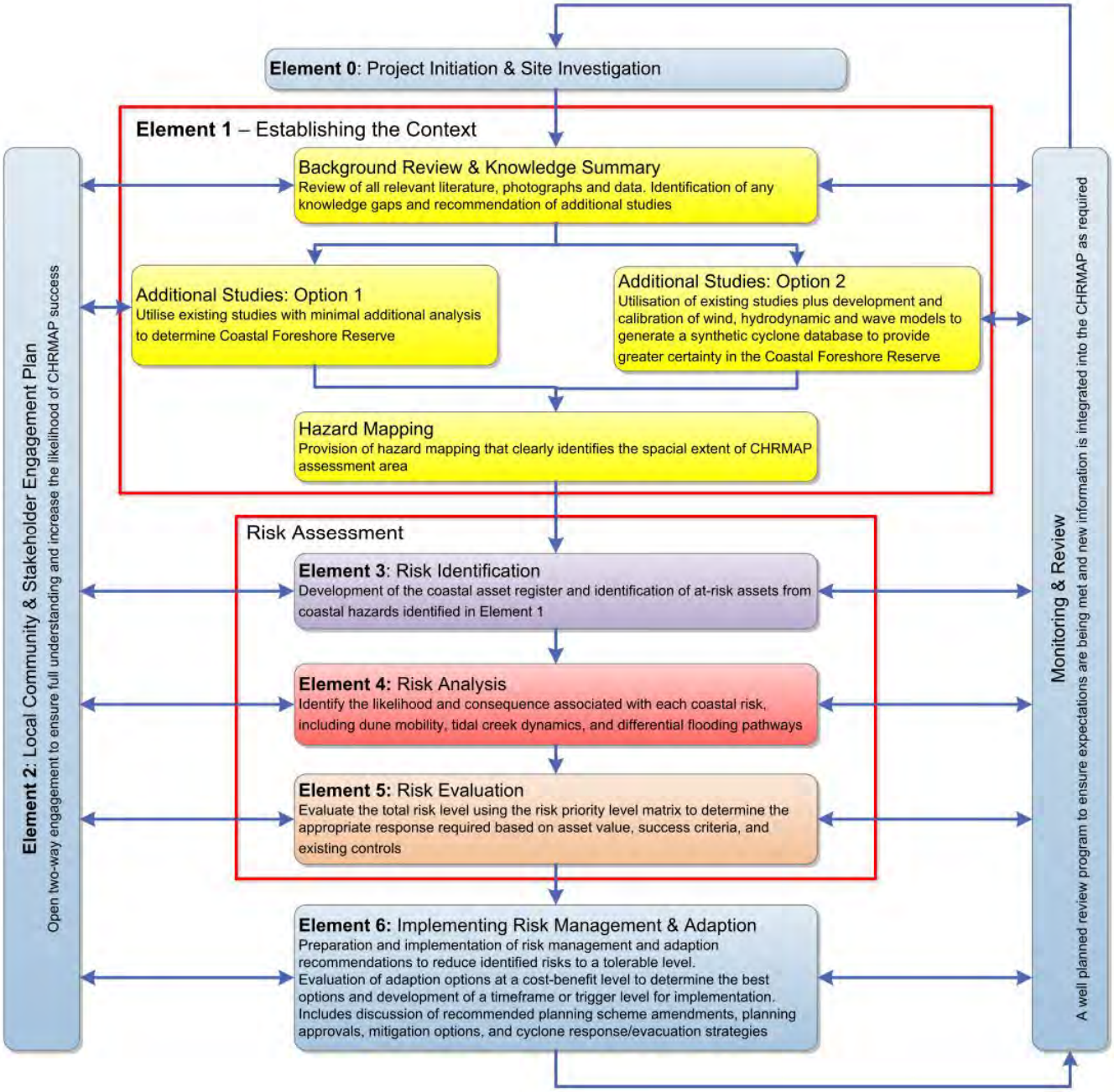

Figure 1-1 CHRMAP methodology flow chart for the Onslow coast (adapted from WAPC CHRMAP Guidelines, 2014)

2 Risk Identification

The coastal hazard maps for the various extreme events and future time horizons were overlain on the town cadastre and assets maps to identify the assets within the predicted hazard zones. Assets were identified to be at risk of coastal erosion and inundation and/or fluvial inundation. Complete details of the risk identification undertaken for the CHRMAP process are provided in the Key Issues Paper (Cardno, 2016b). The process involved the identification and classification of all key assets within the study area. The vulnerability of these assets to coastal processes, such as erosion and inundation, was predicted through a range of modelling techniques. Consultation with the community and key stakeholders was undertaken in conjunction with this process to define the success criteria, to help guide and prioritise risk management options.

2.1 Asset Identification

The identification of physical assets and areas with economic, social/cultural and environmental value, potentially at risk within the study area, involved the following steps:

- Initiation and site visit: General overview of town layout and assets therein. Provision by the Shire of existing spatial asset data;
- Stakeholder engagement: Collection of data on assets and areas seen as important by key stakeholders, including the general community; and
- Further asset capture and classification: Cardno engaged sub-consultants Talis to catalogue, classify and assess the condition of assets within the study area.

An asset inventory was delivered to the Shire in GIS and MS Excel format (Figure 2-1). This report presents only those assets identified as potentially at risk over the planning timeframes (present day, 2040, 2070 and 2110).

Figure 2-1 Physical assets identified within the study area, generally classified by their primary purpose

2.2 Success Criteria

The community and stakeholder engagement undertaken to date has been used to establish the spatial, social, and economic context of the CHRMAP. The stakeholder values were mapped according to the following categories:

- Recreational;
- Commercial;
- Environmental;
- Historic / heritage;
- Physical infrastructure; and
- Aboriginal cultural significance.

Feedback and data collected through stakeholder engagement was used to define the success criteria for the CHRMAP, which will guide the assessment of management options. These criteria are as follows:

- Maintenance of the foreshore;
- Protection and enhancement of the local economy;
- Well maintained community structures;
- Year round accessibility to Onslow via Onslow Road (noting The Onslow Ring Road has been completed and now provides this functionality)

- Realistic and sustainable strategies;
- Sustaining and enhancing natural environmental values;
- Strategy not reliant on building heights;
- Not prohibitive of future development; and
- Year round accessibility to the foreshore (as was the case historically).

These criteria ranged in importance from 24 responses to 3 responses. Whilst all of these success criteria will be considered during the CHRMAP process, it should be noted that not all may be realistically achievable. Preference will be given to higher ranked criteria.

2.3 Vulnerability Assessment

Further to the asset identification process, the vulnerability of the assets or areas of importance were determined in relation to the erosion or inundation hazards.

The coastal processes and fluvial (pluvial) flooding affect different areas of the coast through different impact pathways. Here we categorise the key impact pathways due to coastal erosion and inundation either by ocean storm surge flooding from the sea or rainfall runoff from the catchment flooding the town.

This study is primarily focused on the coastal aspects and fluvial (and pluvial) flooding issues are assessed to a broad level of sufficient detail for theses long-term planning purposes. The Shire is commissioning additional, more detailed flood modelling to assist with the mitigation of the current flood risks within the Town.

2.3.1 Coastal Erosion and Inundation

Coastal process hazard lines were overlain on a map of the study area to determine the identified assets and areas at risk for each of the planning timeframes (Present day, 2040, 2070, 2110). The assets and areas identified, and the planning timeframe in which they are predicted to first be at risk, are provided in Table 2-1. The risk assessment has defined either specific items of infrastructure, collections of co-located assets, areas of importance (i.e. based on stakeholder values) or collections of similar low-value assets within hazard zones. This has allowed each asset, group of assets or area to be assessed in its own right.

Table 2-1 Assets predicted to be at risk from coastal process hazards and the vulnerability timeframe's

Timeframe	Assets At Risk	Value
Present Day	• On-ground infrastructure at Onslow Jetty • Onslow Back Beach picnic area (low risk) • Front Beach / Sunrise Beach • Seawall (the setback allowed for in this section mainly consists of the uncertainty factor required as per SPP2.6)	• Commercial • Aboriginal • Public infrastructure • Recreational • Environmental
2040	• Seaview Drive near 12 Mile Creek / 4 Mile Beach • Assets adjacent to crest of seawall (bins, shade structures, benches) • Shire of Ashburton Offices at the intersection of Second Ave and McGrath Rd • Aboriginal community on Second Ave	• Public infrastructure • Recreational • Commercial • Aboriginal
2070	• Western half of Ian Donald Blair Memorial Walkway	• Recreational • Public infrastructure
2110	• Intersection of Seaview Drive and Back Beach Road • Eastern end of Ian Donald Blair Memorial Walkway • Lot 381 (at the top of the hill at Beadon Point) • Second Ave	• Public infrastructure • Recreational • Residential

2.3.2 Fluvial Inundation

Fluvial inundation within the study area is extensive due to the flat, low lying terrain, with the majority of the town's assets exposed to some flooding in the most extreme scenarios. Because of the large number of assets affected by flooding and the uncertainty about the scale of the impacts, a more general approach has been selected to assess the risks of fluvial inundation. The risk identification assesses the total number of assets affected by a flooding as a percentage of the overall number of assets registered. The type of asset is not considered in this identification but is factored into the risk analysis.

The total count of assets affected by inundation hazards over the various planning horizons and event recurrence frequency are presented in Table 2-2.

Table 2-2 Assets present in 2015 predicted to be at risk from future inundation hazards

Planning Horizons & ARI Event	Affected Assets	Assets Not Affected	Total Assets	Percentage Affected
Present Day 100 Year	259	277	536	48%
2040 100 Year	282	254	536	53%
2070 100 Year	286	250	536	53%
2110 100 Year	373	163	536	70%
Present Day 500 Year	327	208	536	61%
2040 500 Year	352	182	536	66%
2070 500 Year	395	117	536	74%
2110 500 Year	447	84	536	83%

3 Risk Analysis

The Risk Analysis (Element 4 in Figure 1-1) aims to develop an understanding of each risk based on likelihood of the risk occurring and the potential consequences. This provides the basis for the risk evaluation (Element 5 in Figure 1-1).

As discussed in Section 2, different approaches have been adopted to analyse the risks of coastal erosion and inundation and the risk of fluvial inundation. Assets or groups of assets are assessed individually for the risk of coastal impacts, while a more general risk to asset types is analysed for fluvial inundation.

3.1 Likelihood

According to WAPC (2014) and for the purposes of this study, likelihood is defined as the chance of erosion and storm surge inundation occurring or how often they might impact on the existing and future assets and their values. There are two main components that need to be considered when determining likelihood of a risk occurring: the frequency of the event (storm or large waves) and the probability of the event occurring over a given time (WAPC 2014).

Often the Annual Exceedance Probability (AEP) or its inverse, the Average Recurrence Interval (ARI) is used to assess the likelihood of an event occurring (as with the example provided in the CHRMAP guidelines). This assumes that the probability of a coastal hazard event occurring is the same each year. This is not necessarily the case when considering the effects of climate change and the increase in sea level rise over time, which underpins the future planning scenarios assessed in this study. The notion also implies that impacts such as erosion will be event based, occurring over short time periods with long lasting effects. While this is often the case, erosion also occurs gradually over long time periods and this is likely to be associated with a rising sea-level.

Assessment of likelihood has, therefore, been based on the probability of a coastal process hazard impacting an asset or group of assets, over the given planning period. The likelihood scale applied is presented in Table 3-1.

Table 3-1 Likelihood scale

Rating	Likelihood	Probability
Almost Certain	It is very likely that the hazard will impact the asset during the timeframe	80-100% probability of occurring over the timeframe
Likely	It is likely that the hazard will impact the asset during the timeframe	60-80% probability of occurring over the timeframe
Possible	It is as likely as not that the hazard will impact the asset during the timeframe	40-60% probability of occurring over the timeframe
Unlikely	It is unlikely that the hazard will impact the asset during the timeframe	20-40% probability of occurring over the timeframe
Rare	It is very unlikely that the hazard will impact the asset during the timeframe	0-20% probability of occurring over the timeframe

3.1.1 Coastal Erosion and Inundation

The likelihood of erosion and coastal inundation events impacting each of the assets or groups of assets for each planning timeframe has been determined and is presented in Table 3-2. This assessment is based on the coastal process setback lines, but has also factored in coastal engineering understanding about coastal processes and how the setback lines are derived.

Table 3-2 Likelihood of assets being affected by coastal erosion and inundation at Onslow

Vulnerability Timeframe	Asset[1]	Planning Timeframe			
		Present Day	2040	2070	2110
2015	On-ground infrastructure at Onslow Jetty	Unlikely	Likely	Almost Certain	Almost Certain
	Onslow Back Beach picnic area	Possible	Likely	Almost Certain	Almost Certain
	Front Beach / Sunrise Beach	Possible	Likely	Almost Certain	Almost Certain
	Seawall	Possible	Likely	Almost Certain	Almost Certain
2040	Seaview Drive near 12 Mile Creek / 4 Mile Beach	Rare	Rare	Unlikely	Possible
	Assets adjacent to crest of seawall (bins, shade structures, benches)	Rare	Unlikely	Possible	Likely
	Shire of Ashburton Offices at the intersection of Second Ave & McGrath Rd	Rare	Unlikely	Likely	Almost Certain
	Aboriginal community on Second Ave	Rare	Unlikely	Likely	Almost Certain
2070	Western half of Ian Donald Blair Memorial Walkway	Rare	Unlikely	Likely	Almost Certain
2110	Intersection of Seaview Drive and Back Beach Road	Rare	Possible	Likely	Almost Certain
	Eastern end of Ian Donald Blair Memorial Walkway	Rare	Rare	Unlikely	Possible
	Lot 381 (at the top of the hill at Beadon Point).	Rare	Rare	Unlikely	Possible
	Second Ave	Possible	Likely	Almost Certain	Almost Certain

[1] Assets are listed at first impact horizon only and assumed to remain impacted at future time horizons

3.1.2 Fluvial Inundation

The likelihoods of assets being affected by fluvial inundation (Table 2-2) have been broadly categorised to allow a general assessment of the consequences, this is further described in Section 3.2. For inundation, the percentage of assets affected for each future scenario has been directly translated to the probability scale (Table 3-1). This provides a very general likelihood that any one asset might be influenced by flooding for a particular scenario (see Table 3-3). Obviously certain assets will be more prone to inundation than others due to location and topography within the predicted inundation zone. To assess each asset individually would require more detailed investigation of the assets susceptibility to flooding including assessment of floor levels and quantity surveying. As this is beyond the scope of this assessment, this more general approach has been applied.

Table 3-3 Likelihood timescale for assets vulnerable to fluvial inundation in Onslow

Asset Type		Planning Timeframe			
		Present Day	2040	2070	2110
100 yr ARI		48%[2]	53%	53%	70%
	Housing, Buildings & Property	Possible	Possible	Possible	Likely
	Parks & Recreation Grounds	Possible	Possible	Possible	Likely
	Public Infrastructure (fencing, light poles, playgrounds etc)	Possible	Possible	Possible	Likely
	Car parks	Possible	Possible	Possible	Likely

	Roads/Footpaths	Possible	Possible	Possible	Likely
	Sheds	Possible	Possible	Possible	Likely
500 yr ARI		**61%**	**66%**	**74%**	**83%**
	Housing, Buildings & Property	Likely	Likely	Likely	Almost Certain
	Parks & Recreation Grounds	Likely	Likely	Likely	Almost Certain
	Public Infrastructure (fencing, light poles, playgrounds etc)	Likely	Likely	Likely	Almost Certain
	Car parks	Likely	Likely	Likely	Almost Certain
	Roads/Footpaths	Likely	Likely	Likely	Almost Certain
	Sheds	Likely	Likely	Likely	Almost Certain

[2]Percentage of assets affected by inundation (Table 2-2)

3.2 Consequence

WAPC (2014) defines consequences as the impact of erosion and storm surge inundation occurring to the existing assets in the future, taking into consideration the asset value. A consequence rating considers the impact on the social, economic and environmental value of the asset. Additionally, the adaptive capacity and vulnerability of an asset are also considered when determining its consequence rating. Consequence ratings for this study are given in Table 3-4, which are derived from AS 5334-2013.

This assessment assumes that the present day (2015) assets are exposed to the future hazard without any intervention or risk mitigation implementation in the future.

The effect of coastal erosion and fluvial inundation should be assessed separately as their impacts on a given asset are different. Coastal erosion typically causes permanent damage, such as the undercutting and collapsing of foreshore infrastructure. Inundation, however, may result in the short term flooding of an asset but it may maintain its use once flooding subsided.

Table 3-4 Consequence ratings (based on AS 5334-2013)

Rating	Social	Economic	Environment
Catastrophic	Loss of life and serious injury. Large long-term or permanent loss of services, employment wellbeing, finances or culture (e.g. > 75% of community affected), international loss, no suitable alternative sites exist.	Permanent loss or damage to property, plant and equipment, finances >$5 million	Permanent loss of flora and fauna (no chance of recovery) with national impact.
Major	Serious injury. Medium term disruption to services, employment wellbeing, finances or culture (e.g. < 50% of community affected), national loss, very limited suitable alternative sites exist.	Permanent loss or damage to property, plant and equipment, finances > $2 - $5 million	Long-term loss of flora and fauna (limited chance of recovery) with regional impact.
Moderate	Minor injury. Major short term or minor long-term disruption to services, employment wellbeing, finances or culture (e.g. < 25% of community affected), regional loss, limited suitable alternative sites exist.	Permanent loss or damage to property, plant and equipment, finances > $100,000 - $2 million	Medium-term loss of flora and fauna (recovery likely) with regional impact.
Minor	Small to medium disruption to services, employment wellbeing, finances or culture (e.g. < 10% of community affected), local loss, many suitable alternative sites exist.	Permanent loss or damage to property, plant and equipment, finances > $10,000 - $100,000	Short-term loss of flora and fauna (strong recovery) with local impact.
Insignificant	Minimal short term inconveniences to services, employment, wellbeing, finances or culture (e.g. < 5% of community affected), neighbourhood loss, many alternative sites exist.	Permanent loss or damage to property, plant and equipment, finances < $10,000	Negligible to no loss of flora and fauna (strong recovery) with local impact.

3.2.1 Coastal Erosion and Inundation

In general, the consequence of erosion on a particular asset is fixed, regardless of the timeframe. This is the case for the consequences defined for many of the assets listed in Table 3-5. In cases where a set of assets have been grouped for assessment, the consequence may change over various timeframes, if more of the assets within the group are expected to be affected as the coastal hazard advances. For example, various public assets adjacent to the seawall have been grouped, and are expected to be impacted at varying timeframes due to varied distance from the shoreline. The case is similar for areas such as beaches, which might display some loss of beach over shorter timeframes, compared to complete or substantial beach loss over longer timeframes – a more severe consequence.

Table 3-5 Consequence ratings for assets vulnerable to coastal erosion in Onslow over time

Vulnerability Timeframe	Asset	Consequence of Erosion			
		Present Day	2040	2070	2110
2015	On-ground infrastructure at Onslow Jetty	Insignificant	Moderate	Moderate	Major
	Onslow Back Beach picnic area	Insignificant	Minor	Moderate	Moderate
	Front Beach / Sunrise Beach	Insignificant	Minor	Moderate	Major
	Seawall	Insignificant	Minor	Moderate	Major
2040	Seaview Drive near 12 Mile Creek / 4 Mile Beach	Major	Major	Major	Major
	Assets adjacent to crest of seawall (bins, shade structures, benches)	Insignificant	Insignificant	Minor	Minor
	Shire of Ashburton Offices at the intersection of Second Ave and McGrath Rd	Major	Major	Major	Major
	Aboriginal community on Second Ave	Moderate	Moderate	Major	Major
2070	Western half of Ian Donald Blair Memorial Walkway	Minor	Minor	Minor	Minor
2110	Intersection of Seaview Drive and Back Beach Road	Moderate	Moderate	Moderate	Moderate
	Eastern end of Ian Donald Blair Memorial Walkway	Minor	Minor	Minor	Minor
	Lot 381 (at the top of the hill at Beadon Point)	Moderate	Moderate	Moderate	Moderate
	Second Ave	Moderate	Moderate	Moderate	Moderate

3.2.2 Fluvial Inundation

More severe consequences into the future due to more extreme events and future higher sea-levels are likely to retard present day drainage patterns resulting in higher flood levels and longer ponding times. Present day infrequent events will become more frequent in future. This is reflected in the consequences defined in Table 3-6, with higher consequence ratings for the second half of the century, under the assumption that drainage infrastructure is not upgraded.

Table 3-6 Consequence ratings for assets vulnerable to fluvial inundation in Onslow over time

Asset Type		Planning Timeframe			
100 yr ARI		Present Day	2040	2070	2110
	Housing, Buildings & Property	Moderate	Moderate	Major	Major
	Parks & Recreation Grounds	Insignificant	Insignificant	Minor	Minor
	Public Infrastructure (fencing, light poles, playgrounds etc)	Insignificant	Insignificant	Minor	Minor

	Car parks	Insignificant	Insignificant	Minor	Minor
	Roads/footpaths	Minor	Minor	Moderate	Moderate
	Sheds	Insignificant	Insignificant	Minor	Minor
500 yr ARI					
	Housing, Buildings & Property	Moderate	Moderate	Major	Major
	Parks & Recreation Grounds	Insignificant	Insignificant	Minor	Minor
	Public Infrastructure (fencing, light poles, playgrounds etc)	Insignificant	Insignificant	Minor	Minor
	Car parks	Insignificant	Insignificant	Minor	Minor
	Roads/footpaths	Minor	Minor	Moderate	Moderate
	Sheds	Insignificant	Insignificant	Minor	Minor

4 Risk Evaluation

The risk evaluation and ranking process utilises the outcomes of the risk analysis process. The likelihood and consequence defined for assets, under each scenario, are combined to derive a risk level. The risk level for each combination is presented in the Risk Priority Matrix (Table 4-1), taken from the CHRMAP guidelines (WAPC, 2014).

Table 4-1 Risk Priority Matrix (adapted from WAPC 2014)

Likelihood	Consequences				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost Certain	H	H	E	E	E
Likely	M	H	H	E	E
Possible	L	M	H	E	E
Unlikely	L	L	M	H	E
Rare	L	L	M	H	H

This risk level then guides the preliminary assessment of the risk acceptability and the urgency of required action (Table 4-2). This will help to prioritise multiple identified risks within the study area. The evaluation also provides a mechanism to compare the residual risk after a preferred adaptation option is theoretically implemented. For example, a present risk may be “extreme but after the implementation of an adaption option ‘X’ the risk level is re-evaluated and reduces to “medium”. This residual risk rating will be assessed in the next phase of work (Element 6 in Figure 1-1).

Table 4-2 Risk levels and tolerances (example from WAPC 2014)

Risk Level	Action Required	Acceptance/Tolerance
Extreme (E)	Immediate action required to eliminate or reduce risk to acceptable levels.	Unacceptable
High (H)	Immediate to short-term action required to eliminate or reduce risk to acceptable levels.	Tolerable / Unacceptable
Medium (M)	Short to medium term action to reduce risk to acceptable levels, or accept risk.	Tolerable
Low (L)	Accept risk.	Acceptable

4.2 Coastal Erosion

The risk level for each of the identified assets at risk due to coastal erosion and inundation, for each planning timeframe, has been assessed. The results of this assessment are presented in Table 4-3. There is a general increase in risk level over the planning timeframes with predicted sea level rise and the higher probability of an extreme event occurring or having occurred. These factors also increase the potential consequences of coastal impacts, compounding the overall risk levels.

Table 4-3 Risk levels for assets predicted to be under impact from coastal erosion under 2015 timeframe

Asset	Risk Level			
	Present Day	2040	2070	2110
On-ground infrastructure at Onslow Jetty	Low	High	Extreme	Extreme
Onslow Back Beach picnic area (low risk)	Low	High	Extreme	Extreme
Front Beach / Sunrise Beach	Low	High	Extreme	Extreme
Seawall	Low	High	Extreme	Extreme
Seaview Drive near 12 Mile Creek / 4 Mile Beach	High	High	High	Extreme
Assets adjacent to crest of seawall (bins, shade structures, benches)	Low	Low	Medium	High
Shire of Ashburton Offices at the intersection of Second Ave and McGrath Rd	High	High	Extreme	Extreme
Aboriginal community on Second Ave	Medium	Medium	Extreme	Extreme
Western half of Ian Donald Blair Memorial Walkway	Low	Low	High	High
Intersection of Seaview Drive and Back Beach Road	Medium	Medium	High	High
Eastern end of Ian Donald Blair Memorial Walkway	Low	Medium	High	High
Lot 381 (at the top of the hill at Beadon Point).	Medium	Medium	Medium	High
Second Ave	Medium	Medium	Medium	High

4.3 Fluvial Inundation

The risk ratings determined for each general asset group under the various planning timeframes and ARI rainfall events are presented in Table 4-4. Again we see a general increase in risk rating over the planning timeframes, as the intensity of rainfall events is predicted to increase.

Table 4-4 Risk levels for assets predicted to be under impact from inundation under 2015 timeframe

Asset Type	Planning Timeframe			
100 yr ARI	**Present Day**	**2040**	**2070**	**2110**
Housing, Buildings & Property	High	High	Extreme	Extreme
Parks & Recreation Grounds	Low	Low	Medium	High
Public Infrastructure (fencing, light poles, playgrounds etc.)	Low	Low	Medium	High
Car parks	Low	Low	Medium	High
Roads/footpaths	Medium	Medium	High	High
Sheds	Low	Low	Medium	High
500 yr ARI				
Housing, Buildings & Property	High	High	Extreme	Extreme
Parks & Recreation Grounds	Medium	Medium	High	High
Public Infrastructure (fencing, light poles, playgrounds etc.)	Medium	Medium	High	High
Car parks	Medium	Medium	High	High
Roads/footpaths	High	High	High	Extreme
Sheds	Medium	Medium	High	Extreme

4.4 Discussion

Risk Assessment Discussion Notes….this will need to be confirmed/updated once we are happy with the analysis and evaluation process:

- Style and inputs to the risk assessment. Where it has been tailored.
- Discussion around those assets that are at 'high' and 'extreme' risk, and their potential adaptive capacity and therefore vulnerability i.e. if they are built/fixed structures then a higher level of consideration needs to be given relative to those that are 'low'. Their adaptive capacity is limited, and vulnerability is increased.
- The risk of assets to coastal hazards needs to be reduced by implementing adaptation or mitigation strategies (risk management).

5 Risk Management Options

Planning for risk adaption or treatment involves the identification, development and evaluation of options suitable for mitigating the potential impacts of each coastal hazard that requires treatment, as determined in the risk assessment process.

In this CHRMAP the identified risk management and adaption options will be assessed against numerous criteria to evaluate which option or combination of options will be the most suitable. The criteria include:

- Potential benefits;
- Effectiveness;
- Costs, both initial and ongoing – this combines with other criteria to give an idea of economic effectiveness and cost-benefit;
- Equity implications;
- Potential risk creation and negative environmental effects;
- Practicality;
- Reversibility / Adaptability;
- Implementation timing;
- Design life; and
- Acceptance (community, stakeholders, regulators).

While cost-benefit criteria will be important, some criteria are difficult to quantify, so all criteria will be included in the overall analysis (often referred to as multi-criteria analysis, or MCA).

Risk management options should also be assessed in terms of their restriction on future planning and risk management opportunities. Options that allow for a wide range of future strategies are considered more favourably. State Planning Policy No.2.6 (2013) utilises this philosophy, recommending adaptation planning on a preferential basis of avoid, managed retreat, accommodate and protect (Figure 5-1).

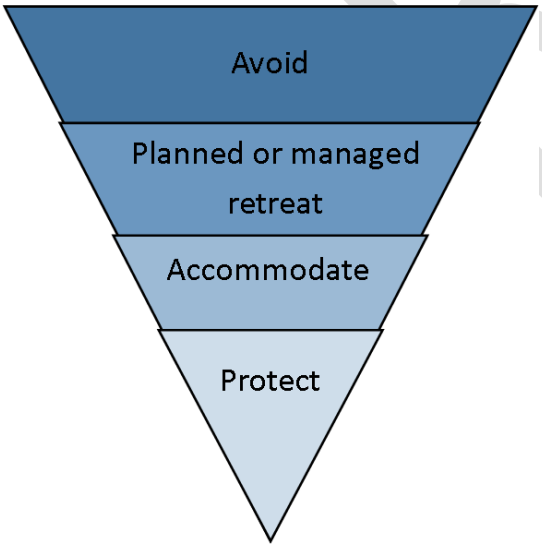

Figure 5-1 WAPC preferential planning hierarchy

Adaptation planning is a somewhat cyclical process, moving through assessment of the preferred options until suitable mitigation is achieved. The CHRMAP management and adaptation plan employs the following steps:

- Determine possible adaptation options for each risk;

- From this list, select at least one option, if possible more, using the preferential basis described above;
- Evaluate whether the selection or selections mitigate the identified risk to a tolerable or acceptable level;
- If necessary, select another option and re-assess whether risks are tolerable; and
- Assess the effectiveness of the new adaptation option(s) compared with the identified success criteria.

5.2 Risk Management & Adaptation Options

The basic characteristics of the risk management and adaptation options relevant to the study area are discussed below. Risk management and adaption options aim to mitigate risk and vulnerability through one or more of the following actions:

- Avoiding the risk
- Removing the risk
- Changing the likelihood
- Changing the consequences
- Increasing adaptability
- Transferring or accepting the risk

'Avoid' and 'managed retreat' options are the preferred options for new and existing developments. 'Accommodate' options aim to re-design existing infrastructure to mitigate potential impacts as they occur. 'Accommodate' options may also be employed for new developments, when there is no practical option to avoid or retreat from coastal hazards. 'Protect' options are often considered the last line of defence and are the least favourable options. These options aim to protect an asset from coastal hazards by preventing the hazard from reaching the asset. They range from 'soft' options such as beach nourishment to hard structures such as seawalls. Hard protection options can potentially reduce beach amenity, can cause negative impacts to the adjacent coastline and are generally expensive.

Table 5-1 again outlines the assets at risk of coastal erosion and inundation within the study area, and allocates them a code for reference in Table 5-2 and further analysis. Table 5-2 proposes the various coastal hazard adaptation options for the Town to consider for implementation as part of Element 6 in Figure 1-1.

Table 5-1 Assets predicted to be at risk from coastal process hazards

Vulnerability Timeframe	Asset Code	Assets at Risk
Present Day		
	1	On-ground infrastructure at Onslow Jetty
	2	Onslow Back Beach picnic area
	3	Front Beach / Sunrise Beach
	4	Seawall
2040		
	5	Seaview Drive near 12 Mile Creek / 4 Mile Beach
	6	Assets adjacent to crest of seawall (bins, shade structures, benches)
	7	Shire of Ashburton Offices at the intersection of Second Ave and McGrath Rd
	8	Aboriginal community on Second Ave
2070		
	9	Western half of Ian Donald Blair Memorial Walkway
2110		

	10	Intersection of Seaview Drive and Back Beach Road
	11	Eastern end of Ian Donald Blair Memorial Walkway
	12	Lot 381 (at the top of the hill at Beadon Point).
	13	Second Ave

Table 5-2 Risk Management Options (adapted from WAPC, 2014)

Option Code	Option Category	Option Name	Description	Preliminary Considerations (MCA, CBA)	Potential Assets Affected[3]	Proposed Actions/Triggers
AV	Avoid	Avoid	Locating/re-locating assets outside of hazard zone	Financial resources will not be required for management and adaptation. Should be implemented wherever possible and practical, and considered every time an asset is repaired or renewed.	12	Significant investment
MR1	Managed Retreat	Accept and repair losses	Assets are left unprotected and loss is accepted following hazard event. Repairs may be implemented for public safety, and asset is retreated outside hazard zone, or in the case of beaches/vegetation, as natural recession occurs.	Save the financial resource for better use. Usually applied to low value assets. Viable where available land allows retreat to maintain beach width.	2, 3, 5, 6, 9, 10, 11, 13	Undertake economic and safety assessment to determine which assets should be left on an economic and safety basis. Repair or remove after hazard results in damage.
MR2	Managed Retreat	Relocate outside of hazard zone	Assets located in the hazard zone are relocated or destroyed. Applied to assets of low value where it is impractical to re-design to withstand hazard impacts.	Allows low value assets to be retained until such time as relocation is necessary. Often coincides with asset replacement, which enables cost of relocation to be shared with cost of replacement, reducing overall cost in present and future planning.	2, 5, 6, 7, 8, 9, 10, 11, 12, 13	Design for lifecycles and expected risk, then monitor. Move low value structure when 'at risk'.
MR3	Managed Retreat	Prohibit further development	Allows continued use of the current infrastructure until such time that impacts arise, but prohibits the development of further infrastructure as the area/asset is known to be vulnerable	Foreshore reserve seaward of the 2110 hazard line should remain council land, thus significant economic development should be prohibited so as not to limit future adaptation options.	1, 7, 8, 10, 12, 13	Potentially maintain all land seaward of the 2110 coastal hazard line as Shire land.
AC1	Accommodate	Notification on title	Indicates to current and future landholders that an asset is likely to be affected by coastal hazards over the planning timeframe. Helps owners to make informed decisions about level of risk they are/may be willing to accept and that risk management and adaptation is likely to be required at some stage.	This option allows vulnerability of an asset to hazards to be conveyed to existing and future owners. One means of implementing that is low coast, is through decision making for subdivision and development.	7, 8, 12	
AC2	Accommodate	Emergency plans and controls	Implement plans for asset that are at risk of coastal erosion due to severe weather. Have procedures in place for before, during and after the events for safety.	This has low financial cost and with a high benefit to public safety. Does not benefit to the asset itself, but increased safety reduces the overall consequences of the	1, 7, 9, 10, 11, 12, 13	Develop practical plans, if haven't already done so.

Option Code	Option Category	Option Name	Description	Preliminary Considerations (MCA, CBA)	Potential Assets Affected[3]	Proposed Actions/Triggers
			E.g. signage barrier to prevent access.	hazard.		Implement upon severe weather warnings.
AC3	Accommodate	Re-design to withstand impact	Where avoiding or relocating are not an option, re-design to withstand impacts e.g…….	Retains existing assets in locations but reduces consequences of hazards. High principle cost, low ongoing costs. Results in extended design life.	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	Significant investment inside the coastal hazard zone.
AC4	Accommodate	Dune care program	Development of a long term program for revegetation and rehabilitation of the dune system.	Low principle and ongoing costs. Small increase in adaptive capacity through some additional buffering. May slow long term recession.	2, 5, 6, 7, 8, 9, 10, 11, 12, 13	Implement now and monitor throughout lifetime
PR1	Protect	Beach Nourishment or Replenishment	Replacement of sand on upper beach face and dunes to re-establish the sandy beach and provide a sediment supply. Generally utilised in conjunction with other methods for sand retention.	High ongoing costs, particularly if available sand is located at some distance. Available sand also needs to be suitable to destination conditions i.e. sand that is finer than existing may be lost more quickly.	3, 5, 6, 7, 8, 12, 13	Investigate potential sand sources. Undertake when erosion threatens significant assets, but before situation is critical.
PR2	Protect	Seawall	Construct small seawall in front of asset or along length of coastline to protect it from coastal hazards. This may need to be accompanied by beach replenishment/renourishment.	High initial cost. Change nature and appearance of coast. Protect land (and associated assets), not the beach itself, thus needs to be accompanied by renourishment/replenishment, which adds to ongoing costs.	2, 5, 6, 7, 8, 10, 12, 13	Most economic if included in original design. Investigate seawall only if absolutely necessary.
PR3	Protect	Groyne	Construct shore normal groynes along the beach to capture sediment and protect the shoreline and assets behind.	Very high initial costs. Effective if designed properly. Can result in significant ongoing costs and negative environmental impacts in adjacent areas due to the high variability of longshore sediment transport. Reduces beach amenity.	3, 5, 6, 7, 8,	Monitor and investigate if absolutely necessary.
DN	Do Nothing	No prohibitions or development regulations	No limitations on development or controls on adaptation planning. Assumes all risks are accepted at their present level.	No initial cost, but potentially very large costs in the future. May lead to increased development and thus future costs when hazards occur whilst also restricting option for future mitigation or retreat. Not recommended.	All	Implement now.

[3] See Figure 5-1

5.3 Discussion

Planning timeframes need to be considered when considering adaptation options. Assets will need to be monitored over time and potentially no action taken until the risk level becomes intolerable. Relocation can occur as part of future town planning schemes.

General notes:

- On-ground jetty infrastructure: ownership/responsibility
- Onslow Back Beach picnic area: (MR1)
- Front Beach/Sunrise Beach: high initial adaptive capacity
- Existing seawall: determine actual extent of seawall and potentially upgrade (AC2) as this protects Second Ave and Shire Offices etc.
- Seaview Drive near 12 Mile Creek/4 Mile Beach: monitor until such time as action is required, relocate (MR2)
- Assets adjacent to seawall: low value assets; accept loss and relocate or relocate before lost (MR2)
- Shire of Ashburton Offices (2nd Ave x McGrath rd): establish condition of existing seawall (PR2), relocate – has potentially already been relocated closer to town on second ave (MR2)
- Aboriginal Community: prohibit further development in that area (MR3), put in place emergency plans (AC1), protect by extending existing seawall (PR2)
- Western IDB Memorial Walkway: MR1-MR2, AC3
- Intersection Seaview Drive x Back Beach rd: monitor until such time as action is required, relocate (MR2)
- Eastern IDB Memorial Walkway: MR1-MR2, AC3
- Lot 381: Avoid new development (AV), design to withstand impacts (AC2)
- Second Ave: MR1-MR2, AC2, AC3

Element 6 of the study involves the Implementing Risk Management & Adaptation Plan (Figure 1-1). This will delve into which of the above options is best suited to the town site of Onslow under predicted coastal hazard situations.

6 Conclusions

7 References

Standards Australia Ltd, 2009, *Australian Standard Risk Management Principles and Guidelines*, AS/NZS ISO 31000:2009. Sydney, Australia

Cardno, 2016a, *CHRMAP for the Onslow Coast: Coastal Hazard Assessment.* Prepared for the Shire of Ashburton

Cardno, 2016b, *CHRMAP for the Onslow Coast: Key Issues Paper*. Prepared for the Shire of Ashburton

WAPC, 2013, *State Planning Policy No. 2.6: State Coastal Planning Policy*. Under the Planning and Development Act 2005. Western Australia

WAPC, 2014, *Coastal Hazard Risk Management and Adaptation Planning Guidelines*. Perth, Australia

Standards Australia Ltd, 2013, *Climate change adaptation for settlements and infrastructure – A risk based approach*, AS 5334-2013. Sydney, Australia

Client: Taylor Burrell Barnett

Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Draft report	V1	HL	SSh	Electronic	30 June 2016
Final report	V2	HL	SSh	Electronic	16 November 2016

Essential Environmental
land & water solutions
622 Newcastle St Leederville 6007
p: 08 9328 4663 | f: 08 6316 1431
e: info@essentialenvironmental.com.au
www.essentialenvironmental.com.au

Plan ID	Type	Comment
1	Bus Only	
2	Time Limited	5 Minute. Driver to remain with their vehicle.
3	Taxi	
4	No Stopping	Authorized people only
5	Disabled	

Overview

Legend

Parking Zones

- Bus Only
- Disabled Bay
- Taxi Bay
- Time Limited Parking
- No Stopping

Onslow Airport Parking Controls Onslow 5

shire of Ashburton
reef to range

SCALE = 1:750

10 0 10 20 30 40 m

Datum: GDA 94 Map Grid Australia Zone 50

CREATED 10/11/2017 CAD File Ref: K:\CAD (General Files)\CAD\16-17 Job Files\170101\170101 Parking Control.qgs

LOCAL LAWS

DA09-3 PARKING AND PARKING FACILITIES LOCAL LAW – AUTHORISED PERSONS

Function to be performed: *This text is provided as a reference only. Delegates shall only act in full understanding of the delegated statutory power, inclusive of conditions [see below].*	A local government may, in writing, appoint persons or classes of persons to be delegated for the purpose of performing particular functions.
Legislative Power or duty delegation:	Powers of the local government as prescribed in the Parking and Parking Facilities Local Law.
Legislative power to delegate:	Section 9.10 of the Local Government Act 1995
Delegation to:	Chief Executive Officer
Delegation:	The Chief Executive Officer is authorised to appoint persons or classes of persons to be authorised for the purpose of performing particular functions, subject to Section 9.10 of the Local Government Act 1995.
Conditions and Exceptions:	The appointment of authorised persons, as nominated below, is to relate to those functions of an authorised person under Section 1.4 of the Parking and Parking Facilities Local Law 2013.
CEO authorises:	~~Director Infrastructure Services~~ ~~Director Corporate Services~~ ~~Director Development and Regulatory Services~~ ~~Manager, Environmental Health~~ All Directors All Rangers
Authorisation by the CEO:	The CEO authorises to the above Officers the exercise of this authorisation power as listed.
Reporting Requirements:	• The authorisations are to be in writing and recorded in Synergy under the appropriate File Number record to meet legislative requirements (including the personnel file). • A copy of the written authorisation and Delegation Form CEO 078 must be recorded in Synergy File GV01.17
Details of Review:	11 December 2013 16 July 2014 15 July 2015 19 July 2015 18 July 2017 21 November 2017

Premier of Western Australia

Our reference: 59-016275/NC
Your ref: RD.RIO.1

Mr Dale Stewart
A/Chief Executive Officer
Shire of Ashburton
soa@ashburton.wa.gov.au

Dear Mr Stewart

Thank you for your letter dated 15 June 2017 regarding Tom Price Road and a Tom Price Royal Flying Doctor Service (RFDS) airstrip. I am aware that you have also written to the Hon Rita Saffioti MLA, Minister for Transport and the Hon Alannah MacTiernan MLC, Minister for Regional Development.

I am advised that Minister Saffioti has met with you and Councillor Kerry White, Shire President, to discuss the proposal to develop a Tom Price RFDS airstrip. From this discussion it was identified that the issue of ownership and need for ongoing funding to maintain the proposed airstrip were significant impediments to progressing this proposal in the near future. On this basis, the current airstrip proposal is recommended to be postponed and reconsidered again in the 2020-21 financial year.

Main Roads Western Australia thanks the Shire of Ashburton for its funding commitment to Karratha Tom Price Road. The funds will be utilised for geotechnical and hydrology surveying, as well as heritage and design aspects of the works. Road designs from preliminary works that the Shire has available to share will be appreciated and accepted.

While sealing the entire length of road would be ideal in order to get the most benefits, this will be subject to funding.

The Transport portfolio looks forward to working together with the Shire and the City of Karratha on the project.

Yours sincerely

Mark McGowan MLA
PREMIER
19 JUL 2017

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Royal Flying Doctor Service
WESTERN OPERATIONS

Corporate Office

27 February 2015

Our ref: ac1733

Mr Troy Davis
Executive Manager Infrastructure Services
Shire of Ashburton
PO Box 567
Tom Price WA 6751

Dear Sir/Madam

PROPOSED TOM PRICE AIRSTRIP

RFDS supports the proposal for an airstrip to be built in the Tom Price locality.

We support the airstrip for the following reasons:

1. Duty and care to our staff and the voluntary ambulance officers in reducing the need to travel to Paraburdoo

2. It will also reduce the pilot duty time and reduce the incidence of fatigue associated with the length of time it is required to drive from Tom Price to Paraburdoo and return.

Yours sincerely

Capt. Michael Bleus OAM
Chief Pilot
RFDS Western Operations

SHIRE OF ASHBURTON

Administration Centre. P.O. Box 567, Tom Price, 6751
Telephone (08) 9188 4444
Facsimile (08) 9189 2252
Email: soa@ashburton.wa.gov.au

Enquiries: Michelle Tovey
Our Ref: TR.AT.01.06/File no.

All communications to be
addressed to Chief Executive Officer

4 June 2014

Mr John Barrett
Level 8, The Quadrant
1 William Street
Perth WA 6000

Dear Mr Barrett

Proposed Tom Price Royal Flying Doctor Service Airstrip

The Shire of Ashburton (the "Shire") is seeking in principle support from Rio Tinto for the progression of the proposed Royal Flying Doctor Service ("RFDS") Airstrip in Tom Price. In addition to this, the Shire is also seeking information pertaining to land access and survey data as outlined below.

Land Access:

Following previous discussions between Rio Tinto and the Shire, it is proposed that the airstrip is located 16 kilometres north of Tom Price within Miscellaneous licence L47/206 for aerodrome purposes and the underlying Hamersley Pastoral Station Lease L3114 1277, which are both held by Hamersley Iron Pty Ltd (see figure below).

The Shire is seeking confirmation that Rio Tinto is still agreeable with this arrangement, and furthermore is seeking guidance on Rio Tinto's preferred land tenure arrangements should this project proceed. The status of Native Title over the area covered by the proposed new airstrip is another important matter the Shire is seeking information and guidance on from Rio Tinto.

Figure 1: Location of the proposed RFDS Airstrip near Tom Price

Data Release:

The Shire of Ashburton is also requesting the provision of any information or survey data that Rio Tinto holds in relation to the site including;

- Topographical;
- Geotechnical;
- Hydrological;
- Environmental; and
- Heritage.

This information would be considered commercial in confidence and only utilised for this project.

Please contact Michelle Tovey, Project and Technical Support Officer, on 9188 4432 or michelle.tovey@ashburton.wa.gov.au should you require further information relating to this request.

Yours sincerely,

Troy Davis
Executive Manager Infrastructure Services

SHIRE OF ASHBURTON

Administration Centre. P.O. Box 567, Tom Price, 6751
Telephone (08) 9188 4444
Facsimile (08) 9189 2252
Email: soa@ashburton.wa.gov.au

Enquiries: Michelle Tovey
Our Ref: 1431594/TR.AT.01.06
All communications to be
addressed to Chief Executive Officer

22/01/2015

Mr Greg Finch
Rio Tinto Iron Ore
Accommodation and Towns Development
152-158 St George's Terrace
Perth WA 6000

Dear Mr Finch

REQUEST FOR IN-PRINCIPLE SUPPORT FOR THE TOM PRICE ROYAL FLYING DOCTORS SERVICE AIRSTRIP

Following initial discussions, including a letter dated 4 June 2014 outlining land access and data release requests, the Shire of Ashburton issued Rio Tinto Iron Ore (RTIO) with a Project Brief for the proposed RFDS airstrip at Tom Price on 11 July 2014. As RTIO provided no formal comment on the matter, the Shire sought a meeting with RTIO.

Troy Davis and Andrew Harvey met Greg Finch and John Barrett at HQ Management offices in Perth on 16 October 2014. At the meeting, Shire of Ashburton reiterated the extent of consultation and documentation undertaken in support of demand analysis. HQ Management has previously had productive discussions with Stephen Langford, Director of Medical Services, RFDS and Michael Bleus, an RFDS pilot, in order to understand operational issues. Both were supportive of a new RFDS airstrip at Tom Price.

In October 2012 the Shire of Ashburton Council supported the establishment of an RFDS strip, and a decision was passed for a business case to be developed and funding sought. Technical reports were completed and a schematic design and cost estimate provided to Council. The current business plan reviewed the likely demands for the airstrip and updated the cost estimate report.

The Shire remains committed to the development of a new RFDS airstrip in Tom Price, as demonstrated through the citing of the project as an 'immediate priority' in the Community Strategic Plan and inclusion in the 2013-2017 Corporate Business Plan as a strategic capital project to be 'actively pursued'.

Rio Tinto indicated to the Shire of Ashburton that to enable it to progress discussions regarding the approval of an RFDS airstrip on RTIO leased land north of Tom Price, RTIO would need additional information including;

- Aerodrome Management Services (AMS) report including schematic plan of airstrip proposal (attached);

- Proposed clearance area polygons in CAD format (attached); and
- Letter of support from RFDS for the proposal (to be provided).

The Shire wishes to commit to an agreed process to provide RTIO with the information it needs to gain internal support for the airstrip. Similarly, the Shire wishes to progress through its business planning in the knowledge that the process will identify critical issues to be resolved and enable the Shire to make clear financial and contractual commitments to deliver the airstrip to the community.

Accordingly, RTIO is requested to agree in principle to the following approach:

- RTIO to provide formal comments on the Shire report, tabled 16 October (attached);
- RTIO to provide comment on the nature of any identified issues with the location as described in the clearance polygons.

The Shire respectfully requests RTIO's agreement in principle to this approach, and we look forward to advancing this important community project.

Yours sincerely

pp

Troy Davis
EXECUTIVE MANAGER INFRASTRUCTURE SERVICES

Enc: Aerodrome Management Services (AMS) report
Proposed clearance area polygons in CAD format
Business Case "New Royal Flying Doctor Service Airstrip For Tom Price"

CC: John Barrett, Rio Tinto Iron Ore
Andrew Harvey, HQ Management